The development of a sustainable construction design process.

Thesis submitted in accordance with the requirements

of the University of Liverpool for the

degree of Doctor in Philosophy by Ruth Michelle Sutton

8th May 2019

DECLARATION

I hereby certify that this dissertation constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions or writings of another.

I declare that the dissertation describes original work that has not previously been presented for the award of any other degree of any institution.

Signed,

Ruth Michelle Sutton

ABSTRACT

The construction industry uses large volumes of physical resource and employs many. Yet its performance often falls short of expectations. Increasing demand for their products to be sustainable requires a radical change in methods employed. Prefabricated construction has been adopted at times of constrained resources. As such it may be able to meet sustainability expectations. However, using this type of design without changing the industries methods will not be enough. Systematic design methods have led to large improvement in the car and electrical product industries and may be able to support change in construction.

The research developed a systematic design process, for use with prefabricated construction. The method was adapted to ensure sustainability requirements were considered during the early design stages by incorporating them into the design process at the product specification.

The adapted method was applied to a building outline and the sustainability of the design solutions were compared to a traditional construction method. In the case study the best performing solution had the design with open timber framed panels, using the largest panel size, without a structural frame. The design tools used were shown to improve the users understanding of the design space and creating possible solutions. The tools included social issues that were poorly addressed elsewhere.

The tool improved some aspects of the building's sustainability but additional tools or redefining some of the functional requirements would be required to fully address whole life sustainability. To improve accuracy the tool would benefit from comprehensive LCA databases for use in the early stages of the design process. Such a database would have value across the industry. The industry should also focus on the development of better relationship along the supply chain.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisors Dr Tim Short and Prof Steve Jones who between them have helped me to make it this far. They have guided me throughout my studies with patience and immense knowledge. Their support has been invaluable.

Many thanks to the project busines sponsor, Ric Frankland, without whom there would not be a project. His continuous striving to improve his product, to achieve a sustainable building led to many valuable conversations and ideas.

The project and my participation was made possible by European Regional Development Funding. I am grateful to have worked alongside many talented researchers within the Centre for Global Eco-Innovation.

Last but not the least, I would like to thank everyone in my home life. To many friends who have been their for me, including Chris for his technical support, and Gill and Helen who offered wise and witty counsel. Finally, those most important to me. To Phil, without whom I wouldn’t have made it to the end, and to my Mum who showed me the importance of perseverance.

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1 INTRODUCTION

1.1 BACKGROUND

We are living through the Anthropocene. While not formally adopted as a geological epoch, the Anthropocene has been defined as the period over which “many geologically significant conditions and processes are profoundly altered by human activities” (Crutzen 2002). The atmosphere, hydrosphere, biosphere and geosphere have been changed and these changes can be identified in the geological record. Increasingly, these changes are causing alarm. The hole in the ozone layer, acid rain and climate change, all result from anthropogenic activity. These environmental changes have been caused by “our progress”.

An increased quality of life has resulted in the increased consumption of natural resources which have led to these changes. However, these benefits have not been universal; inequality exists both within the United Kingdom and across nations.

Free market economics states that the price of everything is determined by the balance of supply and demand. Businesses can exploit inequality or act to reduce it. They have the capacity to close the gap between the rich and poor, or to cement it open, making it more difficult to change.

Sustainability in the business context addresses the challenges of social, environmental and economic impact of its activities. Many businesses are considering the sustainability of their activities, driven by legislation and customer demand. This research addresses the sustainability of small scale houses builders in the United Kingdom.

Housing is considered a universal right (Article 25, (United Kingdom 1998). However, in the United Kingdom, there is a “housing crisis”. House prices and rents mean that many are spending a larger proportion of their income than ever before; homelessness and the number living in inadequate housing is increasing. One solution is to provide new housing. Yet, in 2017/2018, only 222,000 houses were completed; despite Government estimates that an annual output between 240,000 and 340,000 is required (House of Commons Library (UK) 2018). If increased volumes of new housing are to be achieved, then changes to how the construction industry acts are necessary.

Increasing the adoption of “mass produced modular components” is among the proposed innovations for the construction industry to improve housing output (House of Commons Library (UK) 2018). Prefabricated commercial construction has been shown to offer better quality, lower cost and improved reliability, and potential improvements in the sustainability of the industry follows.

While meeting the social need, increases in new housing will lead to the increased use of resources. The construction industry uses more than 400 million tonnes of material per annum (Office for National Statistics 2012). Increasing this by a further 10% to meet target construction rates would add at least an additional 40 million tonnes of material use. However, in traditional construction, between 20% of designed volume (Barrett and Wiedmann 2007) and 40% (Building Research Establishment 2013) is waste material and addressing this would reduce the additional impact. Offsite methods are expected to reduce waste volumes to approximately 10% of total materials (Smith 2013), a saving at least 44 million tonnes of materials each year across the whole industry.

Application of offsite methods would also achieve improved working conditions. In traditional construction, many jobs are low skilled and insecure. Business models adopted require significant workforce flexibility, so many staff are employed on casual contracts. Offsite manufacture enables businesses to stabilise production rates and so offer more secure job roles for the labour force.

Finally, moving construction away from site reduces the risk of injury. Traditional construction is hazardous (Wright 2015) and offsite processes are widely considered to represent lower risk (Blismas et al. 2006, Fard et al. 2017, Pan et al. 2012) . These issues give a small insight into the sustainable improvements which are expected from prefabrication.

This report addresses the need to improve the sustainability of housing construction. Addressing prefabricated methods, which have been identified as offering improved quality, cost and program reliability, a tool for use by design teams to develop sustainable construction methods will be created.

1.2 Research Aims

1.2.1 Aim

The aim of this research is to produce a construction method to reduce negative impacts of the construction of housing to social, economic and environmental resources.

It is proposed that the methods described as engineering design are appropriate for use in construction, and should improve the sustainability of the design, manufacture and assembly of prefabricated housing construction.

1.2.2 Primary Research Question

How should systematic engineering design methods be adapted to produce more sustainable of residential construction?

1.2.3 Secondary research questions

1) What are the sustainability issues affecting housing construction?
2) Are there parallels between car manufacture and housing construction which enable the systematic design method to be applied to construction?
3) How should the systematic design method be adjusted for use in prefabricated construction design? This adapted method will be the Sustainable Construction Design Process (SCDP).
4) Does the new SCDP improve the sustainability of the construction method?
5) How can sustainability be ensured using the SCDP?

1.3 Scope

1.3.1 Outline

This research addresses the development of sustainable prefabricated housing. It explores how engineering design tools can be adapted for use to improve sustainability of housing construction.

1.3.2 Design decisions

The SCDP is for use by a developer or an architect designing the small scale production of residential properties. It focuses on the manufacture and assembly of the structure and fabric of the building. The installation of services, such as plumbing, electrics and ethernet are not included in the assessment.

The research focuses on the building fabric, its manufacture and assembly in the factory and onsite. The outline design places the building into the context of its geographical environment, site conditions and planning conditions and describes the approximate size, form, internal layout and glazing areas of the building. The design process begins once this layout has been established.

The SCDP is for use during the early stages of a project as described by (Pahl et al. 1988) when the power to influence impacts is at its greatest. Although the SCDP does not include design decisions for the outline building, it should be used concurrently.

The tool addresses decisions that have little or no consequential impact on the customer. The decisions addressed are material choices, component sizes and the degree of offsite manufacture. The exception to this has been the cladding choice which will have an aesthetic impact on the outside of the building. Cladding choice has been included in the tool because the different cladding options are installed using very different methods. The impact of the installation is affected by the combination of the cladding choice and the construction methods.

1.3.3 Case study

The SCDP developed was tested using a case study. The case study compared the sustainability of a traditional construction method with that of the design solutions developed using the SCDP. The case study is based in the United Kingdom, using a British company which produces houses for the United Kingdom market.

The design method is appropriate for use anywhere; however, design must be developed in accordance with local regulations. The SCDP tool was developed for use in the UK. Data for the sustainability assessment was taken from a variety of sources. Where possible the database used was for the United Kingdom, however, for some of the environmental impacts for the material European data was used.

1.3.4 Sustainability

The research looked at sustainable issues from a broad, shallow perspective. Where, other work was shown to identify single issues and focus on optimising the design to achieve best performance, this research addressed several issues and identified optimal solutions.

Sustainability was determined in the context of construction in the United Kingdom. The relative importance of the sustainability issues were determined by the business owner.

1.4 Thesis layout & summary of chapters

The research was undertaken in a number of stages following the secondary research questions. First, a literature review was undertaken to understand the state of the art, this is presented in Chapter 2. Then, a methodology for the design process, assessment and decision making was developed, as described in Chapter 3. The results of the experimental research are presented in Chapter 4, and finally the discussion and conclusion draw together all of the research and looks at the effectiveness of the research to meet its aims, in Chapters 5 and 6.

Table 1: Thesis Structure

Chapter 1 Introduction	This chapter gives the background to the research explaining wider context of the problem. It also describes the the scope of the research and sumarises the contents.
Chapter 2 Literature Review	The literature review describes the state of the art for the main themes of the research. The current understanding of sustainability in the context of housing construction is presented with a particular focus on prefabricated housing. Product design methods used in indutrial design is described and the degree to which similar tools have entered the construction industry is described. The research problem is stated, based on the results of the literture review.
Chapter 3 Method	The chapter describes the methods used in the research. It explain why the methods are appropriate in this context. It describes the product design method and the tools chosen to develop the contruction process. It goes onto explain how the sustainability of the solutions are assesed using a life cycle method.
Chapter 4 Results	The results chapter describes the application of the sustainable construction design tool to a case study to test the effectiveneess of the method.
Chapter 5 Discussion	The discussion section considers the methods applied within the research and the succes of the appliation of the enginnering design method apporach in the context of prefabricted construction. The discussion describes how the tool fits within the existing range of design tools available to the industry and describes the benefits achieved through use of the new SCDP in the early design phases. The devlopment of the tool disucusses focussing on the adaption of exisitng systematic method, particukalry the inclusion of sustainable requirements in the early stages. Presenting reccomendation for the industry and academia, it presents future reccomedations for research
Chapter 6 Conclusion	The conclusion summarises the finding of the research. It places the new knowledge in the context of the existing knowledge and shows how the new findings challenge the exisitng apporach.

2 LITERATURE REVIEW

2.1 INTRODUCTION

To meet the housing need in the United Kingdom, sustainable development requires that the need for large scale housing construction in the United Kingdom are balanced by the need to manage social, economic and environmental resources. The first section of this chapter explores the meaning of sustainability in the context of the construction industry.

It is important to address the impacts throughout the lifetime of the product if sustainability is to be achieved. Manufacturing has addressed lifetime impacts in the design of its products. The second section of the chapter describes how sustainability has been addressed. It describes the commonalities between manufacturing and construction and argues that they enable the transfer of methods from one discipline to another.

By adopting prefabricated construction, the processes from manufacturing can be applied to housing. The history of prefabricated construction is discussed and its successes and failures are identified in the third and fourth sections of this chapter. Current knowledge relating to the transfer of product design methods to housing construction, particularly prefabrication are explored and gaps in the current knowledge are identified.

Finally, the lessons from the literature review are brought together to summarise the state of the art, and to identify where knowledge is required to develop sustainable construction. The research aim is presented alongside research questions to shape the research process.

2.2 SUSTAINABILITY

2.2.1 Introduction

The problems with free market exploitation of resources are described in the "Tragedy of the Commons" (Hardin 1968); competitive advantage prevents business making sacrifices when limited resources are exploited by many, without any external controls. Legal instruments act to prevent excessive damage to environmental and social resources. For example environmentally, the Environmental Act (United Kingdom 1995) adopts a precautionary principle to prevent the pollution of land, air and soil from a range of chemicals.

Sustainability provides a framework to consider effects beyond the financial impact and the legal restraint of human activities. It encourages the widening of one's focus, from a single issue to the more complex combination of effects. From its conceptual beginnings in development economics, it is now widely used in business. While sustainability is now considered in more contexts than international development, the definition "meet(ing) the needs of current generations without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987) described in 'Our Common Future' remains powerful.

Weak sustainability is an anthropocentric approach that posits "man-made and natural capitals are ultimately substitutable" (Walton and Emmanuel 2010), so that a price can be placed on loss of amenity. Where resources are limited, cost will increase as resources become scarcer. This should lead to improved efficiency or substitution. However, critics of this approach assert that the market, or regulation is unable to manage this and the adoption of weak sustainability will lead to the over exploitation of some resources, so that they cannot recover.

There are limited and unlimited resources, and the earth has limited capacity to renew itself. These limits require strong sustainability, which ensures resource stocks are maintained or enhanced. The Triple Bottom Line (Elkington 1998) and the circular economy (Kirchner et al. 2017) address sustainability by creating relationships with resources that value and therefore account for the flows of resources at all stages of the product lifetime. This reflects the early thinking used by the Club of Rome (McCutcheon 1974) who used systems thinking to address how materials move through the geosphere.

The strong sustainability approach uses the "carrying capacity" of the system to understand what is sustainable (IUCN-UNEP-WWF 1991); it addresses the comparative impacts the of different activities on communities to ensure social equity is considered in a much broader global context (Walton, Emmanuel 2010).The strong sustainability approach ensures that all social and environmental impacts are positive, without any negative impacts (Robèrt et al. 2002).

2.2.2 Business sustainability

In the simple sense, a business provides a product or service to meet the customers' needs (Luttropp andLagerstedt 2006, Short et al. 2012)Luttropp and Lagerstedt. Business activities are driven by customer demand and this requires a well-functioning product, as "without customers prepared to pay for the function, and if companies cannot make a profit, there will be no market" (Luttropp and Lagerstedt 2006). It is often concluded that a business' economic wants are paramount. However, a sustainable business has responsibilities to additional stakeholders, and must identify the social, economic and environmental issues that affect local and global communities, now and in the future.

The triple bottom line expresses the need to take account of environmental and social impacts alongside the financial balances, Figure 1 (Elkington 1998). Others have suggested that resources such as technology, energy, enterprise and social values (Harder et al. 2013) are included. Here the original three are discussed.

Financially, businesses must maintain liquidity and be profitable to be viable;

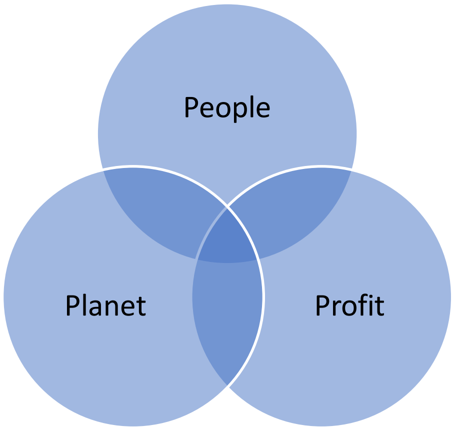


Figure 1: Triple bottom line. Adapted from (Elkington 1998)

failures can be catastrophic (Van Voorhis 2018). Changes required to become more sustainable will require investment in training, labour and equipment (Hasan et al. 2018). Return on investment will occur over the long term and as such phased approaches may be used.

Social capital measures “the ability of people to work together for common purposes in groups and organizations” (Elkington 1998). Poor behaviour, such as labour blacklisting (Pyper 2017), poor health and safety practices (Health and Safety Executive 2017), and labour exploitation (Cockbain and Brayley-Morris 2018) have been found to occur in the construction industry. Principles such as “trust, common meaning, diversity, capacity for learning and capacity for self-organization” (Missimer et al. 2010) should be considered. There has been limited focus on the social aspects of sustainability (Berardi 2011, Short 2008). That less heed is paid to social capital may be because it is a more nebulous concept, hard to measure and subjective (Grosskurth and Rotmans 2005).

Environmental sustainability addresses the impact of business activities on the water, air and biosphere. The extraction of virgin materials, the processing and manufacture, their treatment during their lifetime and final disposal as waste can result in the release of waste materials, the change of physical chemistry, interact with the ecosystems or deplete the original resource. Physical flows of materials and energy are accounted in order to measure the impacts.

Focusing on these capitals, key issues can be identified (Akadiri and Olomolaiye 2012, Basiago 1995)Akadiri and Olomolaiye. Business activities affect the capitals and business decisions determine the impacts. The challenge is to create the conditions which ensure sustainability.

2.2.3 Designing sustainably

A designer wanting to create a sustainable product must be aware of its impacts across its lifetime. As the designer cannot be expected to also be a specialist in sustainability, simple tools are required to assist them to assess whether they are appropriate (Ernawati et al. 2015, Lagerstedt, Luttropp 2006, Luttropp, Karlsson 2001, Short et al. 2012).

There are two main pathways to sustainable production for businesses. Sustainability can be treated as an evolving process with research, development and investment enabling improvements. While a company's initial offering may perform poorly with respect to some issues, the company may know that future development and investment would improve that performance. As such a product would have a number of sub-optimal phases before reaching the final production method, with investment enabling the next improvement to be initiated (Aschehoug and Boks 2013).

Alternatively a strong sustainability could be aimed for, which may increase the time to market for many products or even preventing some from being produced. By designing for eco-effectiveness, solutions using different principles can be achieved (McDonough and Braungart 2010). By understanding the wider stakeholders' needs, new types of products or solutions may be found, which, rather than minimising harm, create additional benefits (Aschehoug and Boks 2013).

2.2.3.1 Design tools

Tools to support the design process occur as frameworks, principles, guidelines and assessment methods. These enable designers to understand how their decisions affect the performance of the products across their required properties.

Frameworks describe the conditions in which the design occurs. They are unlikely to present numerical values and strict rules for adherence, but they describe a range of concepts for use by organisations or states to establish their own requirements. Examples include International Organization for Standardization (ISO) documents, British Standards and the UK Building Regulations, Factor Ten Engineering Principles (Lovins et al. 2010) and "12 principles of green engineering" (Anastas and Zimmerman 2003). Concepts such as "integrative design" and "whole systems thinking" and "solving many problems at once" (Lovins et al. 2010) address the framework in which the design process occurs.

Principles and guidelines sit within the framework and describe widely applicable rules. They describe design properties that should be considered and may be qualitative or semi quantitative. When used alongside the specification, they describe the design space in which the solutions lie. The principles are specific. They address the whole product impact; “the best designs are inherently sustainable”, “efficiency is vital” (Anastas and Zimmerman 2003), focus on elements of the product life or function “the end of life stage must be well managed” (Anastas and Zimmerman 2003), “Promote long life”, “Use as few joining elements as possible and use…according to lifecycle scenario(s)” (Luttropp and Lagerstedt 2006)

2.2.4 Life cycle assessment

2.2.4.1 Introduction

Well-developed life cycle methodologies are available for cost and environmental impacts. Social responsibility is addressed in ISO 26000 but focuses on business behaviour, not product design.

The life cycle assessment (LCA) is an auditing procedure which enables a business to understand the impact of processes on a range of conditions. ISO standards lay out specific methods to calculate life cycle impacts. For construction assessment, life cycle assessments are predominantly one of three types.

- A stand-alone method is undertaken by the manufacturer to provide a quantitative values to the impact of their product.
- Single materials are rarely used in construction, instead functional elements are constructed using several materials. The comparative method addresses element assemblies which perform the same function.
- A prospective assessment is used to understand the product and the relative impacts of the processes, material choices etc. This particularly useful when the product is in manufacture and real data can be collected.

2.2.4.2 Assessment method

The LCA process remains the same for each of the three types. In accordance with ISO 14040 (2006), the assessment comprises four phases as shown in Figure 2. The goal and scope frames the context of the assessment. It describes the purpose of the tool, indicating who will use the assessment results, and the level of detail required. A key element of the scope is the functional unit which describes the product assessed, and which phases of the product's lifetime are included.

The inventory analysis details all of the materials and processes included in the functional unit. The production and manufacture can be visualised as a flow chart showing materials and energy and waste entering and leaving the product system. It describes the data sources, and how impacts are distributed between multiple products and processes, if shared.

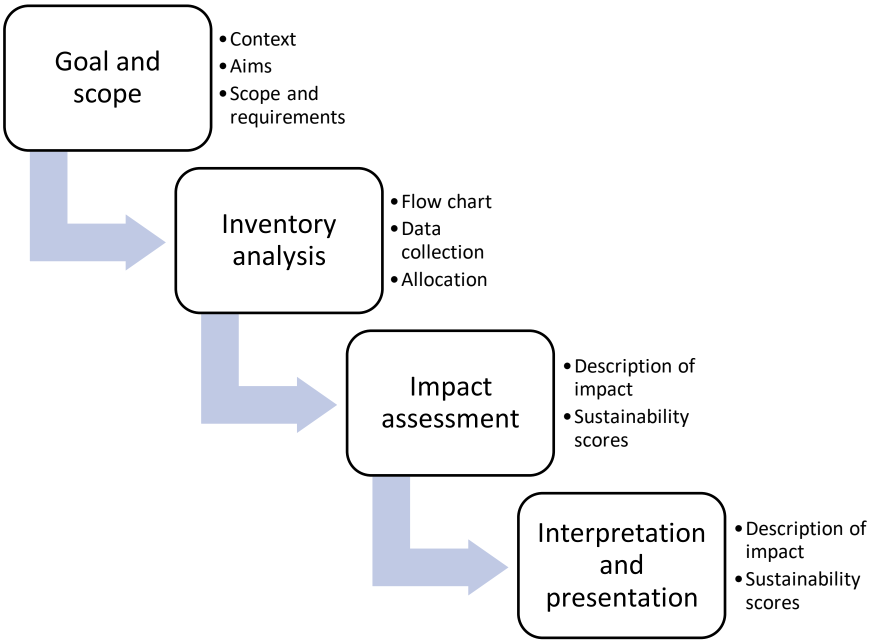


Figure 2: Stages of the life cycle assessment. Adapted from (Baumann et al. 2002)

The interpretation of the assessment occurs throughout the process as the data is collected and understanding is gained from the results as they become apparent. While ISO 14040 (2006) states that "there is no scientific basis for reducing the LCA to a single score", the design process has included a score to aid the critical review and simplify decision making for the user.

2.2.4.3 Summary

Sustainability describes a framework in which the current and future states of global resources can be understood. There are two ways to understand the total resource impact the first considers the value of all of the resources as a whole and allows for the interaction between the resources. The second see the resources as limited and treats the systems independently during assessment.

The next section describes the traditional construction industry, highlighting the issues which sustainable methods need to address.

2.3 HOUSING CONSTRUCTION INDUSTRY

2.3.1 Introduction

The influence of construction on our living environment is clear. Within any city centre, practically every surface has been constructed. In 2016, the value of output from the construction industry in the United Kingdom was £93,467 million and produced, maintained or demolished the built environment. Of this total, 33% was new housing (Department for Communities and Local Government 2017). This section explores housing construction with a focus on processes and decisions which affect its sustainability.

Research into construction is intermediate in maturity (Edmondson and McManus 2007) and exploratory studies have often adopted qualitative methods “to foster development of construction knowledge” (Fellows and Liu 2015). Questionnaires, interviews and workshops have been widely used to gather information about the sector (Yung et al. 2013). They provide valuable qualitative data about attitudes (Meehan and Bride 2015) and decision making (Rahman 2013) across the sector.

Numerical methods have been used for engineering design of components and elements, organisation of site work (Villoria Sáez et al. 2014), performance assessment using optimisation methods (Chardon et al. 2016, Islam et al. 2015), and energy performance (Hong et al. 2016) assess current performance. Proposed design tools have been validated using case study data (Gerth et al. 2013, Villoria Sáez et al. 2014).

2.3.2 Traditional construction

Construction is “a complex interplay of people, tools, equipment and materials coordinated by communication” (Radosavljevic and Bennett 2012). In traditional housing construction, a team of specialists work together to design and build a property. An architect is responsible for the building design, working directly with the client to understand the requirements. Structural, mechanical and service engineers, and quantity surveyors design a combination of systems which work together to offer the occupier a safe, comfortable environment.

Integrating each system into the single product, balancing conflicting needs, while also managing the programme and financial constraints is challenging (Pugh 1991). Increasing the role of the quantity surveyor, and removing decision making power from the building engineer has replaced design efficiency with cost reduction (Clarke and Wall 2000). By focusing on the management of financial aspects rather than on the construction process, opportunities for savings are missed (Sarhan and Fox 2013).

The construction of the building fabric and systems are often not considered until the building design has been completed and little design flexibility remains (Bell et al. 2010). By bringing together the construction team, including designers, engineers and the onsite contractors, at an early stage of the design, and treating the building as a large system, integrated solutions can be found (Lovins et al. 2010).

During traditional construction, work is mostly carried out in-situ onsite. Management of the workflow onsite is difficult. Assumptions about workflow creates difficulties managing the programme (Naoum 2016), wasting time and possibly leading to delays.

Onsite, the location of the workstation is fixed because the building is static, so the workforce must be mobile. Limited space means that only one team of subcontractors can work in an area at a time, requiring careful coordination (Koskela 2003). A team will complete their tasks and move on, allowing the next team to start their work. This sequencing of subcontractors can mean that completed work is damaged in order to carry out the next job. Bringing back the original team to complete the reworking would be costly, so the less skilled subcontractor, who caused the damage, fixes it, leading to reduced quality

(Wingfield et al. 2008). Reworking also requires additional materials. Reducing the amount of reworking is desirable.

The management of materials on site is vital to the site efficiency. The construction industry uses more than 400 million tonnes of material per annum (Office for National Statistics 2012). A traditional four bedroomed house is approximately 1778 tonnes of material (Cuéllar-Franca and Azapagic 2012). Waste material produced onsite is estimated to be between 20% of designed volume (Barrett and Wiedmann 2007) and 40% (Building Research Establishment 2009). As such, any reduction in waste would be significant.

Construction sites are hazardous, with vehicle movements, excavations and accessible heights and without intervention, the likelihood of accidents is high and the consequences potentially fatal. In 2015/16, there were 43 deaths in the construction industry, most caused by falls and vehicle collisions, the financial costs of work place injuries and sickness to the workers, company and country is estimated to be almost £1 billion (Wright 2015). The designer, contractor and workers all have legal duties to manage safety on site; however, too often risk assessments are undertaken too late in the design process, restricting actions available to reduce the risk and missing early opportunities to design out risk (The Royal Academy of Engineers 2003).

2.3.3 Construction innovation

Construction is a traditional industry and tends not to adopt innovation. Where change has occurred, it is often not through a paradigm shift, but by small changes in project management or product delivery (Monahan and Powell 2011).

Government reports into the construction industry have repeatedly identified offsite manufacture as an innovation to improve quality, lower cost and improve sustainability (Egan 1998, Latham 1994). Yet the industry has remained slow to change and reluctant to adopt new methods (Gann 1996). The most recent report, addressing the need for new housing construction has again repeated the need for need for companies to adopt offsite, stating that innovation has often been limited to commercial development (Science and Technology Select Comittee 2018).

2.3.4 Sustainable Design Tools / Sustainable construction

Much of the existing research is qualitative and develops our understanding of the motivations to be sustainable or the blockers to the adoption of new methods. Quantitative research often comprises the detailed assessment of particular solution types. Where research considers design decisions, the number of metrics affected by the design choices can be limited. Hester et al. (2018) compared the impact of design on embodied environmental impacts, operational energy and cost.

Research indicates that for sustainable construction to be effective that energy consumption, reuse/recycling of materials, construction and demolition waste management, effective legal and policy frameworks, long-term costs, efficient use of resources and environmental and economic design and awareness need to be addressed (Sfakianaki 2018). Issues affecting productivity are found to be material supply, supervision, design changes and external work conditions (ground and weather) (Hasan et al. 2018)

For improvements to be made, changes should be made to the design as well as the construction process. Legislation covers many aspects of the construction process and building design but it is focused on preventing damage and ensuring minimum standards. Tools to improve sustainability beyond minimum standards have been developed.

The building assessment tools are developed to “measure and define” buildings (Wallhagen et al. 2013), with each tool addressing the stakeholders needs. Sustainability design and assessment tools are available for construction e.g., and British Standard BS 8905 (British Standard 2011), LEED (Lee 2013) and BRE Green Print (Building Research Establishment 2013).

In 1996, the Building Research Establishment (BRE) introduced the Green Guide to Specification (Anderson, Shiers 2009) to support the selection of construction materials. It has been developed as a summary of life cycle assessment (LCA) data for a range of construction materials and element assemblies. The impacts considered are environmental impacts of materials, at all stages of the building lifetime. Materials and element are ranked between A*- E based on a weighted score of the LCA impacts.

Code for Sustainable Homes (CfSH) tool addressed energy use, site ecology, materials, waste and other factors; some with minimum performance standards (Department for Communities and Local Government 2010). The eight categories were energy and pollution, material and waste, the indoor environment and health and well-being, domestic water, site ecology and onsite management procedures. These categories focus on the in-use phase of the building but also include construction materials and site management. The site management activities category addresses the impact of building construction. Registration with the Considerate Constructors Scheme, gains credits. Audit and management systems are credited, such as waste management plans, and health and safety action plans. Previously, the CfSH assessment was legally required as part of the design process ; the requirement for this was removed in 2015.

In 2012, Green Print (Building Research Establishment 2013) was released; a design tool to encourage collaborative working towards the development of sustainable communities. The tool has a focus beyond the building and its immediate environs, and extends to community, transport, place making and business. While this tool works towards addressing social and economic issues, the scope is much greater than the impact of the buildings, addressing the lifetime of the development on the community.

Beyond project design, companies' sustainability aims are often outlined in the Corporate Social Responsibility documents (CSR) affecting behaviours and practices of the company; progress towards meeting their sustainability goals is assessed by key performance indicators (KPI). Guidance is offered by ISO 26000 (2010) and the areas covered should include the environment, human rights, labour practices, fair operating practices, consumer issues, community involvement and development.

Available building assessment tools cover many key sustainability issues; however, the scope of the tools is by the in-use stage of the building life with limited consideration given to the construction phase. The social responsibility of a business to the worker, customer and local and global community has been subject to limited attention by the designer (Short et al. 2012). Beyond the construction, whole life impact factors such as "flexibility, operations and maintenance" (Berardi 2011) are not addressed.

Where guidance is available it is presented as separate non-binding documents making decision making difficult. A tool that enables the impacts of design changes on many aspects of sustainability at the same time would be beneficial to the designer.

It is the application of the tools in the design process that governs their real value. Having tools and guidance which are not applied, or applied incorrectly reduces their effectiveness. Furthermore, when asked to estimate the cost of the factors there were large ranges in reported values, indicating either lack of knowledge of available options or the cost of implementing the designs (Essa, Fortune 2008).

Furthermore, the tools described offer targets and areas of focus for sustainable design but do not offer methods to optimise the design. As such, designers focus on achieving the highest scores at lowest cost rather than achieving maximum gains for all issues (Essa, Fortune 2008).

There has shown to be a need for innovation in construction, but that so far it is lacking. Other industries may offer analogues which should be explored to identify methods which would be innovative for construction.

2.4 Industrial Design

2.4.1 Introduction

The failure of traditional construction to develop the process and the product to improve sustainability has been established. Meanwhile, the car industry has embraced systematic design and lean production methods to become more efficient. Research has established that the similarities between house construction and car manufacturing could enable lessons to be transferred between industries. In this section, the car and the house, and the industries that produce them are compared in order to develop the focus of the research.

2.4.2 Car manufacture: from craft to lean

Manufacturing is a "system of production involving the concentration of materials, fixed capital and labour in one or more plants" (Gann 1996). By bringing many production processes together in a single location, a range of components can be produced and assembled into a product. Value is added to the product across a number of stages. The organisation of these stages has changed over time and differs across industries. Improvements in methods, materials and management have led to improved quality and reliability, and increased profitability.

Famously, mass production was introduced within the car industry by Ford, and later, the Japanese Toyota Production system enabled mass customisation. The history of car manufacturing is one of continuous development of tools and methods. Over time, production has moved from the work of a master craftsman and his apprentices to mass production and assembly lines, then to the automation of many processes.

Mass production was enabled when Ford introduced gauges as part of the manufacturing process. Consistency in size enabled pieces, which had previously been made to measure, to become interchangeable. This separated the component manufacture and component assembly tasks. A mechanical assembly line, separate to the manufacture of components, could be introduced because any one of a batch of prepared parts could be installed into a car. Furthermore, sub-modules could be pre-assembled before building them into the product (Womack and Jones 1990).

Vehicles were moved between work stations, which would be set up with the correct tools and parts to make assembly easy for the worker. The worker at the work station would repeat a smaller number of tasks; thereby, becoming specialised in those tasks, increasing their efficiency and quality. Ford achieved 88% improvements in "reduction in effort" between 1913 and 1914, from the introduction of the assembly line (Womack and Jones 1990).

In 1950, Eiji Toyoda visited the Ford Rouge plant, in Detroit, to learn from their manufacturing methods. At home in Japan, the family business produced trucks using craft methods. On returning to Japan, he adapted the methods to fit his business. While many of the ideas at Ford Rouge were valuable, the scale of production was much greater than in Japan; Toyota needed the machines to be more flexible (Womack and Jones 1990).

Today, the methods he developed are known as The Toyota Production System, a "system of production, based on the philosophy of total elimination of waste that seeks the utmost rationality in the way we make things" and is the basis of lean production (Womack and Jones 1990).

2.4.3 Comparison of construction and automotive manufacture

This section compares small scale construction with lean manufacturing. Within a small housing development, there may be a range of building products. Typically, a single construction method (e.g. brick and block, timber frame or structurally insulated panels across many sites) will be used across a development; however, design variations, such as knee walls and Juliet balconies, will occur across the product range. Lean manufacturing was developed to enable similar products to be manufactured while enabling some customisation and so is suitable for this purpose.

The car industry is process orientated and highly organised; the assembly line system is heavily supported by machinery and runs continuously. The assembly line describes one or more processes, which can be assessed to remove "waste", in terms of set up time, movement of materials, and stock among others. In contrast, the traditional construction industry is very labour intensive, result orientated and less formalised. In the initial stages, groundworks are at risk of being disrupted by weather conditions and unforeseen ground conditions. Building fabric, like cars, are made from materials with reliable properties designed by engineers using safety factors. As such, the fabric construction process could be more organised and process oriented. Removing the risk presented by groundworks from the construction timetable would enable greater confidence in the manufacturing programme.

Womack and Jones (1990) identified that the use of standardised interchangeable parts was key to improvements in the car industry. Since then, the same principles supported by improved automation have led to customisation. This enables the production of a wide range of products with little additional cost or effort. Brick and timber come in standard sizes and can be used to produce standardised products. However, there has been little development in the provision of customised products. Component preparation occurs onsite using craft methods, requiring labourers to measure and cut to fit in each location.

Factory production enables custom components to be delivered when required. Small scale production would use standard materials to produce their components, because the supply chain does not exist. However, this would require improved quality by the suppliers. It has been reported that for some products actual sizes can differ from specified sizes, for example, timber supplies can vary by several millimetres in length and depth from the catalogue description (Frankland R, Discussions about manufacturing constraints, 2013).

This greater quality control is paramount if expectations of increasing thermal performance, through fabric performance and greater air-tightness, are to be achieved (Lovell and Smith 2010). The degree of precision offered by factory methods is necessary to achieve this quality control no matter where the work takes place, whether on-site or off-site.

Components for the cars arrive “just in time” at the assembly line. Suppliers deliver parts in small batches so that the stock levels at the car manufacturing plant are kept low (Coronado Mondragon and Lyons 2008, Womack and Jones 1990). Onsite elements such as windows are ordered to measure; in the factory, the improved tolerance would allow them to be ordered using design values.

This greater knowledge over the process and the properties of the component enables them to be delivered in small batches, as required for just-in time-methods. Each car and building can be different to the last, but modularity makes making the variations simple.

Materials used in construction may be fragile. On site it is difficult to keep parts safe leading to high volumes of waste, and reworking. In a factory there are better opportunities to store the materials safely. Furthermore, on site, the components are often made to measure with low tolerances. This can require schedules to allow for a lead time between measurement and assembly. The better control of tolerances in the factory enables the components to be ordered in advance because they will fit.

The product offered by traditional construction is altered in order to optimise site layout and to meet local regulations and demand. In turn, the construction process varies using different materials, design variations and engineering solutions. Whilst, the specialisation of the worker in the factory is replicated to a degree on site, electricians, plumbers etc., the processes between products and site have quite significant amounts of variation. Unless a pallet of elements with common properties can be established, the degree of continuous improvement seen elsewhere will be difficult (Wingfield et al. 2008).

On a traditional site, tradespersons will move from property to property to complete work. Furthermore, this prevents the optimisation of the workstation layout. Toyoda researched how the car assembly travelled through the factory, and considered how often parts were delivered to the workstations and how they fitted when assembled. Improved efficiencies were achieved by concentrating on the actions that added value to the car, and removing the need for other "waste activities" (Ohno 1988, Womack and Jones 1990). On site the removal of waste activities from movement of materials and people is difficult; moving assembly work to the factory or to dedicated area on site would assist this process.

Similarly, factory methods have been optimised to minimise set up times, by addressing batch processing, and the number of preparation methods used. Trades moving between locations on site requires additional setting up and packing up time.

The size of the building is considered an issue by Gann (1996). However, modular construction is successful for aircraft and therefore benefits can be found in large scale projects. It is transportation that constrains the size of volumetric modules. More challenging is that buildings are erected in a wide range of locations; the limits on the module size affects the number of journeys required and thus the cost and the environmental impacts.

The consequences of products' end of life can significantly affect their total environmental impact. The recovery of materials at the end of the vehicles life depends on the recyclability of those materials, whether different materials can be separated. The plastic parts in a BMW vehicle were redesigned to allow for recovery and reuse and are now 90% (by weight) recyclable. Seventy five per cent (by weight) of the vehicle is recovered as metal and 15% (by weight) is recovered as thermo-plastics (Vandermerwe and Oliff 1991). Furthermore, BMW also recovers high value engine parts for refurbishment, selling them at 50-70% of the cost of a new part (Thierry et al. 1995).

The use of contractors, rather than a workforce employed on full-time permanent contracts, to complete work reduces the level of in-house training and the ability to achieve continuous improvement, as developed by Toyoda, in the Toyota Management System (Ohno 1988). Training in construction is, in general, lower than that within car manufacturing and the skills developed are focused on the management rather than workers onsite. With better retention of staff, training could be given to improve workmanship and reduce problems with incorrect installation.

2.4.4 Summary

The discussion focusses mostly on manufacture and assembly and as such applies to prefabricated housing unless stated.

As both the car and construction industries are focused on material transformation processes, there are similarities in their methods. As technically sophisticated products, cars and houses must be assembled correctly with few faults if they are to perform correctly. While the product size prevents buildings from being fully assembled off site, there are commonalties between the two industries and the potential for them to learn from each other.

Since Ford's production line was introduced, significant efficiency improvements have been made in manufacturing. Quality control and consistency are key to these improvements and must be the focus of efforts for construction. Factory production represents a better environment to manage processes than the construction site.

Prefabricated construction is a mature process, but has not been adopted as widely in the United Kingdom as in other countries. The Egan report referring to improvements in lean manufacturing, indicated that two options were available to the construction industry "…to ignore all of this the belief that construction is so unique that there are no lessons to be learned; or seek improvement through re-engineering construction, learning as much as possible from those who have done it elsewhere" (Egan 1998). This remain relevant today, understanding the key features of prefabrication and understanding why it has not been as popular will lead to methods to improve the design.

2.5 PREFABRICATED HOUSING

2.5.1 Introduction

The United Kingdom's housing construction industry appears to have difficulties reaping the full benefits of prefabrication, using it produces only 2-7% of all new build housing (Gann 1996, Hook and Stehn 2005, Steinhardt and Manley 2016). Other countries produce much greater proportions of new builds, e.g. Germany (9%) and Sweden (20%) using offsite methods (Steinhardt and Manley 2016).

2.5.2 History

Prefabrication has been used to build housing for over two centuries. British pioneers and colonialists heading out to the US, Africa and Australia, took the first flat packed houses, ready to assemble on arrival, with them (Smith 2010). By the early 20th Century, in the US, prefabricated homes were available to order from catalogues; the companies selling offered all the necessary parts for the construction alongside furniture and appliances. During and following the First and Second World Wars, the UK and the US governments funded schemes to develop the prefabricated housing methods needed to replace damaged homes and to house returning soldiers. UK councils continued using the methods into the following decades to build houses, maisonettes and tower blocks.

Initially, prefabrication was limited to preparing materials offsite so that only assembly was required for construction. Buildings were simple, timber structures with canvas, shingles or, later, corrugated steel for external surfaces (Smith 2010).

Post war housing used new materials. Factories which had been used to manufacture munitions were now for housing (Ross 2002). Traditional construction materials were also scarce but factories which had been used to produce ordnance were now redundant. The Dorlonco system which consisted of a light weight steel frame which could be assembled by unskilled labour. Metal laths were fixed to the external frame and the structure rendered with concrete. Internal linings were clinker block work and plastered on the internal face (Building Research Establishment 1987).

Arcon houses were made from a steel frame, with asbestos cement wall panels and roof panels and glass fibre insulation behind plaster board lining (Davies 2005). The government allocated £150 million for the provision of temporary housing and led a programme to develop new construction methods. Steel frames (ARCON), timber frame (Uni-Seco), precast concrete (Tarran) and aluminium (Aluminium) solutions were developed. The industry was not wholly convinced; one architect and author wrote…

"It is yet to be proved that such a conception [the prefabricated house] is an economic possibility. There are many difficulties to overcome, such as double handling of the basins and baths, damage to the units in transit and adjustments on site and the heavy overheads of factory production as opposed to the low overheads of a small builder."

(Anthony 1945)

Design of the buildings was driven by the availability of materials and skills. The products need to be available immediately and assembled quickly by low-skilled labour. While the design of the Arcon was refined through the construction lifetime, as the manufacturers gathered field data about the performance of the steel frame, tolerances were reported to be poor with steel skirting board hiding the gaps formed where floors and walls met (Davies 2005).

Manufacture of houses occurred in factories recommissioned from war activities. Lustron houses were built on moving assembly lines using automatic metal processing machinery (The Lustron Corporation 1950). High output was achievable with the AIROH design coming from the production line every 12 minutes (Davies 2005).

Failures identified were related to materials, labour, and lifespan. While some of the failures were the results of innovative methods, such as the poor understanding of concrete spalling and risks associated with asbestos, other failures occurred because innovators focussed on elements they felt were problematic.

The life span was limited because of the difficulty obtaining replacement parts, and the difficulty adapting buildings because of complicated structural design. The expected lifetime of the building means that if parts are proprietary, there is the risk that they will no longer be manufactured when needed because of aspects such as improved design, or loss of economies of scale.

Other failings included poor management of transport logistics. Transport is expensive when compared to materials in construction. Factory production mean that transport distances of building elements could be large.

Post war, construction of prefabricated housing has remained at a low level. Councils have adopted the method, hoping to benefit from the economies of scale they can create. Social housing tower blocks were produced using prefabrication methods in the 1960s. However, poor structural design was identified during a design review after an explosion led to significant collapse at Ronan Point, in 1968 (Davies 2005). Subsequently, all designs of large panel systems (LPS), above five storeys, were assessed and in many cases required strengthening (Davies 2005). Many of the LPS blocks still stand as social housing but many have problems with the fabric. Damp is often present, caused by condensation forming at cold bridges within the structure (BRE 2011). Design problems have become apparent over the 50 years that the buildings have stood.

2.5.3 Prefabricated design and construction

Pan et al. (2012) indicated that the traditional methods in the construction industry are more amenable to gradual evolution rather than radical alteration. However, as described above, fundamental design principles must be adopted in order to achieve the benefits of prefabricated methods. Through comparison of the industries, key elements of manufacturing have been identified to improve the construction process. Success of these elements in current prefabricated construction practice is assessed here, supported by the latest research. First, the organisation of the business is considered. Then the design is addressed, focussing on the fundamental elements in the preparation and assembly of components in a factory setting. The use of modular and customised elements in order to enable product variation while minimising cost is discussed.

Firstly, management are found to be reluctant to change and the risks of adoption are perceived as greater than the expected benefits (Nadim and Goulding 2010) indicating that lack of awareness of the benefits, recognised decades ago (Egan 1998, Latham 1994) remains. This lack of awareness has led to a lack of skills. Skills are required at all levels including contract managers, supply chain, onsite design teams (Wesz et al. 2018) and in the factory (Banihashemi et al. 2018, Said et al. 2017).

Companies which manage both onsite and offsite processes have been shown to be successful (Jonsson and Rudberg 2014), in part, because they take ownership of the industrial design process.

Often, prefabrication is treated as a new technology and then adopted at construction stage (Jonsson and Rudberg 2014, Pan and Sidwell 2011, Pan et al. 2012). Where, the decision to adopt prefabrication is made at manufacturing stage, building designers have been prevented from integrating well established principles, such as standardisation, mass production, interchangeability and flow, into the design (Gann 1996, Jonssonand Rudberg 2014, Pan et al. 2012, Smith 2011, Sparksman et al. 1999). These principles require significant change in design approach from traditional methods (Koskela 1992).

Standardisation is the creation of panels and elements which are repeatable, either through common dimensions or the use of identical interfaces. The build up of components to create modules is shown in Figure 3 and definitions are provided in Table 2. Cutting machines have accurate scales for preparing component sizes this reduces the amount of work required to measure and fit parts, as seen in traditional methods (Gann 1996). Mass production results from standardisation and allows the improved efficiency of manufacture because waste is minimised and setup costs are shared across many units (Gann 1996, Smith 2011).

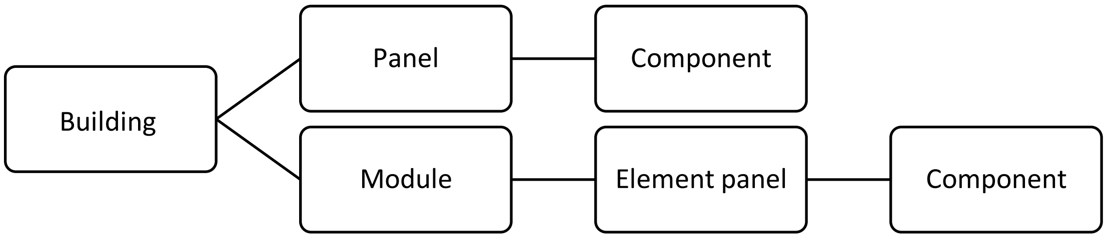


Figure 3: The constituent parts of a prefabricated building. TOP : Panel assembly. Bottom: Volume assembly

Table 2: Definition of parts in prefabricated construction.

Unit	Composition	Description
Material	One material	Material as supplied to factory or site
Component	Single material	Prepared for assembly
Panel	Built from components	Performs a variety of functions
Element	Built from panels and/or components	Performs function within the building
Module	Built from several elements	Combination of several element
Building	Built from elements or modules	Fully assembled product

Interchangeability evolved from standardisation, enabling many of the benefits of standardisation to be maintained, while increasing variation across products. It is achieved by using similar designs across a range of modules, by maintaining interface design, material type, connectors etc. but allowing variation by adopting a modular approach to the design.

Traditional construction was focused on transformation, breaking down the work into tasks and managing these to minimise cost. Koskela (2003) argued that flow and value must join transformation in order to gain the improvements that the industry has been looking for.

The benefits of moving construction processes to the factory are limited unless the design effort addressing the component design is accompanied by focus placed on the manufacturing processes.

Standardisation and interchangeability are often viewed with caution by designers, who see them as restricting the capacity for product customisation. This is supported by (Said et al. 2017) who showed that total fabrication cost and design flexibility behaved in conflict during panel design.

By moving production inside a factory, the work processes can be managed more easily. Time lost onsite due to poor weather is avoided, improving certainty of cost and timescales (Gibb and Isack 2003). Quality assurance checks that would be difficult to complete onsite can be designed into the process; and as long as assembly on site is not complicated by offsite design , there will be improvements to quality (Gibb and Isack 2003).

Work stations can be set up allowing work to be undertaken at a comfortable height with easy access to where the work is required (Gann 1996, Smith 2010). Teams can be more easily managed such that conflicts for space are avoided (Ohno 1988, Womack and Jones 1990). Work can be easily organised so that “break and fix up” can be avoided (Smith 2010). These lead to improved quality and improved timescales.

The benefits of prefabrication, detailed above, are most often related to cost, quality and time. The improvements that lead to these benefits also provide positive sustainability benefits.

Prefabricated methods reduce labour costs through several mechanisms. Firstly, by stabilising the workflow, a permanent team can be employed which reduces human resources expenditure. The improved safety, produced by reducing the time spent onsite, reduces time lost to sickness. These improvements result in social benefits, producing greater security in employment for the labour force, and reducing the level of health and safety risks that they are exposed to.

Improved quality is the result of having standardisation and greater control of the process in the factory environment. Standardisation reduces the amount of component reworking and the factory environment reduces reworking required because of accidental damage. The reduction in reworking reduces material use, which leads to reduce the embodied environmental costs. Banihashemi et al. (2018) showed how parametric design could be used with modular coordination to minimise waste. Shewchuk and Guo (2012) addressed panel stacking during transport.

Improvements in construction time, primarily results from having works occurring concurrently onsite and within the factory. By reducing the work occurring concurrently on site, there is reduction in health and safety risk onsite because there are fewer activities which must negotiate each other. Within the factory, workflow has been addressed using optimisation techniques (Li et al. 2017, Wesz et al. 2018).

The research covers a wide range of parameters but only addresses their relationships in discrete couplings. Widening the scope so that the relationship between different areas of design decision-making can be explored as required.

2.6 The Research problem

Large scale production of housing is required to meet current demand. However, it has been shown that the increase in production could lead to negative impacts on sustainability. Methods to reduce the negative impacts are required.

The literature compared prefabricated construction with manufactured products, particularly from the car industry. While differences were observed, similar product features and design processes were evident. The similarities between the construction industry and car industry suggest that lessons from the car industry could be transferable.

The car industry has addressed many issues within its manufacturing process by improving the design process. It is proposed that systematic design tools, which have led to large improvements to the car industry, could be adapted for use in construction design. Improvements achieved by systematic design, include reductions in materials, decreased energy demand to manufacture the product and reduced waste.

Prefabricated construction brings construction closer to the car industry in terms of the manufacturing process. The literature review described the potential for prefabricated construction methods to provide sustainable housing. Prefabricated construction has previously been used to meet demand in periods of resource and economic scarcity. Presently, prefabricated methods for housing have not been as successful or widely adopted as expected.

Jin et al. (2018) identified areas of prefabricated construction research which required attention; the research question addresses two of the needs by focusing on integrating Design for Manufacture and Assembly (DfMA and sustainability into prefabricated building and the creation of a wider evaluation system of the construction performance.

Whole life design tools to ensure the sustainability of construction have been shown to be limited with design tools having a greater focus on the in-use stage. While the in-use phase of the building lifetime has a greater impact, the designer has greater control over decisions and impacts produced during construction, and so the design stage should receive careful attention. Furthermore, construction phase decisions affect the global supply chain, and the workforce; if the construction phase is not considered then these stakeholders are ignored and the consequences can be fatal.

Tools, available to support the sustainable construction, focus on the overall development characteristics, and where construction stages is considered, they are suited to traditional onsite methods.

A new tool for use in the early design stages of building design is required and is the focus of this research. The tool assists decision making during the design of prefabricated production of housing. The tool focuses on whole life impact of manufacture and assembly, by choices such as material, component design and structure.

2.6.1 Research targets

Based on the literature review the research addressed the use of engineering design methods in construction, with the aim of improving sustainability. This research extended previous work by incorporating a wider range of sustainability issues into the single design tool, the SCDP. It also addressed a broader range of design parameters.

Other tools address the in-use stage of the building lifetime. This tool focuses on the construction process. It looks at the development of a single building, and works at the component level of decision making.

The application of the adjusted design method was used to create a range of solutions. These solutions were assessed for their sustainability. The research expresses the power of the design decisions to impact sustainability throughout the building lifetime.

3 METHODS

3.1 INTRODUCTION

The literature review explored the research problem in the context of existing knowledge. It identified areas where knowledge was incomplete and proposed a research problem. This chapter addresses the problem through the lens of academic research methods.

Academic research pursues knowledge and understanding. By using repeatable processes rigorous methods allow others to recreate the research. Through the development of theories, based on the observation and examination of hypotheses that extend the model, new knowledge can be established.

This chapter proposes novel research, adapting existing methods and applying them to a new context. This chapter outlines the new methods and defends their application in this case.

3.2 RESEARCH THEORY

The scientific method involves exploring relationships between chosen parameters. Hypotheses propose descriptions of how the world works in terms of the defined parameters. In order to test the hypothesis, an experiment is designed which allows for data collection within a defined range of conditions. The validity of a hypothesis is determined by how well it describes the relationship between the data.

Greatest confidence in conclusions drawn from research is when conditions are controlled, where parameters can be clearly defined and the influence of external factors can be removed. In contrast, where research is undertaken in "real conditions" and controlling other conditions is not possible, the phenomenon investigated cannot be isolated. In these conditions, many mechanisms may be considered when exploring the phenomena. In these conditions, case study research looks to expose the relationships responsible and describe how they present.

Where a single, or small number of case studies are used, large numbers of variables are considered. This allows many possible relationships to be explored and inductive reasoning applied to create knowledge. This does not mean that hypotheses are not required, as these determine the framework within which the research is created.

Case studies use a “thick” method (a more or less comprehensive examination of a phenomenon) in a real life context (Gerring 2007). While multiple case studies are often considered to be more valuable, and more similar to carrying out a set of experiments (Yin 2009), the single case study enables greater depth to be achieved.

Construction research often involves case studies for completed projects. Historical data and information from the actors provide a rich data set. However, comparably few examples are found of research taking place alongside business activities. Such research would be intrusive on day to day practice, commercially sensitive, and would have to adapt to the business’ programme rather than the researcher’s.

Action research methods allow for information to be gathered as the research progresses, and for methods to be adapted in response to the results as they become available, enabling research to be completed within the business context. During action research, the investigator may directly affect the results and as such they must take care to understand any influence they have. Similarly, the other actors in the project will affect the research outcomes.

3.3 Outline Method

This section gives a brief overview of the research steps. The structure of the research followed an adapted scientific method is shown in Figure 4. The research method adopted was essentially exploratory. The research aimed to create a design method which produces a sustainable construction process.

The first stage addressed the problem. The literature review explored the context in which the problem is set. Through the critical appraisal of existing research, the nature of the issues and current knowledge was established. With the problem clearly defined, methods to find solutions were identified.

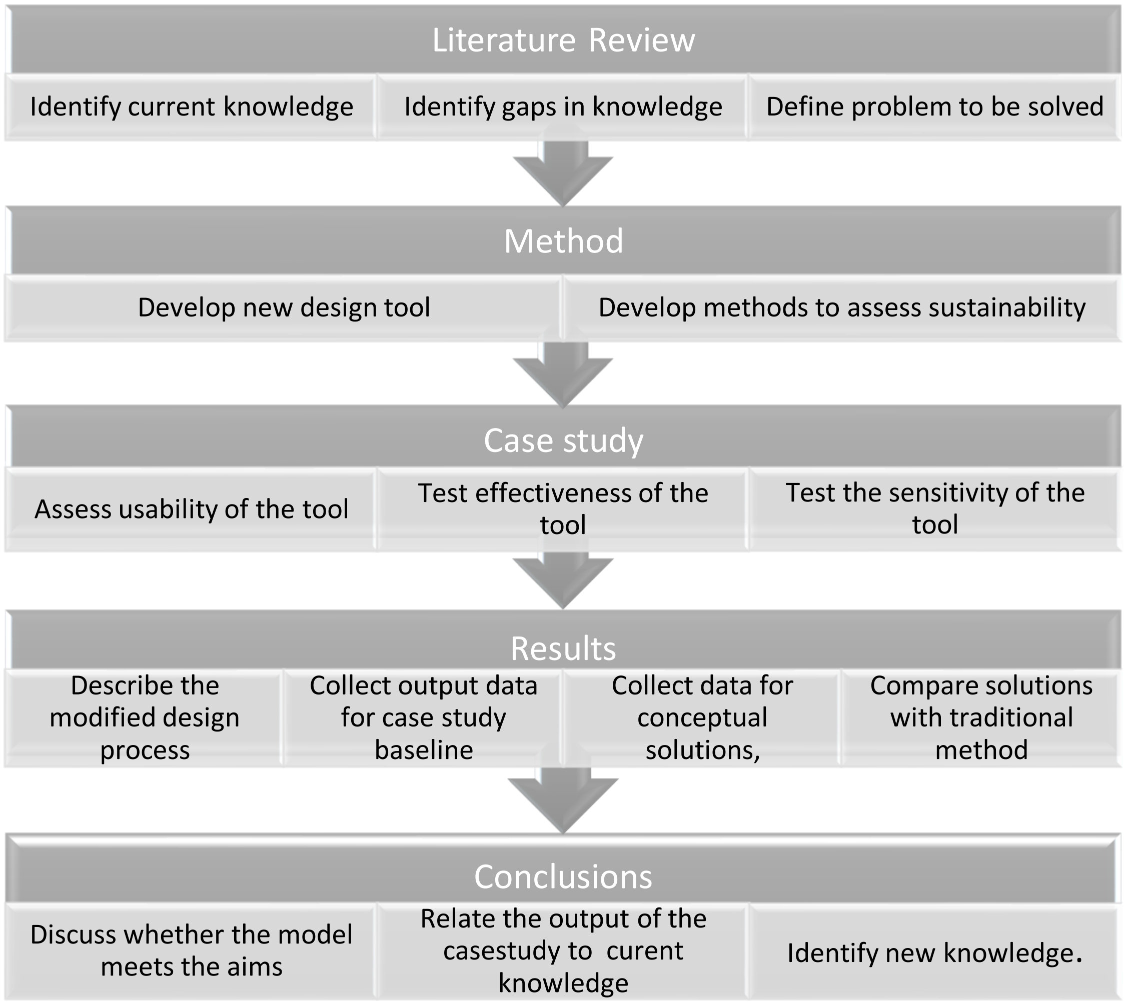


Figure 4: Research method

A new design method was developed by adapting design methods used within other specialisms. In order to assess whether the method could create more sustainable construction methods it was tested using a case study. The design method was applied to a “real life” example. The effectiveness of the tool is tested by comparing the sustainability of the design solutions with a baseline case, which will be a traditional construction method.

A design process used for product design in mechanical engineering was adapted for use in prefabricated construction incorporating sustainability requirements into the design aims of the tool.

The overall sustainability of the design solutions was tested by calculating a sustainability score. The relative importance of issues were determined and a numerical weighting to reflect the relative importance of criteria in this construction context was adopted. A single score was produced to describe the sustainability of the solution.

The results are presented in two parts. The first describes the design process applied to the case study. The second part details the scoring of the design solutions. Success of the design tool is measured by the improvement of sustainability against that of a traditional construction method.

Finally, the discussion and conclusion discuss the effectiveness of the design tool and how it informs our understanding of sustainable construction in this context. It compares the findings to other research findings in the field and describes where new knowledge has been achieved.

3.4 Theoretical frameworks

The aims and methods of the project are constrained by the context of the research. For a business to engage in sustainable activities implies that the social, economic and environmental impacts of its activities have been identified, considered and addressed. The construction activities take place within a capitalist economic model. As such, the environmental and social benefits are constrained by the costs of the design decisions.

The triple bottom line was used as the sustainability model with social, environmental and economic issues as the focus. Sustainability can be addressed by minimising the impacts, or by offsetting the impacts of the process. Offsetting and technological fixes allow the negative impacts to be produced during production and then corrected by undertaking activities which repair the damage, or by supporting the communities and ecosystems to adapt. In the design process the product design should be optimised before production is automated so that the benefits are maximised (Pahl et al. 1988). Similarly, the negative impacts should be minimised, prior to applying any fixes. It was assumed that sustainability is a necessary activity and minimising negative impacts is preferred over the use of a technological solution.

The most sustainable design is not a defined fixed point, independent of context, but instead will be a balance of the impacts of a project, where a stakeholder has defined the relative importance of the issues.

3.5 Sustainable Construction Design Process (SCDP)

Systematic design offers a structured method to support the creative process. The systematic design process places the customer's functional requirements at the centre of a structured method for the product development. Taking a project from product specification through to its delivery, the method describes routines which assist the identification and exploration of innovative solutions. The systematic design process, described by Pugh (1991) and Pahl, Beitz et al. (1988), is the spine of the new SCDP. Including sustainability as a functional requirement ensures that it is accounted for in the design. The design process is presented in Figure 5.

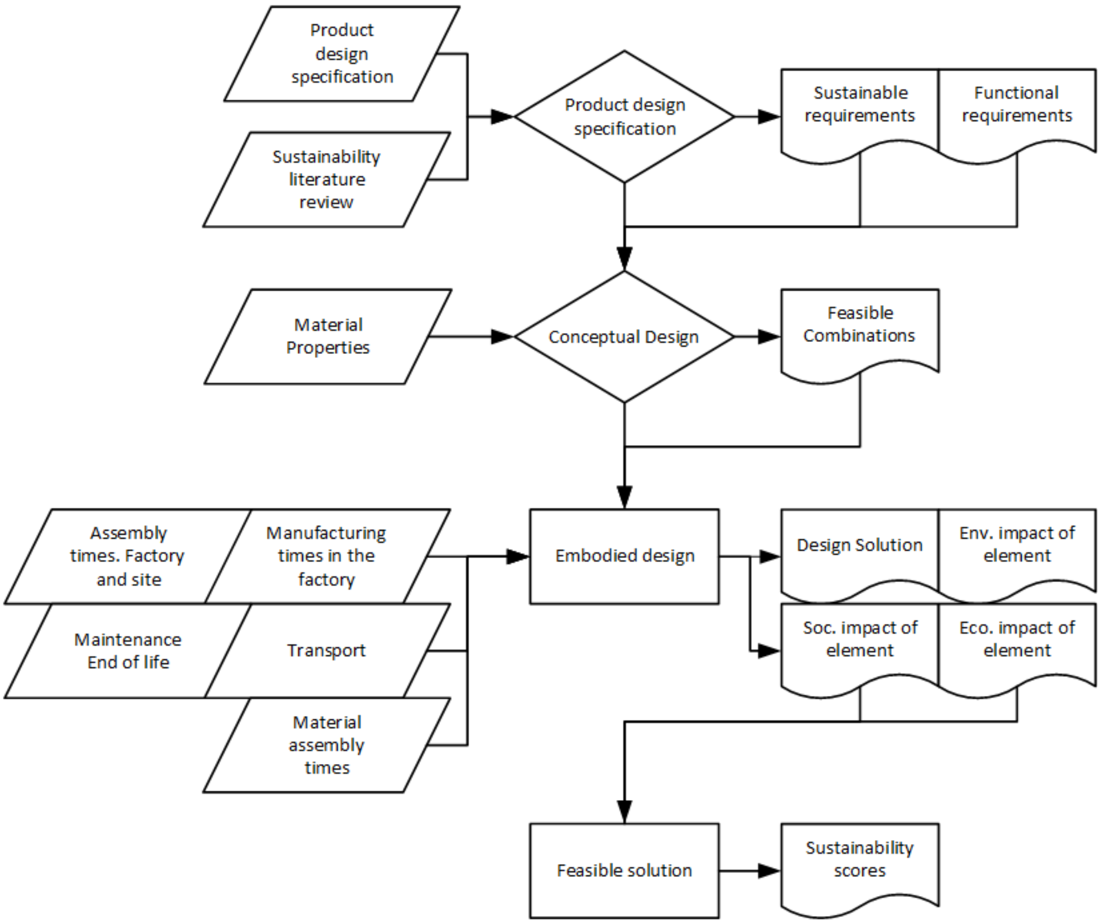


Figure 5: Sustainable Construction Design Tool (SCDP) process

3.5.1 Product specification and functional requirements

The first stage establishes the characteristics of a novel product or a product to compete against an existing offering, creating a specification from which the design space begins to be plotted.

A product design specification (PDS) was developed using Pugh's (1991) list of requirements for consideration; a description of the building as a product was created. Information used was gathered from a range of sources including existing businesses, best practice design guides, legislation and mortgage requirements. From the list, key features of importance, to the customer and the business and legal requirements were selected; these formed the constraints.

Pahl and Beitz (1992) present lists of categories to consider when creating the PDS. The categories spur aims, best practice and competitors' performance to be considered and catalogued.

The resulting specification defines the product, providing a list of targets and constraints. Some requirements must be met, some must be avoided and some should be optimized.

3.5.1.1 Sustainability Issues

A literature review, focusing on sustainability assessment in the construction industry, was undertaken. Academic papers, institutional guidance, design tools and corporate sustainability reports were included. In order to ensure the impacts would be measurable, papers using metrics or targets were filtered for inclusion in the assessment.

3.5.1.2 Conceptual Design

The conceptual design "specifies the design solution" (Pugh 1991). The conceptual design process involves finding solutions to the functional requirements based on the "flow of energy, materials and signals". Pahl, Beitz et al. (1988) recommends that this is approached using a block diagram which can assist the removal of prejudices towards preferred solutions. Feasible solutions are developed and refined using tools which aim to optimise the functional requirements and aspects of the manufacture and assembly.

Functional requirements were developed from the PDS to describe the operation of the product. Once the functional requirements were clearly established, the different ways in which the operations can be met using a series of functions were explored. Starting with structures describing mechanical, electrical and chemical actions, which either singly or in combination, in parallel or consecutively, produced the functional requirements, functional abstractions were developed (Pahl, Beitz et al. 1988). Sketches and text were used to shows the working structure of the product (Moultrie and Maier 2014, Pahl et al. 1988).

Abstract solutions to the requirements were identified for the key functional requirements. Abstract solutions did not describe construction solutions, but instead showed physical arrangements, or mechanical methods to achieve the functional requirement. By describing how requirements could be achieved in the abstract, novel solution types could be explored without the constraint of established construction methods.

The working principles were combined to create solutions. These were presented as a table. The combinations were then tested and dismissed if they were not possible, or if they failed to meet the key design constraints identified within the specification.

3.5.2 Embodied design

The first stage of the embodiment of the design is the identification of the main design constraints. Pahl and Beitz (1988, pg. 167) identify the size, the arrangement of the product elements and material requirements as key requirements.

3.5.2.1 Design for Assembly

Design for assembly was addressed for two phases. Firstly, the assembly of panels/elements onsite was considered; then, the assembly of components to produce the panels themselves was addressed.

Assembly times for the panels were calculated using catalogue tables in Boothroyd (1994). Assembly timings were the product of the component characteristics. The form and symmetry of parts, and the type and positioning of fixings were reviewed to ensure the engagement of components cannot be completed incorrectly but that the ergonomics of assembly is ensured. The designs were reviewed with respect to the storing and handling of parts, identifying, selecting and moving components. Data provided by Boothroyd (1994) was available for sizes up to 3.2m. In the factory, handling of pieces above the size limit used the maximum assembly time given.

Identifying handling times for onsite assembly was more difficult. Detailed descriptions of the tasks, data taken from Boothroyd (1994), industry data and assumptions relating to site layout were used to give estimated times.

3.5.2.2 Design for manufacture

Design for manufacture optimises the manufacturing cost by minimising material, labour and complexity. The number of parts can be minimised by only creating additional parts where mechanically, chemically or physically necessary. Fewer parts minimises handling during manufacture and assembly and reduces machine set up, and it reduces the number of interfaces between parts and the number of connections required. The design process requires every part to meet one of the following requirements:

- Does the part need to move with respect to the rest of the assembly?
- Does the part need to be of a different material or be isolated from the rest of the assembly?
- Does the part need to be separate in order to enable assembly or disassembly?

(Appleton, Garside 2000)

Once a minimum number of parts was established, their manufacture was considered. Handling and preparation of parts was affected by the materials' properties and the component form. Manufacturing times for the components were calculated. Although manufacturing costs are available for machined parts, injection moulded parts, die cast parts, sheet-metal stampings and powder metal parts (Boothroyd 1994). A database for timber machining was identified, instead typical set-up times and cutting rates were provided by a factory equipment supplier.

Simple component forms, minimising the number of faces and enclosed spaces are cheapest to produce and minimise production waste. Simplifying manufacture could require splitting a component into two parts, or altering the configuration. Design engineering for manufacture balances these elements. Considering each independently, may lead to conflicting design aims for each component. Optimisation finds the combination such that the functional requirements are best achieved.

To achieve the best whole life performance of the product other properties are considered. In mechanical products this also includes designing for creep and relaxation, and designing against corrosion damage. Here, the latter has been adapted as design for maintenance which ensures materials that are exposed to the elements, can be replaced during the buildings lifetime.

Materials supplied to the construction industry are available in standard sizes and these materials were used as the input materials to the manufacturing process.

3.5.2.3 Design for maintenance

Maintenance is required to ensure materials function correctly throughout the product lifetime. Most efficient material use occurs when the life span of the materials is a factor of the building life span.

The lifetime of the building was defined in the functional unit of the building, described as 60 years. Replacements factors were not adopted as part of the assessment. Instead it was assumed that all of the materials would be replaced at the end of their lifetime. As such, a material with a lifetime of 25 years would be replaced at 25 years, and 50 years.

3.5.2.4 Evaluating Designs

The evaluation of solutions occurs throughout the design process. Primarily, the design solutions must meet the functional requirements and should be disregarded if they do not.

Beyond the functional requirements, there are design constraints which determine the feasibility of the solution. These include financial, legal and manufacturing constraints.

Some solutions will be found to be unfeasible and Pahl et al. (1988) explain that for solutions that do not work should be disregarded and that most effort should be placed on the solutions which appear most promising. However, Short and Lynch (2004) argue that all solutions should continue to be explored for as long as possible, so that the maximum information can be gained about the product in the design space. The justification for the selection of the solutions to be further developed at each stage of the design is provided within the result section.

3.6 Sustainability Assessment

3.6.1 Scope

The assessment of sustainability needs a clear definition of the scope, including the purpose of the assessment, definition of the product, activities included or excluded and the issues of concern. The scope was developed from the information in the product specification and the a literture review.

The sustainability assessment was undertaken in accordance with ISO 14040 (International Organization for Standardization 2015) which detail the principles for Life Cycle Assessment. The functional unit and system boundary have been developed in acordance with industry standards and are described below, Table 3.

3.6.1.1 Clarification of the task

The sustainability assessment enabled the comparative assessment of sustainability of the manufacture and assembly of the outline building. The assessment also contributed knowledge of the design space to assist design decisions. Bassed on the results, the most sustainable method can be selected.

3.6.1.2 Functional unit and system boundary

The research addressed the design of a single house layout. Factory and site location parameters are fixed. The design life time of the house was 60 years.

The design tool focused on the production of the house; as such, only phases related this will be included. Materials flowed through processes and activities performed to them were recorded. Materials arrived at the factory or on site as “raw materials” from the supplier. Recycled materials are described as “raw material” in the product phase. They enter the manufacturing process with the same properties as “new” materials. Raw materials were manufactured creating components and waste. The components were assembled to produce elements for the building. Throughout the in-use phase, materials were replaced; the frequency was determined by the life span. Changes caused by updating the property or changing fashions were not included. The maintenance on the building creates waste through the removal of material that has reached the end of its life span and new waste is produced by the replacement of the elements/components removed (Silvestre et al. 2014). At the end of life, the waste pathway for the building was included.

Table 3: Life cycle phases included in model.

<table>
<tr><th colspan="3">LCA boundaries</th><th>Life Cycle phases/ LCA information modules</th><th colspan="2">Life cycle phase designation and description</th><th>Included</th></tr>
<tr><td rowspan="12">Cradle to cradle</td><td rowspan="12">Cradle to grave</td><td rowspan="5">Cradle to gate</td><td rowspan="3">Product phase</td><td>A1</td><td>Raw material extraction and processing, processing of secondary input</td><td rowspan="3">✓</td></tr>
<tr><td>A2</td><td>Transport to the manufacturer</td></tr>
<tr><td>A3</td><td>Manufacturing</td></tr>
<tr><td rowspan="2">Construction process phase</td><td>A4</td><td>Transport to the building site</td><td>✓</td></tr>
<tr><td>A5</td><td>Installation into the building</td><td>✓</td></tr>
<tr><td rowspan="7">Gate to grave</td><td rowspan="5">Use phase –information modules related to the building fabric</td><td>B1</td><td>Use or application of the installed product</td><td>✓</td></tr>
<tr><td>B2</td><td>Maintenance</td><td>✓</td></tr>
<tr><td>B3</td><td>Repair</td><td>✗</td></tr>
<tr><td>B4</td><td>Replacement</td><td>✗</td></tr>
<tr><td>B5</td><td>Refurbishment</td><td>✗</td></tr>
<tr><td rowspan="2">Use phase – information module related to the operation of the building</td><td>B6</td><td>Operational energy use</td><td>✗</td></tr>
<tr><td>B7</td><td>Operational water use</td><td>✗</td></tr>
</table>

LCA boundaries			Life Cycle phases/ LCA information modules	Life cycle phase designation and description		Included
			End of life phase	C1	De-construction, demolition	✓
				C2	Transport to waste processing,	✓
				C3	Waste processing for reuse, recovery and /or recycling	
				C4	Disposal	✓
			Benefits and loads beyond system boundary	D	Reuse, recovery and/or recycling	✗

3.6.2 Inventory analysis

Collating the inventory involved identifying all important materials and activities within the study boundary. Material and energy flows were recorded in order to identify the impacts. The model aimed to account for 95% of the fabricated materials. However, where materials and assembly processes were identical across all solutions the element was not included; such as windows, doors, guttering and roof trusses. Internal fixtures and fittings, such as carpets, kitchens and bathrooms, were not included because the customer would be given freedom to choose these for themselves.

The boundary conditions detailed BRE Global Methodology for Environmental Profiles of Construction Products (Building Research Establishment 2008) were adopted. The conditions are repeated here with any adaptations made for the model.

- Witihin the definition of the functional unit, 95% of all materials were included, excluding only materials which were present in small volumes.
- The impacts of capital equipment, such as energy and cost to run offices, factories and the support systems therein were not included. This did not extend to the power use of machinery, which was included within the inventory.
- Within the BRE methodology, construction impacts were not included. Within the model, cost for the use of crane is included, however, fuel impacts were not included separately. Time taken to assemble modules on site was considered and associated labour costs were included .
- Site wastage during the manufacture process is included. Wastage rates for prefabricated methods were assumed based on reported literature estimates.

Waste during traditonal construction was already included within the data sources.

- The quantity and transport of any significant materials used (e.g. in painting and varnishing) over the lifetime of a product will be included.
- The BRE methodology includes flooring. This was not included within the model.
- What allows the designer to consider the overall impact from quantities of different materials required to produce different building solutions without having to consider differences in energy consumption resulting from different thermal resistance values. In general, comparison between elements with the same functional unit can ignore lifetime energy use within the assessment. However, care should be taken where aspects such as thermal mass may have implications on energy consumption in the building.
- The impact of the demolition process is not included. Data sets are not widely available and the impact is considered to be small and difficult to allocate to specific materials.
- The boundary of the LCA includes the impacts of disposal of all materials. Models for the amounts for construction materials estimated to go to landfill, incineration, recycling and reuse. The environmental impact included these impacts. Cost of the disposal of the materal was determined using costs provided by a local company. Routes for disposal were based on industry averages.

3.6.3 Impact assessment

Sustainability is understood in terms of the impact of activities on issues important to the stakeholders. In order to be able to assess the sustainability, these impacts must be definable, using “aims, objective and scope” (Kaebernick et al. 2003). Only then can suitable metrics be developed.

Widely recognised metrics were adopted where available, from sources such as the Green Guide, LEED and BREEAM. In other cases qualitative assessment methods from the literature (Gosling et al. 2013) were adapted to provide quantitative scores.

The selection of issues is subjective; as such, the process should be transparent to allow for criticism. The criteria should be comprehensive, applicable, transparent and practical. Comprehensiveness intends that the scope of the index is fully covered by all criteria and by being applicable the criteria can be measured in each of the design solutions. This is balanced by a need for the assessment to be practicable; it should be possible to gather and analyse data for the metric using the resources available (Akadiri and Olomolaiye 2012).

Criteria were derived from the sustainability requirements described in the product specification. Constraints for each criterion were then identified and a network of the relationships between the constraints and the criteria was drawn. This also allowed the criteria to be checked for redundancy and interdependence.

3.6.3.1 Stakeholders

To the construction firm, the commercial project stakeholders include the customer, the regulators, the workforce and suppliers. Addressing sustainable design, stakeholders include more remote actors that have little influence on decisions but are affected by them. Stakeholders are described in Table 4 the main stakeholders selected for the design assessment are in bold.

Table 4: Project stakeholders

	Stakeholders
Local	Customer Community Workforce local to the factory Workforce local to the site Council Local businesses Local environment- ecology, land, local water bodies, ground level air quality
Regional	Construction industry Regional population Regional economy Regional environment- ecology, rivers, troposphere
International	Raw material suppliers Global population Global economy Global environment- hydrosphere, ecology, troposphere and stratosphere

Environmental criteria which correlate to the release of compounds were chosen. These include compounds which represent a risk of climate change, acid rain potential, ozone depletion and creation, land, air and water toxicity, human toxicity and water.

Economic criteria were reviewed. The profitability of the activities was important, but profit levels cannot be defined at this stage. Creating employment, in the factory and onsite, support the local economies and is represented by labour cost. A new business would need investment to set up a factory. Material cost reflects the cost of the building and is important to the consumer. The cost metric will reflect elements of each of these.

The social criteria were reviewed. The adaptability of the building, as an indicator of the potential to extend the lifetime of the building, was considered important. Health and safety during the build was considered very important. Moving operations inside of the factory made controlling the process is much easier; however, the size and weight the components meant that some onsite assembly would always be necessary. On a larger geographic scale, responsible sourcing of materials was selected. Impacts on stakeholders can operate over local, regional and international scales. However, it is recognised that for the small business holder, managing the chain of custody is onerous.

3.6.3.2 Criteria

Based on the established stakeholders the social, economic and environmental impacts were identified using a literature search, as detailed in Table 5, Table 6 and Table 7.

Table 5: Environmental issues identified during the literature review

Environment	**References**
LCA / embodied energy of materials	Akadiri and Olomolaiye 2012, Anastas and Zimmerman 2003, Barratt Developments PLC 2013, Berardi 2012, Howarth and Hadfield 2006, Kubba 2012, Labuschagne et al. 2005, Persimmon 2013
LCA / footprint/ resource scarcity	Akadiri and Olomolaiye 2012, Anastas and Zimmerman 2003, Howarth, and Hadfield 2006, Labuschagne et al. 2005, Luttropp and Lagerstedt 2006
LCA/pollution/ contaminants/ toxicity	Akadiri et al. 2012, Anastas and Zimmerman 2003, Department for Communities and Local Government 2010, IKEA 2013, Persimmon 2013, Sobotka and Rolak 2009
Waste: minimise recycle reuse	Akadiri and Olomolaiye 2012, Anastas and Zimmerman 2003, Barratt Developments PLC 2013, Howarth and Hadfield 2006, Kubba 2012,

Environment	References
	Luttropp and Lagerstedt 2006, Persimmon 2013, Sobotka, Rolak 2009
Waste: hazardous material	Akadiri and Olomolaiye 2012, Anastas and Zimmerman 2003, Berardi 2011, Labuschagne et al. 2005, Luttropp and Lagerstedt 2006, Sobotka and Rolak 2009
Climate Change	Building Research Establishment 2013, Department for Communities and Local Government 2010, Kubba 2012, Luttropp and Lagerstedt 2006
Acid rain potential	Department for Communities and Local Government 2010
Photochemical smog	Akadiri and Olomolaiye 2012
Ozone	Akadiri and Olomolaiye 2012
Energy consumption	Barratt Developments PLC 2013, Department for Communities and Local Government 2010, Howarth and Hadfield 2006, Kubba 2012, Persimmon 2013
Renewable energy	Barratt Developments PLC 2013, IKEA 2013
Transport	IKEA 2013, Labuschagne et al. 2005, Persimmon 2013
Nature/ Biodiversity	Barratt Developments PLC 2013, Building Research Establishment 2013, Persimmon 2013
Water use on site	Barratt Developments PLC 2013, Department for Communities and Local Government 2010
Water in-use	Akadiri and Olomolaiye 2012, Department for Communities and Local Government 2010, Kubba 2012, Sobotka and Rolak 2009

Table 6: Social issues identified during the literature review

Social	References
Adaptable /long life	Department for Communities and Local Government 2010, IKEA 2013, Kubba 2012
Housing to meet a mix of needs	Barratt Developments PLC 2013, Building Research Establishment 2013, Persimmon 2013
Affordable	Barratt Developments PLC 2013, IKEA 2013, Persimmon 2013)
Impact during construction	Department for Communities and Local Government 2010, Howarth and Hadfield 2006, Persimmon 2013
Reporting and audit	Barratt Developments PLC 2013, Building Research Establishment 2013, Department for Communities and Local Government 2010, Howarth and Hadfield 2006
Health and safety	Barratt Developments PLC 2013, Labuschagne et al. 2005, Persimmon 2013
Locally sourced material	Sobotka, Rolak 2009
Noise	Howarth, Hadfield 2006
Ethical sourcing	Barratt Developments PLC 2013, Building Research Establishment 2013, Department for Communities and Local Government 2010, IKEA 2013, Persimmon 2013
Local employment	Howarth and Hadfield 2006, Labuschagne et al. 2005, Sobotka and Rolak 2009)
Local heritage and culture/land use/aesthetics	Barratt Developments PLC 2013, Building Research Establishment 2013, Kubba 2012, Persimmon 2013, Sobotka and Rolak 2009
Infrastructure and service	Howarth and Hadfield 2006, Kubba 2012, Persimmon 2013
Listening to stakeholders	Howarth and Hadfield 2006, Kubba 2012, Labuschagne et al. 2005, Persimmon 2013
Occupant experience	Department for Communities and Local Government 2010, Kubba 2012, Labuschagne et al. 2005

Table 7: Economic issues identified during the literature review

Economy	**References**
Staff training/CPD staff retention	Barratt Developments PLC 2013, Berardi 2012, Labuschagne et al. 2005, Persimmon 2013
Financial health	Labuschagne et al. 2005
Profit to company	Barratt Developments PLC 2013, Labuschagne et al. 2005
Good governance	Barratt Developments PLC 2013
Long term business model	Berardi 2012, Labuschagne et al. 2005
Local employment	Labuschagne et al. 2005
Life time cost initial cost, maintenance and disposal	Sobotka and Rolak 2009
Occupant influence	Department for Communities and Local Government 2010
Economy national and global equity	Building Research Establishment 2013

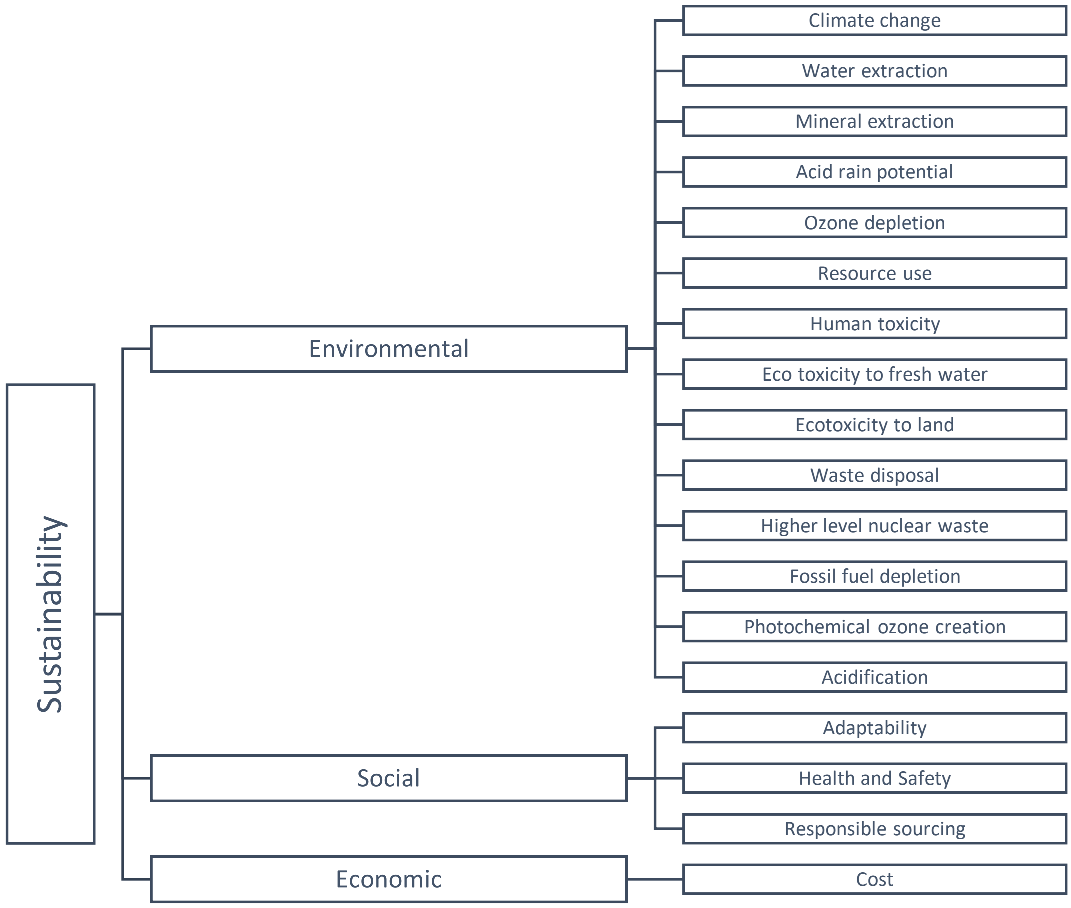


Figure 6: Sustainability hierarchy

A literature search identified sustainability issues of importance to the construction industry. The key issues, in the context of the prefabrication of the fabric, were selected, and criteria were developed. Criteria are shown in Figure 6 and summarised in the text below.

3.6.3.3 Metrics

Environmental

A full detailed life cycle assessment addressing the lifetime impact each of the assembly of all the components would provide the most accurate value for this metric. The data required would include material volumes, lifespan, environmental impacts for each material, power consumption during manufacturing, transport and waste pathways.

Creating the inventory for these processes would be time consuming and expensive. Furthermore, environmental impact data available is is not precise enough to accurately reflect the difference in performance between the small changes affected by the design process As such, a full LCA was considered inappropriate and more general metric was selected.

The Green Guide to Specification was adopted for environmental assessment. The assessment addresses the impacts of the release of pollutants to the geosphere, hydrosphere and atmosphere. It also considers the extraction of limited natural resources. A list of the metrics used are included in Appendix A.

Ratings, between A+ and G, are given to assemblies to describe the whole lifetime impact. By using assemblies, the embodied impacts of the materials and their in-use performance are reflected in a single value. Their incorporation into the sustainability assessment enable simple assessment of environmental impacts which otherwise require complicated lifecycle assessment.

The Green Guide applies a rigorous Life Cycle Assessment method to assess the element assemblies. The guide has a list of completed, audited assembly types which provide details of materials and element assemblies. The scores are based on a standardised functional unit which enables direct comparison. As such, the use of proxy assemblies to compare very different construction styles is considered appropriate an the early stages.

For the purpose of this research the closest assembly was chosen. The Green Guide offers a calculator for BREEAM assessors to build their own assessment using their specification. However, this was not available so the generic elements were used. In future research it would possible to use the BRE’s proprietary calculator to calculate more accurate ratings.

When materials for manufacture were selected, possible solutions were reviewed. A minimum element performance, above “B”, was required for the element design to be progressed further.

At the embodied design stage, a score describing the environmental impact was produced. Element scores as given in the Green Guide were converted to a numerical score, as described in Table 8. The impact score was adjusted to reflect the proportion of the material in the building.

Table 8: Environmental impact scores (Anderson and Shiers 2009)

Element score	
A+	10
A	6
B	2
C-G	0

Energy consumption was included in environmental data. Cost of energy consumed for machining processes in the factory was included. Dust extraction, lighting and general factory building consumption was not included. The cost of energy consumption on for crane activity was included as part of a day rate for the crane, provided by a local company. Other on site energy consumption was not included, because it is expected to be low (Anderson and Shiers 2009).

The environmental impacts of the element and module transport were included as part of the environmental assessment (Anderson and Shiers 2009). Costs were determined using data from a local haulage company.

Labour spent on machining and assembling, onsite and in the factory was included. Factory and site management and administration were not included.

Economic: Cost

Costs to the company occur in different forms. Assessment of the cost is achieved by considering the three elements of investment, materials and labour. Scores are given based on the relative cost of the solutions under consideration.

At conceptual design stage the cost of investment is used to assess the whether the solution is feasible. Initial costs to the business will occur to prepare the design, and set up manufacture. Factory premises and equipment is a long term commitment. The design establishes whether equipment must be bespoke or may be resold.

At embodied design stage a detailed cost model was produced which included the cost of materials, manufacture, labour and transport.

Material costs were based on the component size, and included 10% waste (Cuéllar-Franca and Azapagic 2012). Where required, the cost of materials replaced during maintenance were included. The cost of materials used for maintenance did not incorporate any inflationary price increase.

The cost of manufacture and assembly of the components, in the factory, comprised of labour for machining and assembly, and power during machining. On site assembly was either by hand, which had labour cost alone, or required the use of a crane. The price of a crane was calculated using a day rate.

Waste materials at the end of life were accounted for. Prices were obtained from a waste disposal company and assumed that materials were separated, as detailed in Appendix C.

Social: Responsible sourcing

Responsible sourcing assessed the materials supplied and their suppliers. Three aspects of responsible sourcing were assessed: environment assurance, chain of custody, and internal business practices. One credit could be achieved in each, giving a maximum of three credits. Credits could be gained by providing evidence of being audited or accredited by recognised scheme, see Appendix A. In order to not be unduly penalise small companies which do not have the resources to undertake often cumbersome accreditation processes, half points were made available if the company had reports of reviewed in house assessments. Three points are credited if an external report produced in accordance with the GRI reporting guidelines is available.

Where material types were identified during the conceptual design stage, products from the suppliers that performed best against the responsible sourcing assessment.

Social: Health and Safety

Health and safety risks associated with the construction was assessed following embodied designs. At the conceptual design stage, the risks were not apparent. The construction was split into six key phases, as found in the LCA, Table 3. Possible events from hazardous activities included falling, exposure to weather, handling, exposure to toxic materials, injury caused by equipment, multiple activities in a small area, Table 9. The risk score of the incident was the product of consequence and likelihood, Table 10. The higher the score, the greater the risk as shown in Table 11.

Table 9: Potentially hazardous activities

Handling	**Risk of falling**	**Exposure to toxic materials**	**Exposure to the elements**	**Risk of injury (equipment)**	**Multi activities in small area**
Lifting materials	Trip hazards in factory	Inhalation of materials during cutting	Exposure to cold	Minor cut to hand	Trip hazards
Lifting panels in factory	Trip hazard on site	Treatment of material (preservatives)	Exposure to heat	Serious blade injury (hospital)	Equipment injury
Lifting panels on site	Fall from height: scaffold	Irritant	Excessive damp and cold	Collision with vehicle (in factory)	
Moving panels using crane	Fall from height: ladder			Collision with vehicle (onsite)	
Moving construction materials to height (on scaffolding)	Fall from height: roof				

Table 10: Phases and risk description during prefabricated construction

Activities	**Consequence**	**Likelihood**
A: Manufacture of parts in factory	1) Recordable incident (>3days incapacitated)	Low- (1) remote, unlikely
B: Assembly of parts in factory	2) Reportable incident (7 days off work)	Medium- (2) possible, could occur some time

C: Preparation of parts on site	3) Death of a person	High- (3) Likely occur repeatedly/event only to be expected
D: Assembly of parts on site		
E: Maintenance		
F: End of life		
G: Transport		

Table 11: Health and safety scoring

Consequence of incident				
	Death*	3	6	9
	Reportable*	2	4	6
	Recordable	1	2	3
*must be reported to the HSE.		Low	Med	High
		Likelihood		

Social: Adaptability

For a building to be sustainable, it must be valuable to the householder throughout its lifetime otherwise it may be become unusable and require replacement. Furthermore the building design should incorporate flexibility, otherwise the business would be required to invest in facilities to make changes, by investing in additional design process, or machinery.

The adaptability metric assesses the feasibility to make changes to the building throughout its lifetime. The assessment addressed the flexibility of the building design during three phases of the building lifetime, during design, in-use and end of life.

During the design stage, influence of changing climate on the building across its lifetime must be considered. As such, functional requirements, which reflect this need are necessary. The ability to change the building during the in-use phase of the life will increase lifetime of the building. For a household the capacity to adapt a building rather than relocate is valuable. The ability for a house to change to reflect changes to lifestyle increases the expected lifetime. Finally, the ability to change the use of the building at the end of the as-designed life, and to use part or all of the fabric as part of a new building.

3.6.3.4 Scoring

Each metric produced a score determined by the assessment method. In order to aggregate the scores a process of normalisation and weighting was undertaken.

Normalisation enables scores across the different metrics to be compared. It creates “compatible measurements” (Jahan and Edwards 2013). For each metric, the scores were normalised to give a value out of 10. Triantaphyllou (2000) indicates that normalisation should be undertaken once alternative solutions have been identified and a range is known. This allows the assessor to identify the range of values for the metric and from the range a scoring method can be identified, typically linear or logarithmic scales are used. Normalisation methods are adopted so that the metric becomes unitless and can be added together. A linear distribution was assumed for the scores of each metric.

The relative importance of sustainability issues are not the same for each individual. Any design tool must include a method to create the relative weightings. By consulting industry specialists their knowledge is captured in the weighting. Business’ and customers’ preferences can be captured by using the business knowledge of the market and issues. The development of weightings should be transparent and so a user can interpret the results of an assessment.

For the purposes of analysis, there should be mutual independence of preferences, ensuring that each criterion can be assessed without knowing the scores gained for other criterion. Double counting should be avoided to prevent alternative solutions gaining high index scores because certain properties contributed towards the score in more than one criterion.

Simple ranking is an often used weighting method. The stakeholder orders the criteria in order of importance on an ordinal scale. There is no scale to the ranking so the weightings increase in equal increments, reducing the level of complexity that can be reflected in the scores. However, where many stakeholders' opinions are being represented, and a single solution only provides a representation of their views it offers a simple methodology, removing the need to apply "unrealistic assumptions about the underlying distributions" (Akadiri and Olomolaiye 2012).

A linear additive model is used here to create a scoring for the alternative solution. Linear additive methods have three key stages, scaling of the performance of criteria, weighting the importance of criteria, and determining the relationship between the weight and the scaling. These are then combined with the weighting to create a criteria score. The sum of these values is the sustainability index, as shown in Table 12.

Table 12: Sustainability index weighting

Economic	**Social**			**Environmental**
Cost	**Health and Safety**	**Responsible sourcing**	**Adaptability**	**Aggregated environmental impacts**
0.33	0.11	0.11	0.11	0.33

3.6.3.5 Data quality

The assessment of the design method requires both qualitative and quantitative data. Data was collected, where possible using the most recent accurate and relevant data.

Data relating to materials were either supplied by the manufacturer or were taken from generic sources. Environmental data was collected from BRE Global Environmental Profile Certification Scheme and BRE Global Environmental Profiles Scheme. The quality of the data used is detailed in the BRE Global environmental profiles methodology. Their assessment of data quality has been included in Table 13.

Table 13: Data quality framework adapted from BRE Global ltd 2008

QUALITY	**GOOD**	**FAIR**	**ACCEPTABLE**
Age	From 2010	Between 2005-2009	From 2000-2004
Geography	UK*	Europe	Rest of World
Source	Trade Association	Single Manufacturer	Single Manufacturer
Representativeness	Over 50% of industry	20-50% of industry	Less than 20% of industry
LCA Practitioner	LCA verified by 3rd Party	Non-verified	Student, Non-verified
Methodology	Transparent and including all inputs and	Some transparency or some aspects missing	No transparency, unclear methodology or significant

QUALITY	GOOD	FAIR	ACCEPTABLE
	output		aspects missing

3.6.3.6 Interpretation

Assessments are undertaken to improve understanding of impacts of products and processes. Where comparative assessments are completed, relative total scores help to identify the best. The process of completing the assessment produces information which enables the designer to identify hotspots, where the impact of the decisions are significant. The supports designers' efforts to develop an understanding of the design space (Baumann and Tillman 2004).

Case Study

In the case study, a traditional brick construction method is compared to new designs developed using this design tool. The designs developed using the tool adopt prefabrication and use low carbon materials. These two innovations are closely linked; the use of prefabrication requires that non-traditional materials are used. As such, the impact of material choice and the impact of prefabrication cannot be separated.

Limitations

The reseach is limited to the scope of the design tool. The research does not present a fully devloped tool but instead explores the impacts during the conceptual and embodied design stages. This scope of the research restricts the design tools to addressing the design and manufacture of the building fabric.

Coupled to the limtied scope of the research, the design efforts have been litmed to the design of components and elements. A structural assessment has not been completed to ensure the feasibility of the research, instead rules of thumb, often applied in the ealry stages of design (Pahl et al. 1988) have been adopted. Any solution would need to be assessed for structural feasibility and finding would need to be fed back into the design process, if alterations to the design are required. As such, detailed design would be completed following the embodied design phase.

The use of a single case study restricts the confidence in the wider applicability of the product design. The sustainability of the solutions will to some degree be dependent on the skills of the designer. The degree of the improvement is partially affected by the skills employed. However, it is the development and application of the method which is of interest. As such, it is the degree of improvement between the traditional construction method and the design solutions.

In all, the research cannot be considered a scientific method and the conclusions will be limited to informing the success of the method for the case study and the general findings from the process.

3.7 Summary

This chapter described the methods applied in the research process undertaken. Methods used by other researchers were compared and most appropriate selected for adaption to make them suitable for the context of sustainable construction. Reasoning behind the choices were defended.

Sustainability has been shown to be the balance of competing needs, which is dependent on context. Based on this, a method to assess the sustainability of any product has been provided. The sustainability assessment will be used to compare possible design solutions for the manufacture and assembly of a prefabricated house. The designs will be developed by the application of a systematic design method, which has been adapted by extending the scope of the design tools to new materials, assembly and product requirements.

Using these methods, the next chapter describes the application of the design process to a case study. A product design method is developed for the prefabricated house, the design process creates conceptual and embodied design solutions, and the solutions are assessed using the sustainability assessment method.

The research will inform how the design process for prefabricated construction should be directed and the importance of the identified design parameters. The success of the design tool to produce sustainable solutions for the case study house, will inform the validity of the design tool and indicate whether the tool should be to further case studies.

4 RESULTS

4.1 INTRODUCTION

Chapter 3 describes the SCDP adapted from Pahl et al's (1988) systematic approach. Changes to the original process were made to make the process suitable for application to prefabricated building construction and to incorporate sustainable requirements. In order to explore the application of the SCDP in real conditions a case study was employed. In this chapter, the results of the design process are described alongside the assessment of a traditional construction method.

Comparison between a business-as-usual approach and the improved design was made in order to assess whether the SCDP is effective. A traditional construction method was compared to new solutions developed using the SCDP. The sustainability of the traditional method and the new solutions were calculated using the sustainability scoring method. shows the design process with information input and creation.

4.1.1 Company

The case study gathered information from house design and construction business. At present, the business is a small enterprise run by a single director. The product considered was small houses, to be built as part of a development within the UK. At the time of the research, the factory had not been established; as such, the following assumptions were made.

- The output was approximately 52 buildings per year.
- The factory premises was located in Manchester.
- The company employed the factory labour, while assembly on site was completed by a construction firm local to the site.
- Small investment capital was available for the set-up of a manufacturing process.

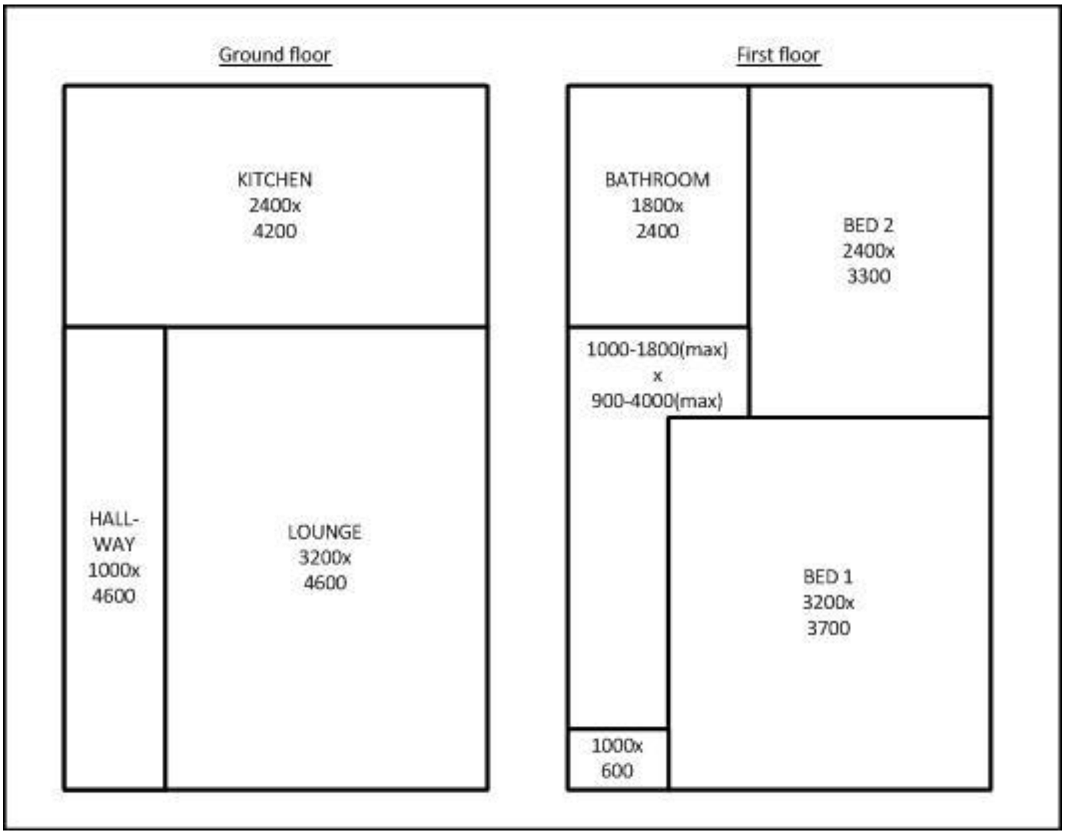


Figure 7: Outline of the building

4.1.2 Outline design

The house was a two storey detached property. Figure 7 shows the outline layout of the proposed house design. Downstairs, the property comprised a hallway, lounge, kitchen and dining room. The first floor comprised a landing, two bedrooms and a bathroom. Minimum dimensions for some areas have been prescribed; otherwise, minor alterations to the layout could be considered.

Built for the United Kingdom's market, the building must meet the legislative requirements for use as a permanent residence. It should have a design life over 60 years in order for it to qualify for a mortgage.

4.1.3 Functional unit

The next section describes the whole life cycle and then outlines the embodied design process to be taken.

4.1.3.1 Whole life cycle

The whole life cycle of the building was recorded in order to capture all of the phases and develop the scope of the design, as described in Table 14; it also acts as the framework for the inventory

Table 14 Activities during life cycle phases

	Traditional	**Timber frame**	**SIP panel**	**Volumetric**
Materials	Deliver to site	Deliver to Factory	Deliver to factory	Deliver to factory
Manufacture	Preparation of materials on site	Manufacture of components	Manufacture of components	Manufacture of components in factory
Assembly	Assembly of materials on site	Assembly of components	Assembly of components	Assembly of components in factory
Assembly				Assembly of panels in factory
		Assembly of panels on site	Assembly of panels on site	Assembly of modules on site
Cladding	n/a	Assembly of cladding	Assembly of cladding	Assembly of cladding
	Building	Building	Building	Building
In-use: Maintenance	Maintenance	Maintenance	Maintenance	Maintenance
End of life	Dissasssmebly and disposal	Dissasssmebly and disposal	Dissasssmebly and disposal	Dissasssmebly and disposal

The first phase involves the extraction or harvesting and processing of the raw materials, and could include reprocessing of recycled material, or the refurbishment of recovered elements. The possible range of processes and geographical locations in which they could occur are extensive. Activities are managed by others and the resulting products are purchased to be employed in the manufacturing process. As such, improvements are outside the control of this project, but selection of materials can take their sustainability into account. Construction materials are often specified by their technical properties, and in some cases, require certification, for example, I joists and C16 timber. Furthermore, many materials are delivered in standard sizes when purchased from a builder’s merchant; obtaining larger or custom sizes are possible but there will be a premium to pay.

Materials are transported between the material supplier, the building merchants, the factory and site and distances can vary significantly. The number of vehicle trips depends on the volumes of the materials transported, but weight is rarely an issue. Abnormal loads can be transported on a trailer, but will need to be accompanied by safety vehicles which increases the vehicle mileage and cost, and creates paperwork.

Manufacturing methods in the factory are determined by the types of materials and equipment used. Investment in workstations, saws, moulds and other equipment is a significant cost, and will affect the flexibility of the product design and the rate of output.

The more simple the design of the components, the easier they are to produce. Timber cutting involves routers, circular saw and plane saw. Computer Numerical Control (CNC) routers enable component lists to be programmed and cut. Concrete panels use moulds which into which the mix is poured and allowed to set over 24 hours. Sandwich panels require similar tools to timber cutting, but also glue spreading machinery plus clamping tables to prepare the panels.

Assembly processes occur both in the factory and onsite. The shape, weight and symmetry of the components affect how easy it to orientate and fix them together. During assembly, handling components presents health and safety concerns. In the factory, the processes can be controlled and refined, while onsite access constraints will vary for each location. Onsite conditions may affect the type and cost of lifting equipment, access may limit the vehicles entering the site. Labour required will be affected by assembly processes applied.

During the in-use phase, the fabric will suffer from natural wearing and corrosion and eventually require replacement. When maintenance should be completed will be dependent on the material life span.

Finally, at the end of life, the building will demolished or dismantled and waste treatment of the material occurs. Materials will go to landfill, be recycled, or be reused. If recycled or reused they can be considered to contribute to the feedstock of raw materials.

4.2 PRODUCT DESIGN

4.2.1 Introduction

The following sections describe the results of the design process. In order to describe the results, it has been necessary to impose a linearity to the process. However, the following should be read with the understanding that many of the design stages were revisited as the design space became better understood. The results describe the final outputs and as such, describe the optimised designs and the accurate assessment of the impacts.

4.2.1.1 Product specification

A product design specification (PDS) of the building lifetime was created using the building outline, information from the business and the literature review and is presented in full in Appendix B. The key requirements are described here and summarised in Table 15

The business indicated that that they intended to use the sustainability of the building as a selling point; as such, as well as performing sustainably, the palette of materials chosen should be understood as being sustainable by the public.

The functional requirements were extracted from the full PDS document and presented alongside the sustainability requirements. Design requirements which constrain the solution were identified. The combination of the functional requirements with the constraints defined the design space and all viable solutions would lie within the design space.

Table 15: Functional requirements identified from the product design specification

Functional Requirements
Two storey building with pitched roof
Internal layout required as described in the building plan
Walls must be solid with little deflection or movement. Loads from building materials, wind, snow and live loads to be transferred to the foundations.
Maintain internal temperature ~18-21^{o}C during occupation.

Functional Requirements
Sustainability requirements
Minimise environmental impact to resource and pollution
Minimise cost
Minimise social impact: to householders, to labour and global communities

4.3 CONCEPTUAL DESIGN

4.3.1 Functional requirements: Building

The conceptual design process unpacks the product requirements to unveil solutions to the main operations. The building operations were described in order to create an abstraction of the product requirements. By using abstract descriptions of the product functions, the designer can develop solutions without preconceived notions of how they should be formed, maximising the potential for novel solutions.

The functional abstractions are presented in Table 16. Each functional requirement was considered individually and the abstraction developed by building function structures and sub function structures.

Table 16: Abstractions of the functional requirements (Pahl et al. 1988)

Multiple spaces interconnected by openings
Openings between internal and external environments
Stable thermal environment

Functional abstraction 1: Create volumes

A volume is contained within surfaces and can be described by the internal and external environments. Given a surface material, a volume can be created by producing a pressure difference between the internal and external environments, like a balloon. In this context, this is not feasible because, among other things, of the expense of maintaining the pressure difference between the two environments.

Without a differential air pressure, a volume requires structural strength. Materials must support their self weight and any live loads on the volume. An engineered structural frame can be designed to support the loads of the building. Efficient design will optimise the transference of loads through beams and posts to the pad foundations. Such a frame allows for a skin to be formed by materials with little engineering strength; infill panels would only need to be self-supporting.

Thin membrane construction engages the reaction between the structural frame and the taught skin. Like a tent, the external skin is stretched over rigid, fixed, elements; the tension in the skin compresses the fixed elements. Any opening in the fabric must be included during the design of the structure because the skin is designed to rest in equilibrium.

Finally, load bearing structures have elements (walls, floors, and roof) that are strong enough to bear their own self weight, dead loads transferred to them and live loads. Floor and roof elements will be rigid enough to transfer their weight and any additional loads to the outer loading points. Loads are transferred to trench foundations, with Figure 8 representing three such structures.

		
A. Structural Frame	B. Thin membrane structure	**C.** Load bearing elements

Figure 8: Images representing working structures to create volumes.

Functional abstraction 2: Create a series of internal volumes

The creation of internal volumes can be considered in terms of the division of the large volume into smaller compartments, or the accumulation of small volumes into a larger form. This informs how the solution is approached.

Structural walls are able to carry loads and provide rigidity to the building if integral to the structure. Acting as part of the whole structure, load bearing capacity of the structural elements in the shell can be reduced.

Light weight partitions can support their own weight and act as dividers; but do not provide any structural strength to the larger structure. They may be fixed in place by securing them to the floor, ceiling or wall panels. As they are not structural, there is a limit to their size. Figure 9 represents three such structures.

		
A. Stacked volumes	B. Infill	C. Non structural internal walls

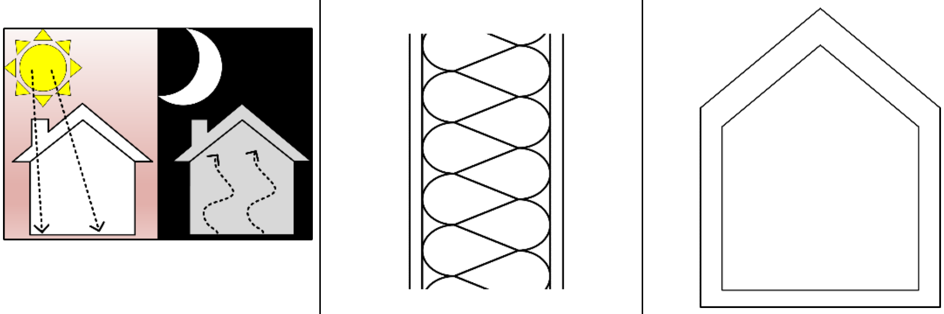
Figure 9: Images representing working structures for the creation of volumes.

Functional abstraction 3: Stable internal thermal environment

Internal temperature is determined by the balance of heat losses and gains. Central heating, solar, metabolic and equipment gains contribute heat to the house. Losses occur by air change with the outside, and by fabric heat loss.

Limiting air changes is achieved by creating a continuous air barrier. Insulation requires materials with low thermal conductivity.

Thermal mass can slow the rate of heating up and cooling by absorbing and releasing heat based on the temperature gradient. Thermal mass can be created by using materials with large heat capacity. Figure 10 illustrates 3 such structures.



A. Thermal mass B. Insulation C. Airtight barrier

Figure 10: Images representing working structures for internal thermal environment.

4.3.2 Design conflicts: Building

The working structures for each functional requirement were combined to create conceptual solutions in a selection chart, as shown in Table 17. Each of the combinations were assessed and solutions were disregarded if they were not feasible.

Table 17: Working structures

	Abstractions	Working Structure A	Working Structure B	Working Structure C
1	Create large external volume	Load bearing materials	Thin membrane (Structural frame with membrane in tension)	Structural frame with infill materials
2	Create series of internal volumes	Internal elements working with external structure to achieve stability	Light weight partitions within the external structure act independently of it.	Smaller volumes form the larger volume.
3	Create openings	Construct large opening using a structural frame.	Insert self supporting structural unit.	
4	Stable thermal environment	Thermal mass	High thermal resistance materials reduce the rate of heat loss.	Air tight barrier

The review identified that structural frame and load bearing solutions have been widely adopted during the construction of houses. However, no examples of thin membrane structures used for residential homes were identified. As a very light weight structure, with no thermal mass and little thermal resistance, the internal temperature control would be difficult with extremes of temperature requiring additional systems. As such, thin membrane structures have been removed from the options. A summary of these assessments are shown in Table 18.

Table 18: Feasibility of working structure combinations for building design

Working structure A	Working structure B	Working structure C	Feasible combination
Thin membrane	Structural internal walls	Thermal mass	X
Structural frame	Structural internal walls	Thermal mass	✓
Load bearing materials	Structural internal walls	Thermal mass	✓
Thin membrane	Light weight partitions	Thermal mass	X
Structural frame	Light weight partitions	Thermal mass	X
Load bearing materials	Light weight partitions	Thermal mass	✓
Thin membrane	Volumetric construction	Thermal mass	X
Structural frame	Volumetric construction	Thermal mass	✓
Load bearing materials	Volumetric construction	Thermal mass	✓
Thin membrane	Structural internal walls	Insulation	X
Structural frame	Structural internal walls	Insulation	✓
Load bearing materials	Structural internal walls	Insulation	✓
Thin membrane	Light weight partitions	Insulation	X
Structural frame	Light weight partitions	Insulation	✓
Load bearing materials	Light weight partitions	Insulation	✓
Thin membrane	Volumetric construction	Insulation	X
Structural frame	Volumetric construction	Insulation	✓
Load bearing materials	Volumetric construction	Insulation	✓

✓ feasible X not feasible

4.3.3 Functional requirements: Building elements

The conceptual design process was repeated for the building elements. The functional requirements for the panels were considered, presented in

Table 19 and Table 20.

Table 19: Abstraction of functional requirements for panel /element (Pahl et al. 1988)

Structural unit
Construction supporting the stable thermal and acoustic environment
Cosmetic surfaces

Table 20: Abstraction of panel functional requirements

<table>
<tr><th>Abstraction</th><th>Working structure A</th><th>Working Structure B</th><th>Working Structure C</th></tr>
<tr><td>Structure</td><td>Box frame structure</td><td>Composite structure</td><td>Strutural frame</td></tr>
<tr><td rowspan="3">Thermal and acoustic environment</td><td colspan="3">Insulation</td></tr>
<tr><td colspan="3">Thermal mass</td></tr>
<tr><td>Membrane</td><td colspan="2">Continuous plaster barrier</td></tr>
<tr><td>Aesthetic</td><td>Outer layer is supported by panel</td><td colspan="2">Structurally independent outer layer acts as surface</td></tr>
</table>

The creation of large external volume with a series of internal volumes has been simplified and is described as the panel needs a structural strength. The need to provide a stable thermal environment remains. The creation of openings has not been included as this is achieved by other components.

The building envelope and element types were differentiated into external wall, floor, ceiling, roof and internal wall, each with individual performance requirements.

All of the panels required structural components. The load bearing capacity was dependant on the function of the building solution. Solutions identified were a box structure and a composite structure.

The panels would act as part of the system providing a stable thermal environment. Elements separating the internal and external environments require insulation to restrict heat and sound transfer. The passage of sound between areas within the building must also be restricted. Materials with insulation properties were required.

The position of the panels determined the functional requirements of the surface facings. External surfaces must provide protection to the core elements. The surfaces will also need to have positive aesthetic properties; externally these are determined by the customer with input by planners. Internally, the surface must be visually pleasing. The surface choice will vary depending on the use of the space. However, here the most frequently used surface material, plaster has been selected.

Panels which interface between the internal and external environments require insulation and protective facings.

Thermal performance is not required for the internal panels; however, insulation from sound is needed. Dependant on the structural solution, the panels may have different strength requirements.

4.3.4 Design conflicts: Building elements

The function structures for eachof the functional requirements were combined to create conceptual solutions in a selection chart, as shown inTable 21 Each of the combinations were assessed for their feasibility, and solutions were disregarded if they were not feasible, as presented in Table 21.

Table 21: Feasibility of working structure combinations for panel design

Box frame structure	Membrane	Cladding	X
Composite structure	Membrane	Cladding	✓
Box frame structure	Continuous	Cladding	✓
Composite structure	Phase change material	Cladding	✓
Box frame structure	Membrane	Structurally independent layer	X
Composite structure	Membrane	Structurally independent layer	X
Box frame structure	Phase change material	Structurally independent layer	X
Composite structure	Phase change material	Structurally independent layer	X

4.3.5 Summary

The conceptual design process translated the product specification into possible product layouts. The solutions identified have the following features:

- The load of the building is supported by an structural frame or by the panels. Where necessary the internal walls can provide additonal load bearing support.
- The panels incorporate the insulation in their form.

- Thermal mass if present if provided by plasterboard. If plasterboard is used an air tight barrier must be included.
- The building has an external cladding layer.

4.4 EMBODIED DESIGN

4.4.1 Introduction

The embodied design stage developed the conceptual design using a variety of tools. The character of the solution was developed, shaped by manufacturing and assembly constraints, legal requirements and technical constraints. The following section describes how the product arrangement was developed through consideration of the manufacturing and assembly processes.

The design process required the repetition of design methods; a range of options were considered and the impacts of each decision assessed leading to refined solutions. The results of the processes are described here as if a linear process, with outputs of one design process becoming the inputs to the next stage; however, in reality the process has a cyclic nature.

4.4.2 Size requirements and layout.

The main constraint determining the module size leaving the factory was the ability to transport the prefabricated units from the factory to site. The size and weight of units were considered to ensure that they could be transported to site on a standard trailer. Unless the factory is set up adjacent to site, units must be transported along the road network. Table 22 details loading limitations of the transport options. A quick review of the limits indicates that the weight of loads is not a limitation but that the volume is.

Table 22: Transport constraints

	Length /mm	**Width /mm**	**Height total inc. vehicle /mm**	**Load**
Standard trailer	12300	2400	2540	
Abnormal load	rigid length >1865	2900	2540	>44,000 kg

Comparison of the building dimensions, shown in Figure 7 with the transport constraints, in Table 22, indicate that transporting the building as a fully assembled unit, from the factory to site on a trailer, is not feasible because it is too wide. As such, the building fabric must be divided into smaller modules.

Addressing panel elements, the dimensions of the full elements are given in Table 23. Single storey wall panels could be transported as single elements; however, the floor and roof elements were too wide to fit onto a trailer in any orientation. As such, they had to be divided into smaller modules. By transporting the elements to site as individual panels, a greater packing density can be achieved. Two designs were explored.

Table 23: Onsite assembly. Module dimensions

	Minimum	Maximum
Wall	4200*2400mm	7000 *2400 mm
Floor	7000*4200mm	
Upper floor and ceiling	7000*4200	
Roof	2177*7000	
Internal	2400*2400	4600*2400

Open panels comprised the core structure of the panel, without insulation, cladding or linings panel, when they left the factory. Transporting the panels without facings, allow them to be stacked on top of each other, which is the most space efficient method.

Closed panels were fully assembled in the factory, including cladding and linings. As they were more fragile, they were transported in a frame, on edge, as if in a toast rack. Where panels were too long to stand upright on the trailer, they were transported on their side perpendicular to the design assembly intention.

Both packing arrangements were able to transport the panels, (lining and cladding materials in the case of open panels) in two trailers. A third trailer was required to delivered roof trusses from the supplier to site.

Volumetric assembly achieved a lower packing density than the panel arrangements because of the empty volume within the room modules. As a starting point the volumes were determined by splitting the building in half, as shown in Figure 11. This produced two modules of 7.0 x 2.1m. Three of the volume sides were external walls and the fourth face had little, if any, support from internal wall elements. Including roof panels, transport from factory to site required four trailers. Two modules had long spans (4.6m) without any upright structural support for the

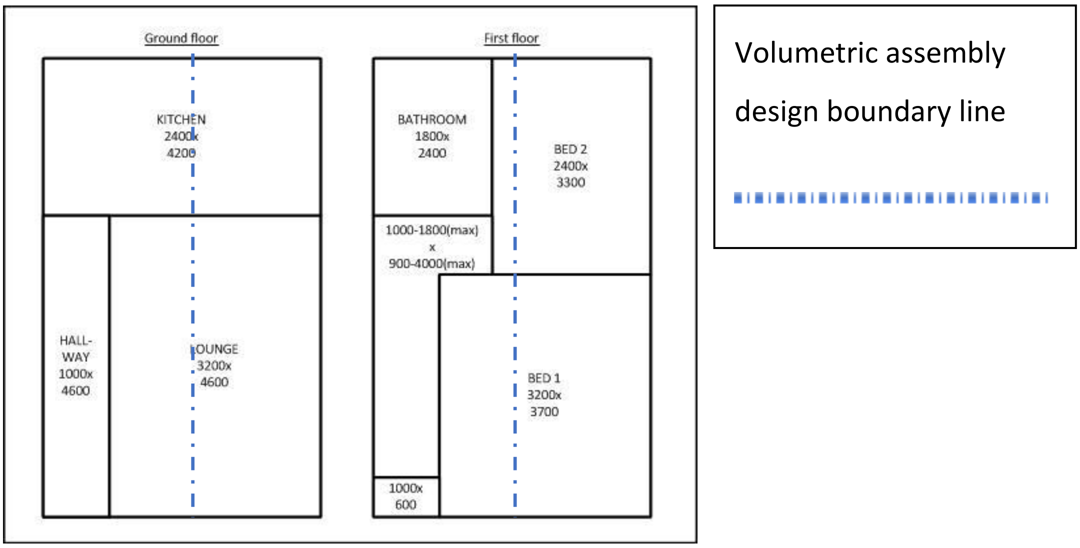


Figure 12:: Volumetric assembly: Equal sized modules: 1

ceiling panel; as such, structural supports to bear loads and provide rigidity during transportation and assembly would be needed.

A second arrangement considered nine modules of equal size, 4200*2330mm; 3 for each floor, as shown in Figure 12, the kitchen and bathroom walls were just beyond 2.33m at 2.40m, and could fit the transport width constraint of 2.55m. However,

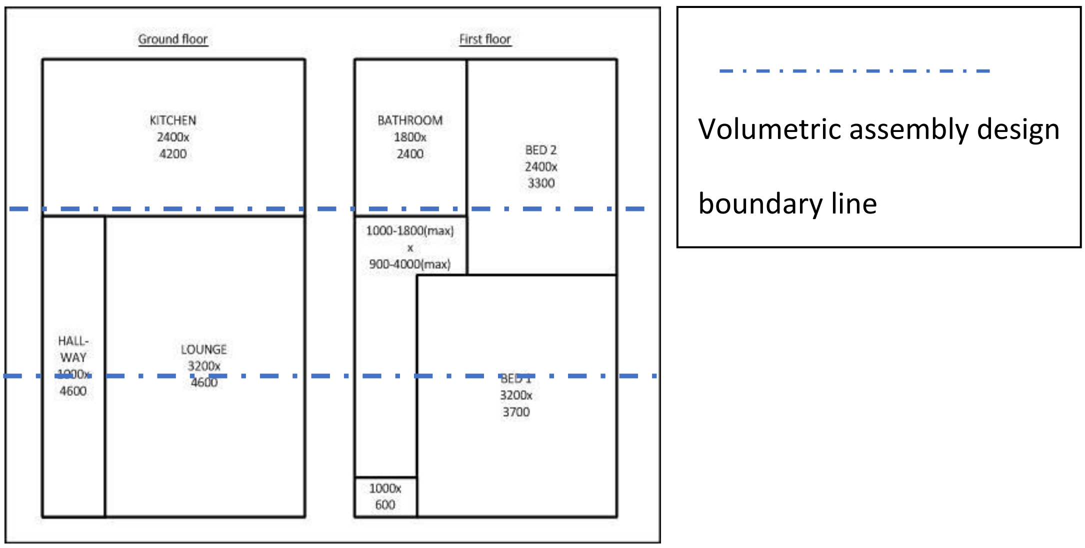


Figure 11:Volumetric assembly: Equal sized modules: 2

the building width is too large to fit three modules, from a single storey, on a single trailer, meaning that 5 trailers were required, Figure 15.

Using the principles of force transmission and stability (Pahl,Beitz et al. 1988 pg. 213), the final volumetric design was divided into room modules using the internal and external wall panels as module faces, Figure 13. The building layout indicated that while 2 rooms were larger than a standard trailer, they each had three load bearing walls and, as such, they could be engineered to be stable with bracing during transit. The layout in Figure 15 shows the packing arrangement. In order to minimise the number of trailers, the delivery of panels would not be in the order of assembly, and as such modules would be stored on site and require double

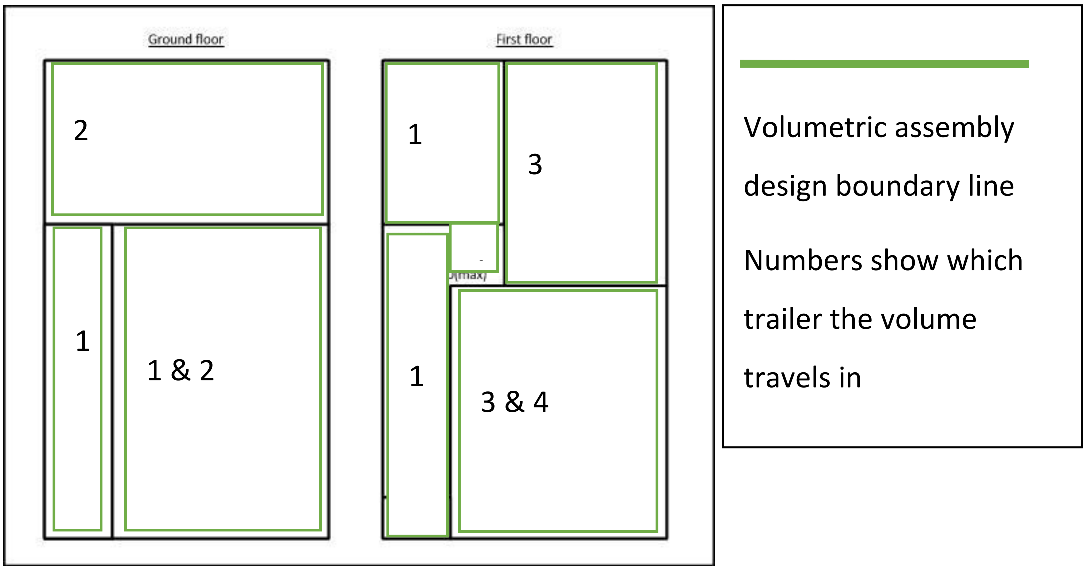


Figure 13: Volumentric Assembly: Room modules

handling. The number of trailers and the double handling meant that this solution was disregarded.

Many of the modules for each storey are the same, assisting the clarity and simplicity of the design. The basic layout assists structural design, structural elements should be aligned and by having the modules aligned the designs can be checked by overlaying the designs. If the internal elements were structural then some internal walls upstairs and downstairs would need to be aligned.

On this basis, the only volumetric option taken forward was "Volumetric assembly: Room modules"; both panel methods were also taken forward. A summary of the transport options is presented in Table 24.

Table 24: Summary of factory to site transport

	Typical module dimension Length *width (mm)	Number of trailers	Sequential assembly?	Packaging
Volumetric: equal sized module 1	7000*2100	4	No, but double handling only necessary for 1 module)	Additional structural supports
Volumetric: equal sized module 2	4200*2300 (adjusted to 2400 to utilize partition walls)	5	Yes	Additional structural supports
Volumetric: Room modules	Range 1000-4600	4	No	Additional racking support
Closed panel	Walls 2400*600 (1200/1800/2400) Floor 4200*600 (1200/1800/2400)	2 (plus delivery of roof trusses to site +1)	Yes	Protective wrapping
Open Panel	Walls 2400*600 (1200/1800/2400) Floor 4200*600 (1200/1800/2400)	1-2 (plus delivery of roof trusses +1)	Yes	No

4.4.3 Summary of transport design

Adressing the transport of the building between the factory and the site has defined the transport constraints for the modules. The buiding can not be transported as a single unit and as such must be divided into module. Three module types were considered, panel stacked (open), panel toast (closed), equal sized (vol.). The following summarising the finding for each type:

1) Volumetric design:
    a. Transported modules as single storey, including floor and ceiling panel.
    b. Using room shapes to determine modules allowed for greatest structural stability during transport.
    c. Four trailers were required

d. Module dimensions 1000-4600mm

2) Open panel design:

a. Core of the panel was transported flat within 3 trailers

b. Panel size up to maximum 4200 length.

3) Closed panel design

a. The panel core with lining and cladding were transported on their edge.

b. Up to three trailers were required.

c. Panel size up to maximum 4200 mm

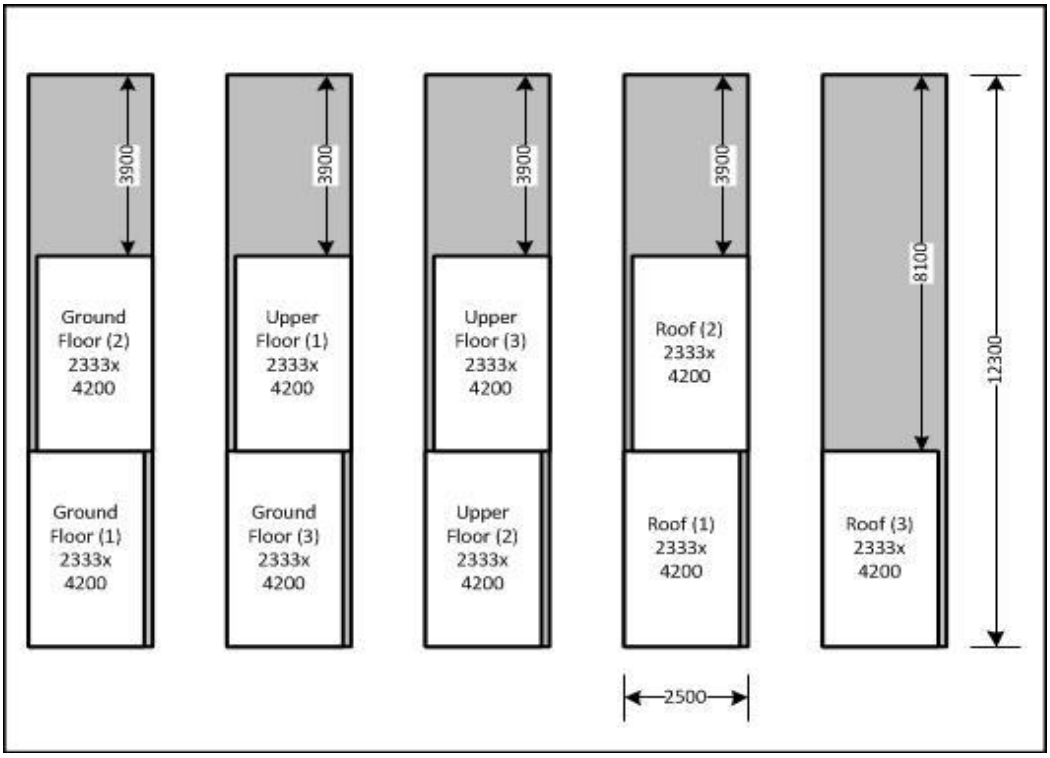


Figure 14: Feasible volumetric packing arrangements: Equal sized module 2

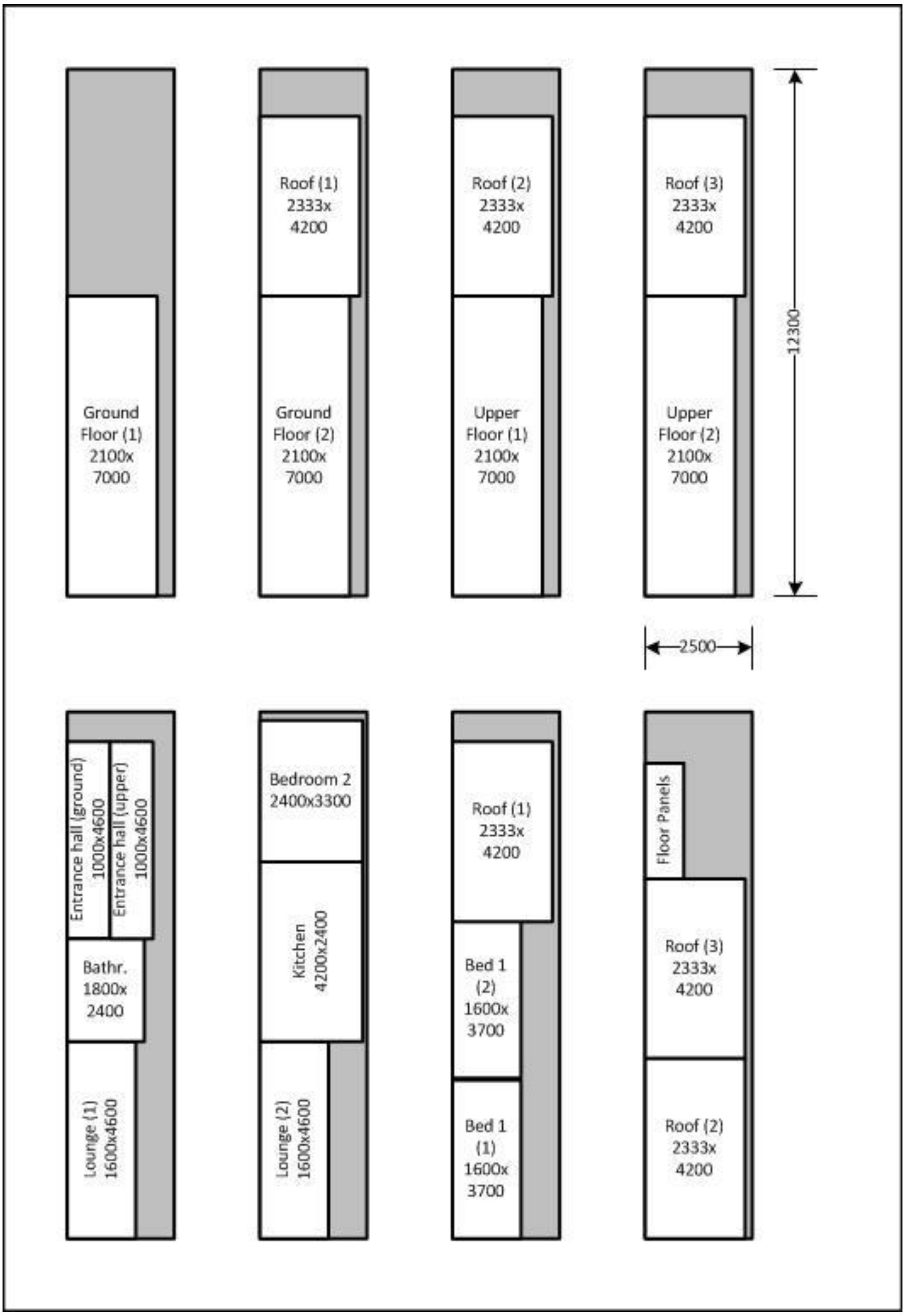


Figure 15: Feasible volumetric packing arrangements: Equal sized module 1 & Room modules

4.4.4 Element design

The functional requirements identified the product needs at the building level. This level addresses of functional requirements of the elements in the building. Each element as a unit must meet their own specific set of functional requirements determined by their position in the building. Each of the functional carriers met several requirements including structural requirement, thermal and acoustic performance, and aesthetic requirements as detailed in Table 25. In order to maitain a modular approach, a similar design was used for the core of each panel solution. Adaptions then ensured the panel met the functional requirements of the element, as described in Section 4.3.

Table 25: Functional elements of panel

Panel profile	External wall	Internal wall	Ground floor	Roof	Roof gable	Upper floor	Ceiling
Aesthetic surface Internal protective surface /thermal mass	✓	✓	✓			✓	
Air gap, and services channel	✓	✓				✓	
Air barrier	✓			✓	✓		
Structural components	✓	✓	✓	✓	✓	✓	✓
Insulation	✓	✓	✓	✓	✓	✓	✓
Membrane	✓		✓	✓	✓		✓
Air gap /hygrothermal	✓	✓		✓	✓	✓	✓
External protective surface Aesthetic surface	✓	✓	✓	✓	✓	✓	✓

4.4.4.1 Materials palette

A material palette was developed based on the functional requirement. Materials were chosen which were well established in the construction industry. Information relating to materials that met the requirements of the working structures were gathered and detailed descriptions are presented in the Appendix D. Table 26 summarises the key design factors.

Structurally timber, laminated timber, steel and concrete are among materials that provide the structural strength required in the frame. Where a frame is in place, infill panels may be used for the walls, otherwise panels must be designed to be load bearing.

Composite panels use an expanded polystyrene foam core with a rigid material on the outer surfaces. Concrete, oriented strand board (OSB) and steel are possible outer materials using sandwich form.

Box panels can be structural or non-structural and are produced using a combination of structural and non structural components to produce a box shaped panels. Insulation is inserted into the internal volume of the box, sheathing materials are used to face the top and bottom of the panel.

Insulation typically comes as highly porous material, such mineral wool, glass wool, or sheep wool. These are supplied as rolls of material between 400 and 600 mm wide and are cut to the length required. Thicknesses of the of the insulation are available as multiples of 25 mm, between 100 – 300 mm. Blown materials, such as recycled paper and expanded polystyrene (EPS) balls can be installed into contained volumes. Finally, rigid insulation materials are available as batts, examples are EPS and dense wool slabs. Thermal mass can be made available through concrete elements or plasterboard impregnated with phase change materials (PCM).

Vapour barriers control the passage of moisture through it based on temperature, allowing warm air through, but remaining closed to cold air. There is little variation between membrane products. In order to be effective membranes must form a continuous layer, this is achieved by overlapping membrane sheets and taping. Wet plaster can be used to form a continuous air barrier if carefully detailed. In order to achieve the continuous air barrier the plaster must be applied on site. Plasterboard can be used to create an air barrier as long as a continuous ribbon of sealant is used to fix the board.

Structural Insulated Panels (SIP) are created from a sandwich of two 18 mm OSB board with an EPS sandwich filling. Manufacture requires gluing and compression of sandwich to fix.

The EPS can be formed by heating pellet styrene polymers, reducing initial storage requirements. However, it is reported that manufacture of EPS is only economical for very large volumes, over 500,000 m^3 , which is not feasible in this context. EPS is available to the factory in their expanded form in sheets up to 1200 mm from builders merchants. Larger custom sizes could be available; however, the glue machines are restricted to a maximum 1360 mm.

Table 26: Material palette

Function	**Material**	**Life span**	**Standard sizes**	**Production**
Building Structural frame	Glulam	Life time	Custom to order	Custom to order
Building Structural frame	Steel	Life time	Custom to order	Custom to order
Building Structural frame	Concrete	Life time	Fixed by design	Wet trade, molds
Load bearing material	I joist	Life time	Custom to order	Custom to order
Structural panel internal walls	I joist	Life time	Custom to order	Custom to order
Load bearing material	Oriented strand board	Life time	2400*1200 mm	Table saw
Structural internal walls	Oriented strand board	Life time	2400*1200 mm	Table saw
Light weight partition	C16 Timber	Life time	2400*240 mm	Circular saw
Load bearing material	Plywood	Life time	2400*1200 mm	Table saw
Insulation	Sheep wool	Life time	Custom 525*240 mm	Scissors
Insulation	Warmcell	Life time	Custom to order	Blown
Insulation	Mineral wool	Life time	Custom 525*240 mm	Scissors
Insulation	Expanded polystyrene	Life time	2400*1200 mm	Table saw
Light weight partition	Plaster board	Maintenance	2400*1200 mm	Jig saw
Thermal mass	Gypsum plaster	Maintenance	2400*1200 mm	Wet trade
Thermal mass	Plaster board with PCM			Jig saw
Air barrier	Gypsum plaster	Maintenance	2400*1200 mm	Wet trade
Air barrier	Membrane	Lifetime		Scissors
Aesthetic	Red cedar	Maintenance	Unit lengths to nearest metre	Saw- onsite
Battens	Timber	Maintenance	2400*44*38 mm	Circular saw

4.4.5 Panel arrangements

The panel functional requirements were combined with the material palette to create the panel solutions. The relative position of the materials affected the performance of the panel. Two solutions were created and the arrangements for the wall panels designs are presented in Table 27 and Table 28.

Panel depth varies according to the materials used. SIP panels are the slimmest with an open panel depth of approximately 150 mm to achieve a wall u-value of

0.17W/m2K. Timber frame with a sheepwool insulation will have an open panel depth of ~240 mm to achieve similar.

Table 27: Panel profile: Timber frame

Timber frame Panel profile / Thickness of parts			Wall (mm)	Floor (mm)	Roof (mm)	Roof gable (mm)	Upper floor (mm)	Ceiling (mm)
Inner surface	Plasterboard		12.5	0	0	0	12.5	12.5
	Battens (horizontal)		38	0	0	0	0	
	Battens (vertical)		38	0	0	0	38	38
	Membrane		1	0	1	1	0	0
Box panel	Sheathing board		11	11	11	11	11	11
	Insulation		240	240	240	240	240	240
	I-joist		240	240	240	240	240	240
	Top and bottom boxing		240	240	240	240	240	240
Outer surface	Sheathing board		11	11	11	11	11	0
	Vapour membrane		1	1	1	1	0	0
	Battens (horizontal)		38	0	38	38	0	0
	Cladding	Battens (vertical)	38	0	38	38	0	0
		Red cedar	19 (38)	0	19 (38)	19 (38)	0	0

Table 28: Panel profile: Structural Insulated Panel (SIP) (solution 2) Option 2

SIP Panel profile / Thickness of parts			Wall (mm)	Floor (mm)	Roof (mm)	Roof gable (mm)	Upper floor (mm)	Ceiling (mm)
Inner surface	Plasterboard		12.5	0	0	0	12.5	12.5
	Battens (horizontal)		38	0	0	0	0	0
	Battens (vertical)		38	0	0	0	38	38
	Membrane		1	0	1	1	0	0
Composite Panel	OSB		18	18	18	18	18	18
	Insulation (EPS)		240	240	240	240	240	240
	OSB		18	18	18	18	18	18
Outer surface	Vapour membrane		1	1	1	1	0	0
	Battens (horizontal)		38	0	38	38	0	0
	Cladding	Battens (vertical)	38	0	38	38	0	0
		Red cedar	19 (38)	0	0	19 (38)	19 (38)	0

A joist spacing of 600 mm was is the maximum spacing advised by the suppliers. Based on this spacing, panel sizes were multiples of 600 mm. This also enabled components size to correspond with standard sizes. While SIP panels do not necessarily have to conform to the same structural design constraint, machinery available for gluing panels has a maximum width of 1200 so multiples of 600 mm have been adopted to simplify comparison between solutions. Furthermore, standard size of materials used to produce the SIP panels are based on 600 mm.

4.4.6 Sustainability assessment

4.4.6.1 Environmental assessment

An environmental assessment was produced for each whole-bulding design. By creating a single score for cumalative impact of the building materials, each solution could be presented. Scores for the elements were aggregated, based on surface area.

The environmental impact was described using a score out of 10. The higher scores correlated with low impact elements. Table 29 shows how the ratings used in the Green Guide were converted to metric scores. Details of Green Guide Ratings which correlate with the general solutions are given in Appendix D and are summarised in Table 30 below.

Table 29: Environmental Assessment: Green guide rating conversion to metric score

Green Guide	**A+**	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Environmental metric	10	6	2	0	0	0	0	0

Table 30: Environmental Assessment: Elemental Green guide rating

Element		**Range**
Upper floor construction	Timber frame Concrete floor slab	A/E E
External wall construction	Cladding on timber frame construction Cladding on light steel framed construction	A+/ A A+/ A
Separating floor	Steel Timber	A/B A+/A
Internals wall	Framed partition Proprietary and demountable partitions	A+/A A+ / D
Roof construction	Pitched Roof steel construction Pitched roof timber construction Pitched Roof SIP construction	A+/ B

The case study company determined that the building should be able to be promoted as sustainable building to the public. As such, a design requirement that individual elements must achieve a Green Guide rating above "B" was determined. Scores for the elements were combined according to the surface area within the building. Output scores for the environmental metric had little variation, as shown in Table 31.

Table 31: Environmental score (surface area) of the panel types

Panel Type	Environmental score
Timber panels.	10
SIP panel	10
Structural	6
Non structural	10
All insulation types	No change

The environmental assessment has limted scope to inform the designer about the design space. The use of elements assessment to calculate the score meant that design improvements are not accounted for. Improvements are achieved by a reduction in material volumes, waste and energy consumption. Within a solution type the saving achieved by panel size are reflected in the material inventory and manufacturing time, as such, the information relating to the environmental impact within the the design space can be understood.

4.4.6.2 Responsible sourcing

The responsible sourcing metric was based on the material choices and their suppliers. Each material product was given an individual score based on the social responsbility of the supply chain. Solutions scores were calculated by aggregating scores using the weightings in Table 32. Solution scores were in the range 4.85-5.6, with a mean score of 5.3. The traditional construction score was 5.5.

Table 32: Responsible sourcing: Weighting

Element	Weighting
Panel	0.4
Cladding	0.2
Insulation	0.1
Lining	0.2
Structure	0.1

Table 33: Responsible sourcing: Scores

Timber panel	**SIP**	**Red cedar cladding**	**Lining**	**Glulam structure**	**Steel structure**
3	3	2	2	3	0.5
EPS	**Warmcel**	**Rockwool**	**Sheepwool**		
0	2.0	2.5	3.0		

4.4.6.3 Health and Safety

No filtering of materials, based on the health and safety assessment was made at this stage. This metrics focusses on processes which have not ben developed at this stage in the design.

4.4.6.4 Adaptability

Asessing adaptaboility at this stage. The design flexibility of the proposed solutions were assessed. The assessment identified that concrete panel method had low modular design flexibility because changes to panel size or form alteration required new moulds and additional investment. As such, concrete was considered not suitable.

4.4.6.5 Cost

As a first level assessment, the initial investment cost for equipment was considered. The assessment identified that concrete panel required significant investment in moulds or forms for pouring panels, and that this method had little adaptability with respect to design. As such, concrete was considered not suitable.

4.4.7 Design for Manufacture: Panel

Design for manufacture and assembly tools methods were developed to improve the efficiency of manufacture and assembly in the factory, and in the factory setting the data developed in Boothroyd (1994) can be applied. The panel design was addressed using the method described in Section 3.5.2.2. Each component was considered, addressing whether it could be eliminated, reduced or replaced. The summary of the assessment is presented in Table 34.

Table 34: Assessment of components

Function	Material	Replace/ Eliminate/ Minimise
Structure	Glulam Steel, Concrete Composite	Adopt a structural design that does not require a structural frame. Building layout can be designed to optimise structural efficiency.
Panel (Structural)	I joist Steel	Ensure spacing is maximized.
Panel (Structural)	Timber	Remove components if other parts provide structural integrity. Optimise structural efficiency by minimising number of panel elements.
Panel (Form) (Top and bottom of panel)	Timber	The part forms a spacer to separate other components, then design the components to they replace with a single manufactured component. removing the need for the additional parts.
Structural racking strength	OSB	Plasterboard could offer some structural rigidity. Where a structural frame is used this will provide. Racking strength to be achieved by using diagonal bars.
Hold insulation in place	OSB	Rigid insulation may not require boarding. For SIP panels for the insulation also forms the structural component. Membrane, netting or nails could be used to hold insulation in place.
Structure	Plasterboard	Plasterboard comes in a variety of weights, the minimum weight for the purpose should be used.
Thermal mass	Plasterboard	PCM plasterboard has good performance and can reduce the need for less efficient materials.
Insulation	Insulation	Replacing with alternative material with greater R-values would reduce required wall thickness.
External protection	Cladding	External protection: Alternative materials can be identified; however, a sacrificial material is required. If the core structure of the panel can maintain its function over the lifetime of the building then is may be suitable.
Air tightness	Air tightness membrane and tape	Use wet plaster to create an airtight seal. Tape board without using membrane. Remove difficult arrangements and layouts during design to maximize performance and minimize failings.

Addressing the panels, the original design comprised two timber I-joists as upright structural components; two horizontal timbers were used to create a box frame. OSB sheeting provided rigidity and created and internal volume that also contained the insulation. A final surface was formed by a membrane.

Based on the assessment the following design assessments were made

- SIP panel requires fewer parts than timber frame, as shown in Table 35.

- Panel size affects the number of I joists required. Materials and material manufacture can be minimised by maximising the size of the panel. Larger panels require few I joists. Material saving for using I joists, as shown in Table 36.
- A membrane could be suitable for holding insulation in place reducing the volume of OSB board required for timber frame.
- Wet plaster could replace membrane to ensure air tight construction.

Table 35: Number of components per building (core panel)

	600	1200	1800	2400
Timber Frame	2738	1788	1290	1024
SIP	1542	1016		

- Table 36: I-joist material in timber frame panel building

	600	1200	1800	2400
Per wall panel /m	4.8	7.2	9.6	12.0
Total I joist length in building /m	960	765	639	540

4.4.8 Machining parts

An inventory of parts for each panel was created. Machining times were then calculated for the parts. Costs were prepared for each panel and then for the whole building. Table 26 details the material preparation methods used.

Insulation and membranes were not cut using machinery blades but were cut by hand. They did not account for any power consumption associated with their preparation. Prepepared I joists were supplied at the necessary lengths from the manufacturer.

Timber machining data comprised setup time and cutting time. Cost of materials and labour and power consumption were calculated for each component based on the machining data. Parts were cut from standard sized materials. The maximum number of components were manufactured from a single sheet and the total cutting time divided among the total number of pieces. Where multiple components of the same size were required, one machine set up was required for all of the components of that size in the building.

Panel sizes were selected which optmised the cutting lengths required. For example froma OSB board, a single piece 2400 mmx 1200 mm would not require any cutting, but a 600 mm required one cut of 2400 mm and produced two pieces.

The impact of panel size affected total machining times and cost. Table 37 and Table 38 describes the total material machining times for wall panels in timber frame and SIP respectively, results for all materials are presented in Appendix F.

Table 37: Machining time in factory: Timber Frame Open Panel

Panel size	**Factory setup (number of unique components)**	**Set up times**	**Total setup**	**Total time**
600	11	612.00	660	386581.72
1200	8	612.00	480	218367.03
1800	15	612.00	900	231785.68
2400	8	612.00	480	256997.72

Table 38: Machining time in factory: SIP panel Open panel

Panel size	**Factory setup (number of unique components)**	**Set up times**	**Total setup**	**Total time**
600	9	612.00	540	292271.88
1200	7	612.00	420	236577.64

4.4.9 Panel assembly time in the factory

Panel assembly in the factory occur at a workstation. Butterfly tables enable the minimal handling of heavy partially assembled modules. Assuming that parts could be organised in a workstation arangement around a central assembly point, time were calcluated for the assembly of panels using methods described in Boothroyd (1994)

Panel assembly was calculated in accordance with the description in Section 4.4.4. Parts typically had at least 180 degrees of symmetry which enables easy and could be positioned and fixed easily. Assembly and fixings were typically from above, except for top and bottom box panels which required horizonatl fixing. Panels were square and the use of a butterfly table would assist maintaining the correct shape.

Where lining and cladding were fixed to the panel, this was completed with the panel in an upright position.

Table 39: Factory assembly times for timber frame panels. Total for building in hours

	600	1200	1800	2400
Open	88	49	61	48
Closed	100	64	68	52

Table 40: Factory assembly times for SIP. Total for building in hours

	600	1200
Open	1.1	2.5
Closed	0.3	2.2

4.4.10 Volumetric manufacture and assembly in the factory

The design of the volumetric solution divided the building into volumes of different sizes. This led to a larger number of different sized element units, compared to the panel assembly method. As such, volumetric assembly required a larger number of element panels which did not match the standard module sizes (600, 1200, 1800, or 2400 mm) and a larger number of component set-ups, assembly set-ups creating a greater inventory of parts. Table 41 shows the comparison between panel and volumetric assembly. Manufacture and assembly times for the panels are presented in Table 42.

Table 41: Total number of panels

	Panel	Volumetric
600	187	234
1200	98	128

Table 42: Assembly times for Timber Frame volumetric modules

	Machinery Setup	Set up time	Assembly times (panels)	Assembly time volume
600	17	1020	333247	195806
1200	16	960	244915	106020

A second phase of assembly in factory created volumetric modules. It was assumed that panel elements were assembled from the components prior to the asembly of volumetric modules. The larger inventory of panels means that there is greater handling. This has not been fully reflected in the assembly times because the times assumed that the modular components are available at the workstation.

4.4.11 Design for Assembly: Panel assembly on site

Having established the general sizes of panels and volumetric modules as determined by transport constraints, the assembly of the units on site was considered. The panel size and the arrangement of materials affect the assembly methods and the sustainability of the process. Designing for assembly aims to minimise time of construction and with the additonal sustainable requirement the heath and safety impact of assembly is considered here.

In the factory, assembly time is minimised by reducing the number of parts and optimising the form. In the factory, where small components can be arranged close to the assembler at the workstation, moving components from storage has little effect and so the number of parts, the ease of positioning and fixing are most important. Onsite, modules to be assembled are much bigger and must be manoeuvred by more than one person and often also require lifting equipment. Frequently, the modules must also be moved to the location of assembly from a distant position. These factors affect how the design for assembly results present.

Boothroyd (1994) described methods to calculate the time taken to assemble components in a factory and these were adapted for use on site. Assembly times were calculated using a combination of literature data and estimated values. The assembly times for the proposed solutions are presented in Table 40.

Onsite, if elements (wall, floor etc.) are transported as single modules, cranes would be required to lift them into position. However, if elements were divided into modules small enough, they could be carried into positions without additional lifting equipment.

The weight of structural panels are shown in Table 43. Assuming a worker can carry 20-25 kg and an upper limit of 6 workers handling a panel as a team, panel weights of 120-150 kg can be moved. All open panel types of width 600 mm and 1200 mm and closed 600 mm can be handled without lifting equipment. Where lifting equipment is required, the panel size determines the number of lifting points required and the speed the panel can be moved.

Where the volumetric modules were assembled in combination with a structural frame, only self-loads act on the modules. These units can slot into the frame like drawers. In contrast, infill panels transfer their load directly to the frame, and therefore, require structural elements to be present before they are built.

Table 43: Weight of structural panels (kg)

	Elements					
	Open			Closed/ Volumetric		
Mass per whole panel	Minimum	Maximum		Minimum	Maximum	Handling
600	17.94	73.86	Person	32.02	119.22	Person
1200	29.53	126.30	Person	57.69	217.02	Lifting equipment
1800	41.12	178.74	Lifting equipment	83.37	314.83	Lifting equipment
2400	52.71	231.18	Lifting equipment	109.04	412.63	Crane

Sealing the building to ensure airtightness appears to be most difficult for the modular solution. While, the assembly of volumetric modules in the factory can be produce better quality outputs, where finishes are in place, connecting the module interfaces present challenges. Where plasterboard is designed to be the primary air barrier in a dwelling, a continuous ribbon of adhesive is required. Similar measures should be considered when faces are connected. Using a sealant on site has the lowest economic cost and was adopted in the design. Alternatively, a gasket could be installed in the factory; however, accurate information for costs was difficult to obtain and was not pursued further here. Finally, the vapour barrier already presented could be relied on to ensure airtightness. Tiems to lift and install the panels are presented in Table 44.

Table 44 : Times taken to assemble panels onsite

Summary	Person hours for assembling house on site		
	Lifting panels into place on site /s	Sealing panels	Total
600	155.47	156.47	311.93
1200	67.53	68.14	135.68
1800	51.60	52.13	103.73
2400	37.47	37.88	75.35

The assembly of the building using volumetric units minimised the number of module moves required on site. Distances moved between storage location and building can be larger, and have been assumed to be 15000 mm, greater than the 7000mm assumed for the panel assembly. The position of lifting points must to be carefully designed by engineers for each module; here the number of points was assumed based on the weight of the module. As for the panels, crane speeds were adjusted to account for the weight of the modules. Assembly time presented includes time for assembly of volumes in the factory.

Table 45 shows the assemby times for the different panel sizes. The shortest onsite assembly time was for the volumetric assembly. This is in part because much of the assembly would be completed in the factory. Of the panel designs, the smallest, 600 mm panel was the fastest assembled onsite because it could be positioned without lifting equipment. The adoption of larger panels meant fewer moves, and as such for the panels which required crane movements, assembly times fell with increased panel size.

Table 45 Sumarry of assembly time (Panel positioning and sealing)

Module	**Handling**	**Total Assembly time /hours**	**No of persons**	**Construction time /days**
600	Two person	64.29	4	3.10
1200	Crane	186.61	2 + crane operator	6.16
1800	Crane	121.74	2 + crane operator	4.02
2400	Crane	115.25	2 + crane operator	3.77
Volumetric (Baed on 600mm panel)	Crane	8.63 (+39.9)	2 + crane operator (assembly in factory	

4.4.12 Sustainability assessment

The impact of assembly times on the environment are considered to be small and not discussed here. Material choices are not imapcted by onsite assembly so responsible sourcing metric is not affected.

The cost implications of onsite assembly are related to the hiring of the crane which has a day rate. The times presented in Table 45 described the total time, for all of the activities, and do not account for work to be completed concurrently. Cost of the crane are included the each solution dependant on the panel size.

The positioning of panels and modules on site was considered the most hazardous activitity. The movement of large objects across site requires careful management. With 600 mm panels the risk is low. Handling of panels can be controlled and the severity is lower than for large panels.

4.4.12.1 Design for manufacture: On site

Manufacturing decisions affected by the activities on site were panel size, and choice of cladding materials. Transport of the panels, affecting panel and module sizes has been discussed above. The preparation of cladding is discussed here.

Cladding and lining materials provide a protective covering to the core sturctural materials and provide the aesthetic surface. Building fabric can achieve a long life, as long as the external surfaces protect the internal materials. To achieve this, the external facing and internal linings were treated as sacrificial and allowed to have a shorter lifetime than the building. Recognising that materials will need to be replaced, the design should enable maintenance. Where materials are removed and replaced, damage to remaining parts should be minimised.

Cladding systems considered were determined by the functional requirements described in Section 3.5.1. Red cedar was selected for cladding, which could be assembled in the or onsite. Red cedar was provided as timber pieces 5000 mm long. Materials were cut to length and could be assembled in the factory or onsite. If assembled in the factory, the cladding panel was more delicate than the core panel module, and transport to site was in a “toast rack” method, on end.

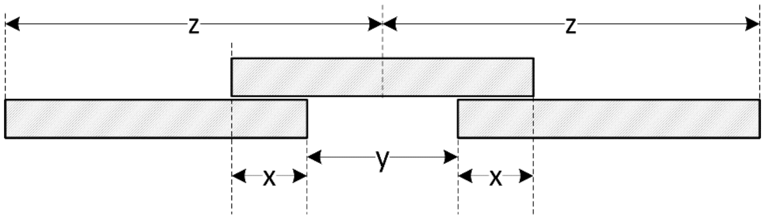


Figure 16: Cladding layout using overlapping pieces

The cladding layout used over lapping pieces, as shown in Figure 1616. The minimum overlap to prevent water ingress was 13 mm. In order to enable assembly units that matched panel sizes a range of overlaps were calculated. Table 46 shows the results. 19 mm overlap was chosen as the requiring the least material but allowing for the most simple assembly.

Table 46: Overlap options for red cedar cladding

	Option 1	Option 2	Option3	Option 4	Option 5
Board width	94	94	94	94	94
Gap (y)	56	60	65	67	70
Overlap (x)	19	17	14.5	13.5	12
Overlap test	Pass	Pass	Pass	Pass	False
Repeating unit	150	154	159	161	164

Manufacture of parts in the factory was assumed butonly the two conditions. assembly in the factory and asembly onsite were considered. Assembly in the factory was designed to be completed as part of the panel assembly and on site a connecting piece to ensure continuity would be fitted. On site assembly would require assembly in situ. This would require scaffolding to enable safe handling of materials.

Assembly times were calculated for onsite and factory assembly. Additional assembly time resulting from onsite assembly was estimated based on expected fixing times and movement of materials from the working area to the building. On site data, similar to Boothroyd (1994) is not available and as suvch time have been increased by 50% to reflect the additional effort.

4.4.12.2 Summary

The embodied design process has explored the design space through the application of design tools. Taking conceptual designs, design for manufacture and assembly was used to develop the construction process. The tools have created design information, in the form of component inventory, and time and cost data as well as sustainability information. The information will be used in the next section to assess the whole life sustainability of the solutions.

The design process has produced solutions which meet the functional and sustainable requirements. Through the embodied design process the design space has been explored and the solutions have been refined. Based on the information gathered the following design conditions are considered to be the most favourable.

- SIP is the most efficient method because of the efficiency of parts. The low number of parts meant that maching and assembly times were reduced compare to the timber frame alternative.
- The selection of SIP means that the insulation parameter was fixed.
- Volumetric construction has shown the benefits of reduced assembly time onsite.

4.5 TRADITIONAL CONSTRUCTION METHOD

The traditional construction method in the United Kingdom is a brick house with a tiled roof. The outer leaf of the building has an insulated cavity wall. The roof has a trussed construction and is covered with a vapour membrane and tiles. Internal walls are a mixture of structural and non-structural elements. The ground floor is built over a hardcore layer; insulation and a damp proof membrane (DPM) are covered with a concrete floor slab. Upper floors are built using timber joists; where spans are greater than the length of the available joists, additional beams may be used to provide extra support. The following sections described the materials and construction process in greater detail.

4.5.1 Materials

Materials were chosen to meet the requirements of the element construction and are described in Table 48.

Table 47: Design options and recommnendations

Conceputal				**Transport**	**Materials**	**Design for manufacture (factory)**
Building	**Panel**	**Thermal**	**Aesthetic**			
Structural	Box frame structure	Air tight membrane	Cladding	Open	Timber frame materials defined Insulation options	Smaller panels do not require a crane to complete assembly
Non-structural	Composite structure	Phase change materials	Lining	Closed	SIP panels defined Insulation :EPS	
		Continuous plaster		Volumetric Module size based on rooms	Cladding options	

Table 47… continued

Machining (factory)	**Assembly (factory)**	**Assembly (onsite)**	**Adaptability**	**Health and Safety**
Preference for 1200 and 2400	SIP panel	Larger panels	Independent structure	Smaller panels
	Larger panels	Insulation installation in the factory	Smaller panel	SIP panels
	Insulation installation in the factory			Structural frame

Table 48: Material selection for traditional construction

Element	Material
Ground floor	Hardcore: aggregate
	Insulation: Mineral wool
	DPM
	Concrete floor slab/ Screed
External wall	External brick work: clay brick
	Mortar (ready mix: sand and cement)
	Void Wall ties
	Insulation: Mineral wool
	Internal block (pg. 173) : Aerated concrete brick
	Plaster: Wet plaster
Internal upper floor	Gypsum skim
	Gypsum base board
	Timber joist Beam Struts
	Insulation 100 mm
	21mm softwood floor boarding /chipboard
Roof	Rafters and trusses
	Insulation
	Roof felt
	Battens
	Plain tiles (burned clay) Ridge tiles
Internal wall (structural)	Internal block (pg. 173)
	Plaster
Internal wall (non-structural)	Clay block
	Wet plaster

4.5.2 Construction process

This section describes the construction process used in the research.

Ground conditions vary significantly across the country. Foundation depth for a house is usually about 1.2 m. Soil conditions in each location must be investigated and foundation and service routes should be designed accordingly. The development of brownfield sites requires increased caution. The construction process outlined here, starts at the point that the building is raised above ground level. As such, preparation of foundation and services have not been included.

The ground floor is built onto a hardcore layer, onto which a insulation layer is installed. A DPM prevents moisture wicking into the fabric of the building. The DPM is continuous from the floor level, over the internal block work and external brick work.

Building up from the prepared ground level, and assuming strip foundations, the double skin of concrete block and brick are constructed by bricklayers. Insulation is fixed, flush to the inner layer as the wall progresses. The leaves are attached to each other using wall ties.

Structural internal walls are constructed at the same rate as the external walls.

The first floor is constructed when the external walls reach the suitable height, this provides a platform for the safe construction of the walls to the first floor.

Joists and beams for the first floor and the upper ceiling are installed using joist hangers.

A wall plate is installed along the external wall of the building. When construction is managed solely on site, ridge board, rafters and trusses will all be prepared and assembled. Pre-fabricated trussed rafters are very widely across the housing construction industry. As such their usehas been assumed here.

Once assembled roofing felt is used to enclose the roof space. Battens are constructed, running horizontally along the length of the wall, onto which tiles are fixed. Tiles are fitted with an overlapping patter. Special tiles are required at the edges and the ridge of the roof. The lining is a wet plaster.

Windows and doors are installed, making the building water tight. The first fix installs the plumbing and electrical fitting which are then encapsulated within the fabric by the lining. The second fix completes the building by installing fitting such as switches, sockets, and surface finishes.These stages are not included.

4.5.3 Sustainability assessment

4.5.4 Environment

The building element were review using the Green Guide and the elements all had ratings A+. Details are presented in Appendix D. As such, the traditional building method has an environmental score of 10.

4.5.5 Cost

Cost for the traditional construction was calculated using an estimating guide. Disposal of waste at the end of life was clauleted based on the volume of materials. Unit areas for each of the elements were calculated and used to estimate costs for the build. The whole life time cost was £24,030.

4.5.6 Health and Safety

A risk assessment was undertaken for the construction processs. The original metric addressed the the construction in phases, and addressed the onsite and factory work separately. Traditional construction does not have a LCA phase in the factory factory. As such, the building construction was considered in terms of the work required to assessmbl the building elements, as shown in Table 49.

Table 49: Risk Assesment for traditional construction

	External wall Internal wall	**Ground floor**	**First floor/ upper ceiling**	**Roof**	**Internal finishes**	**Mainten-ance**	**End of life**
Traditional construction	**Con. * L-Hood**	**Con. * L-Hood**	**Con. * L-Hood**	**Con. * L-Hood**	**Con. * L-Hood**	**Con. * L-Hood**	**Con. * L-Hood**
Handling	4	1	6	6	4	6	2
Risk of falling	6	2	6	9	1	6	4
Exposure to toxic materials	4	4	2	4	4	1	1
Exposure to the elements	4	4	4	4	4	4	4
Risk of Injury (by equipment)	2	1	1	12	1	4	4

4.5.7 Adaptability

The adaptability of the traditonal design and construction was considered using the methods described in Section 3.6.3.3. The results are presented in Appendix H.

4.6 SUSTAINABILITY SCORE

The design process enabled much information and understanding to be created about the design space. Individual metric scores indicated how each solution performed with respect to a sustainability issue and enabled patterns to be to identified. Table 47 summarises the design recommendations developed from the SCDP.

In order to understand how the conflicting design requirements balanced a single sustainability score was calculated by aggregating the metric scores. Metric scores were calculated and aggregated to give a sustainability score for each of solutions. In order to reflect the relative importance of environmental, social and economic factors, agreed with the business, weightings were applied. It was considered that environmental and social impacts had equal importance to economic factors. Environmental issues were predetermined by industry experts to give the weighting used within the Green Print assessment. Responsible sourcing, adaptability and health and safety metrics all contributed towards the total social impact. Their weightings were adjusted to give equal contribution to the social impact. The weightings applied to the criteria scores are described in Table 51.

4.6.1 Sustainability metrics

Each of the sustainability issues identified were scored by the application of a sustainability metric. The metrics scores values reflected the method and as such had different ranges to each other. In order to ensure that the magnitude of these scores did not scew the total score, the metric scores were normalised. The following section describes the sustainability metric results.

4.6.2 Cost

This metric most closely resembles the life cycle assessment method. The cost metric required the most detailed data collection of the selected metrics. Table 50 summarises the cost included at each stage

Table 50: Costs included at each stage of the lifecycle

Stage		
Raw materials	Material cost based on volumes Waste assumed to be 10% added to material	Costs of materials were collected from material supllier. Materials were priced either for compompontent, or for system if appropriate.
Factory manufacture	Cost of labour based on time Cost of power based on time	Labour cost from SPONS Power cost based on industry xxx
Transport from factory to site	Based on total number of journey required to transport modules from factory to site.	Cost per journey was obtained from local company.
Assembly	Equipment cost based on panel weight Labour cost based on time	Crane cost obtained from local company Labour cost from SPON
Maintenance	Material cost based on lifetime of materials	Lifetime based on product data or industry accepted values
End of life	Waste disposal determined by industry averages.	Industry averages for the disposal routes were used. Costs provided by local company

The first stage of the assessment required the preparation of an inventory of all parts for each solution.

- The cost of each component was calculated, including material cost, plus an additonal cost for waste materials.
- Manuacturing cost which includes the power used for cutting the materials and labour for the manufacturing process.
- Time for assembly was calculated and a cost for the labour of assembly in the factory was included.
- Cost of transport, based on the number of trailer journeys to transport panels or modules was included.
- On site, the cost of assembly comprising labour and labour related to craning panels and modules.
- Materials required for manitenance was calculated using the service life of the msterials. The cost of maintenance materials was included but no manfacturing or labour costs were included.
- At the end of life, demolition costs were not included, but costs for waste disposal were included.

The results of the whole lifetime are presented in Appendix .I.

The total lifetime costs were between £25,703 and £39,937. The average cost is £29,519. SIP panels solutions have lower costs, with an average cost of £24,496. The average cost of a timber panels solution is £30,455.

4.6.3 Social assessment

4.6.3.1 Health and safety

The health and safety metric was based on manufacture and assesmbly processes. The construction processes during each stage of the construction lifetime are reviewed, the hazard events are identifed and the risk is assessed. The risk score was calculated as the product of potential consequence and likelihood of the event. Each design solution was assessed for risk. Detailed risk assessments are shown in Appendix H.

Health and safety metric scores were between 7.41 and 8.13 with an average score of 7.66. The solution scores show little pattern reflecting the wide range of processes required in each construction. Within the assessment process specific design properties were identified as being influencial. The following activities were associated with reduced risk:

- Manufacture and assembly in the factory has lower risk than onsite.
- Smaller panels are considered to have lower risk because the likelihood of accidents during moving panels and assembly is reduced.
- In contrast larger panels, and volumetric modules reduce the number of movements and as such the likelihood of accidents is reduced.
- The construction of a structural frame reduces the risk, because it removes the need temporary support during assembly.

4.6.3.2 Adaptability

The adaptability of the design was assessed against a number of requirements identified in the literature (Gosling et al. 2013, Gu et al. 2004, Schmidt,Robert, I.,II, Austin 2016). The adaptability of the design in the design phase, in-use and at the end of life was considered. For each phase marks were scored with higher marks being correlated with greater adaptability.

Adaptability of a building is affected by many different factors which have complicated interactions. A simple comparative assessment method was used enabling the whole solution to be considered as a whole and the scores are presented in Appendix H.

4.6.4 Normalisation and weightings

The range of metric scores, before normalisation, for each of the parameters are described below. Each of the metric scores were plotted in order from low to high to understand the distribution of the score.

The environmental metric score were created by produced a weighted sum, of the element scores taken from the Green Guide Rating. At conceptual design stage the elelement were retricted to well performing elements. As such, there was little variation between the environmental scores. The final scores for the environmental metric were either 9.2 or 10.

The cost metric was the sum of financial cost of the materials and activities across several phases of the building lifetime. Material and waste disposal cost, machining power cost, transport and labour all contributed towards the total cost. The solutions developed had cost scores that showed a mostly linear distribution between £17,623 and £47,585. Values at the top and bottom of the range move away from the trendline slightly; however, a linear relationship was used for normalisation.

The adaptability score was determined using a design assessment. By considering the materials and panel arrangements, the adaptability of the building in the design phase, during use and at the end of life were considered. Component and assembly properties are critiqued to assess the capacity for design flexibilty, adaptation during use and resue of components at the end of life. The solutions developed had adaptability metric scores between 3.1 and 7.2. Most scores lie in a linear distribution between 5.2 and 7.1; the traditional construction score is an outlier lying away from the trendline and also has the lowest score.

The health and safety scores was calculated by summing the risk scores of activites during each phase of the building life. A list of hazards were considered for each phases and the associated risk for each was scored out of 9. A maximum total score of 1080 was reduced to a score out of 10. The design achieved scores between solutions between 7.41 and 8.13. Most scores lie in a linear distribution. The maximum value 8.13 is the traditional construction score.

The responsible scourcing metric was scored using credit method. Credits were gained for environment assurance, chain of custody, and internal business practices. Solutions had responsible sourcing scores between 4.85 and 5.6. The scores lie along a linear distribution.

Scores were aggregated using a simple summing method. Each of the metric scores was decimalised. Weightings were applied to the metric score and summed.Weightings are presented in Table 51. This sustainability score was then used to compare solutions.

Table 51: Weightings applied to the criteria scores

Economic	**Social**			**Environmental**
Cost	**Health and Safety**	**Responsible sourcing**	**Adaptability**	**Aggregated environmental impacts**
0.33	0.11	0.11	0.11	0.33

4.6.5 Total Score

The aim of the design process is to create sufficient understanding that the best performing solutions can be identified. It supported the creation of knowledge and understanding of the design space.

The design process created a number of feasible solutions developed using design tools adapted from the engineering design. The solutions were created using functional and sustainable requirements. In order to assess the success of the adapted method the sustainability of the designs were measured using a sustainability index.

In order to assess the success of the design process to develop sustainable design solutions based on the requirements, it was necessary to compare the total impact of the solutions on the selected issues. Alongside the assessment of the designs described above, sustainability scores were developed for the feasible design solution combinations. By creating scores for the full range of feasible solutions the power of the design process could be more clearly understood.

Total sustainabilty scores were in the range 29.5 and 50 out of a total 60. The average score was 39.3 as summarised in Table 52.

The total scores indicate that the top performing solutions perform better than the traditonal construction method. However, the traditional method is found in the top decile of perfromance, as shown in Table 53. Also notable, all of the top performing solutions are have large panel sizes.

Table 52: Summary of total scores

	Environ-mental	Cost score	Adaptability	H&S	Responsible sourcing	Sustainbility score
Minimum	9.2	0.0	3.1	7.4	4.9	29.5
Average	9.5	5.5	6.0	7.7	5.2	39.3
Maximum	10.0	10.0	7.2	8.1	5.6	50.0

Table 53: Summary of top design solutions in the top decile of sustainability scores.

Panel type	Panel Size	Module	Structure	Insulation	Sustainability score
Timber	2400	Closed	Non-structural	Sheep wool	45
Timber	1800	Open	Glulam	Rockwool	46
Timber	2400	Open	Glulam	Sheep wool	46
Timber	2400	Volumetric	Non-structural	Warmcell	46
Timber	1800	Open	Glulam	Warmcell	47
Timber	1800	Open	Non-structural	Sheep wool	47
Timber	1800	Open	Steel	Warmcell	47
Timber	2400	Closed	Non-structural	Rockwool	47
Timber	2400	Open	Steel	Warmcell	47
Timber	2400	Open	Steel	Rockwool	47
Timber	1800	Open	Non-structural	Rockwool	48
Timber	2400	Closed	Non-structural	Warmcell	48
Timber	2400	Open	Glulam	Rockwool	48
Timber	2400	Open	Glulam	Warmcell	49
Timber	2400	Open	Non-structural	Sheep wool	49

Timber	1800	Open	Non-structural	Warmcell	50
Timber	2400	Open	Non-structural	Warmcell	50
Timber	2400	Open	Non-structural	Rockwool	50
Traditional					46

5 DISCUSSION

5.1 INTRODUCTION

The aim of the research was to improve the sustainability of housing construction. In this chapter the results of the research are brought together and the degree to which they respond to the research aims is described.

This chapter discusses the development of the SCDP. It describes how the new design tool has responded to the gaps in knowledge, identified in the literature review. The research aims and the methods applied are then discussed. The implication of the results with respect to the aims of the research is discussed and then the findings are expanded to relate their meaning to existing knowledge.

5.2 JUSTIFICATION FOR THE RESEARCH

The research aimed to create a tool to improve the sustainability of housing construction methods. The urgent demand to increase housing production represents large impact potential on the environment through resource use and the release of environmental pollutants. The construction industry must supply the houses, despite a shortage of suitably skilled workers. It must too respond to the need to improve the performance of the houses.

Construction is a large industry, of which housing development is a small part. It has been subject to fluctuating demand and pressure to increase productivity within a system where profit is produced by increasing value through developing land value rather than the transformation of construction materials. In part, this has led to housing being developed by a fewer, large developers who subcontract the building activities to smaller companies. As such, value added, and potential profit available for these activities have been reduced. Smaller profit margins have led to a redution in investment in the labour force creating insecure employment conditions and reduced training budgets.

At the same time as the industry is squeezed financially, the need for sustainable development is reaffirmed. The literature review described the need to address social and environmental issues. The construction industry has been repeatedly challenged to improve both the quality of the building and their productivity, and it was proposed that mechanical engineering methods would lead to the desired improvements.

Within in this context small construction firms have the oppurtunity to offer better quality housing with improved sustainability. This research addressed the needs of the housing construction sector by delivering a sustainable construction design process, which improves social and environmental performance of the construction process while recognising the economic constraints of the sector.

The literature review showed that lean methods and prefabrication have been used within the construction industry for several decades. However, the research uses large manufacturing works, such as the car industry, for comparison and the construction industry projects are often large in scale. This research, focusing on the application to small scale businesses, shows how benefits can be achieved using the principles for low volume housing.

Literature addressing the design and construction methods of both traditional and prefabricated was reviewed. A comparison between the car industry and construction showed that many aspects of the production can be compared. More importantly, the design processes were shown to offer approaches to construction issues which traditional methods struggle to tackle.

A variety of tools are available to the industry to support the development of sustainable housing. The literature review highlighted that tools often addressed sustainability, focussing on the whole development site, not the building. While tools such as BREEAM, encourages the implementation of sustainable design into the design process, it is designed to support larger projects, and requires much resource. By integrating sustainability into the design process, benefits are integrated into the decision making process and increases the likelihood of adoption. On this basis a new the need for a new tool was established.

5.3 THE SCDP

5.3.1 Sustainability

The literature review identified that sustainability metrics are poorly addressed in construction design tools particularly addressing social issues. The literature review identified issues affecting the stakeholders of the housing construction industry. Analysis of the issues placed them into social, economic and environmental groupings, as such the research adopted the triple bottom line model of sustainable business practices approach (Elkington 1998).

At the sustainability scoring stage, the indiviudal metrics were attributed to one of environmental, social or economic impacts so that the scores could be aggregated. However, the impacts of each criteria were also felt in each of the other criteria. For example, adaptability was addressed as a social issue; however, the factors considered could also have environmental and economic effects. Where the adapatability of the building extends the lifetime of the building so that it is not replaced, and components are reused, financial and environmental benefits are also achieved.

Similar benefits across the the triple bottom line can be described for health and safety. In the UK, the economic cost of illness due to accidents at work is approximately £1 billion (Wright 2015).

This contribution of the factors to triple bottom line criteria meant that creating weighting factors which were developed by placing the factors in competition with each other was problematic.

Equal weightings were given to the triple bottom line criteria. This was to reflect that each were equally important. Consideration was given to creatings weighting by the business owner, but in the first instance he felt he did not have the expertise to prioritise environmental issues; then when the scoial and economic factors were discussed it was difficult to constrain the discussion to weighting of impacts within the scope of the tool. As the business owner, he had decision making power beyond those dealt with here, which meant that he was concerned with a broader scope of issues than those dealt with in the research.

5.3.2 Product specification and scope of tool

In the traditional design process, functional requirements which are the focus of the PDS are driven by the in-use phase of the product. However, the whole life sustainability has a broader scope.The identification of the stakeholder to the construction and design process, ensured that the wider sustainability issues were covered.

5.3.3 Metrics

The research has illustrated the complexity of aiming for sustainability. The number of stakeholders and the variety of impacts mean that considering each criteria independently becomes time-consuming and is likely to be omitted in the early stages. Placing sustainability as a functional requirement , requires that the impacts are identified and incorporated into the design.

The success of the product is determined by the delivery of a product that customer wants, at a price they are willing to pay. Sustainability is not yet a driving factor for the customer when buying houses, particulalry elements of sustainability which do not impact the in-use phase. As such, the cost of the building could be argued to be the most important criteria to the customer. On the other hand, prefabrication is not a traditional construction method, and as such, the customer selecting such product is most likely to be seeking sutainability among the product functions. With such an interest, the attention to the whole life impact would be a selling point for the company.

It is assumed that labour employed in the factory have fulltime permanent roles. This increases the labour costs to the company, but has been adopted so that the full benefits of prefabricated manufacture and lean processes can be achieved.

The literature review identified issues such as labour blacklisting and labour exploitation. These are impacted by the product cost. However, where a business is more able to control its costs, it is in a stronger position to address poor business practices.

The importance of employment to the economic sustainability of the communities in which the business operates and in which the houses are built has been discussed. In summary, local employment is that employment undertaken onsite, by local tradespeople. These tradespeople are not directly employed, and so there is risk to the company relating to the commitment and the need to ensure a consistent rate of work. By moving construction offsite, the workers local to the development do not gain from the development.

Environmental methods of assessment are well established. However the methods are resource intensive. The research adopted a simplified approach by using a proxy. The use of Green Print data has the benefit of using recognised industry data. The adoption of the proxy data with a standard units does not allow for the design other than material choices to be understood.

Responsible sourcing reflects whether sustainability has been considered by the material suppliers. Ensuring sustainability is addressed across the supply chain which ensures whole life sustainability. As such, suppliers should be able to show that they too have addressed economic, social, and environmental impacts of their activities. In order to minimise the burden of work to the decision makers, the metric required the supplier to provide evidence that they had addressed the issues themselves, through certification.

Materials gained credits, when they were shown to have considered elements of their supply chain. The use of creditation schemes mean that a thorough assessment process has been completed, beyond what would be feasible without the use of proxy assessments. However, again the use a third party data source meant that the limited scope to compare the impacts.

Where several materials were considered for the same funtion, the best performing option was selected. This meant that high scores were achieved. However, there is also the need to ensure that if descisions are made on the basis a particular supplier and product that cheapar products are not chosen as a replacement further along the the design process.

The use of certification in this way prevents the the selection of “gold star” performers who can be identified as performing better than other products. Better performance could be driven by the requirement for additonal certification to be met. As the industry improves, the list of possible schemes will expand and should be added as they become available. In contrast, the method can establish a minimum performance by adopting a set of design parameters which must be met. In this research, this has been achieved by demanding a minimum environmental performance, and by the adoption of the best perfoming material when a nube rof alternatives are available.

The literature review showed that it was considered important to bring assessment of health and safety earlier into design process in order to achieve benefits. As the risks are related to activities, the health and safety assessment is not addressed at conceptual design stage but considered during embodied design.

5.3.4 Metrics Scoring

The metrics were created to be suitable for use by a small company with limited resources. The criteria metrics addressed issues which could be described by both qualitative and quantitative properties. In order to develop a single score to describe sustainability the metrics, assessments needed to be available as a quantitative value. This has been been achieved by a mixture of methods including quantitative assessment, scored qualitative assessment, and credit methods. It is felt that information relating to the design space has been lost during this translation. The benefits creating a detailed knowledge of the design space is discussed below.

5.3.5 Design improvements

The SCDP developed and assessed solution for an outline building. The tool created a variety of ideas which were explored and refined. The solutions were compared to traditional construction. It was shown that prefabricated solutions were able to compare favourably to the traditional construction method, given the weightings.

The design tools created knowledge about the design space. This enables the designer to understand aspects of the manufacturing system which would otherwise have remained unclear. It is suggested that this information is valuable to the designer even when it it not used.

The design process identified activities which, although too small to capture by the sustainability metric, created improved conditions for the whole sustainability of the building. The following actions were identified

- Replacing nails and staples with screws would improve the recoverability of materials from the building. However, screws are a more expensive connector, and they take longer to fix leading to increased labour costs. This is capture in the adaptability of the design
- Within the panel, larger panels used less material for vertical elements.
- Where component sizes correspond with standard sizes delelivered by the supplier than machining work is minimised.
- Improvements to the adaptability of the building require that the constructability of the building is respected. Traditional construction methods adopt destroy-and-rebuild techniques to for adapt buildings. This may involve knocking down stud and masonry walls, incorporating steel reinforcement where necessary and then making good. If a prefabricated building was designed to have some engineering redundancy then changes could be made without requiring additional materials; however, if no changes were made then the building will have been over engineered throughout its lifetime.

5.4 Design process

The tool presented here can not be a standalone solution. In terms of sustainability it only addresses the manufacture and assembly of the building. As is widely accepted, the in-use phase of the building represents a significant part of the whole life impact and must be addressed. The in-use energy consumption is not considered here.

Furthermore, the design tool presented here has only developed the embodied solution with respect of manufacture and assembly. The product requires additional input from other specialisms, such as structural engineer in order to refine the design.

The points at which the sustainability assessment is completed is, to a degree, arbitrary. The solutions do not represent the completed product but have been design with the main manufacture and assembly. Once the embodied design is competed, then detailed design would be undertaken.

Related to when the sustainability assessments are made, choices to remove solutions from the development process must be made for in order to focus the design space. Removing solutions from the design process prevents knowledge coming from further refinement of the design from being contributed to the design. (Short, Lynch 2004) argued that designs should not be removed from the process too soon because of the value that the knowledge contrbutes. However, continuing with the designs beyond when they are viable, as described by the degree to which they meet the requirements, represents work which may be have limited value. Pahl and Beitz (1998) recommend that solutions are filtered at each design stage. The research here reinforces the view that understanding the impact of solutions must be pursued because design activities provide conflicting sustainability impacts. All of the design tools must be pursued before decisions are made.

The aim of this research is not to introduce novel materials to the architect's palette, rather it is to show that a robust assessment of sustainability of options is possible. This is achieved by using a range of materials with similar functional properties but which differ in other ways and comparing their impacts. While the designer is likely to have a palette of preferred materials with which they are familiar. It is important that alternative materials fulfilling the functional needs are also identified to maintain design freedom. However, designers are not, nor should they be environmental experts, due to the time constraints involved. As such the design guidelines are useful.

The adoption of the modular approach, initially driven by transport constraints, was appropriate. By adopting a dominant panel width for the building and discrete inventory of was created. Further research could explore the benefit of greater modularity using standard panel lengths also.

The volumetric design, that divided the building into several volumes, each with different sizes, required a relatively large inventory. Within the factory this increases workload and waste because it is necessary to hold the inventory for longer, to have double handling of parts and to increase the number of machinery set-ups.

During the conceptual design phase, the development of functional structures and working structures enables the designer to explore new types of solutions. It is during this phase that unconventional solutions should be considered.

Design for manufacturing and assembly methods were initially developed to minimise cost while ensuring the functional requirements are met. Design for manufacture and assembly ensures only necessary components are included and, then addresses their form and manufacture. This was shown to be applicable to construction. For example the choice between timber frame and SIP affected the simplicity of the design as SIP requireded fewer component per panel. However, the use of SIP constrained the size of the panel to 1200 mm. This led to more panels being handled during the more difficult onsite assembly process.

The application of the tool led to improvements by minimising the number of parts, simplifying manufacture and assembly by the design of identified design parameters which to minimise material in the construction process. In addition, the completion of the design assessment meant that issues relating to adaptability and health and safety could be exposed. It is noted, again, that the recording and transfer the issues identified during the design process is required, otherwise while much of the knowledge has been created the associated impact will not be achieved.

As the design tool will be used again and again to develop optimised manufacture and assembly solutions, revised weightings can be developed and fed into the next design. In this case the weightings should be monitored to assess whether they stabilise to give a set of “ideal” weightings which reflect the stakeholders’ needs in the current design setting.

The research shows the richness of knowledge that can be gained from completing a systematic design process. Although time consuming, a model can be developed overtime with feedback from projects. Once complete the database of information can be configured in a number of ways to elucidate aspects of the building design. The design process itself enables the team to understand the relationship between factors. Additional research should be undertaken to tie the design methods to other design research, such as ensuring creative problem solving methods are used to produce the best conceptual designs.

5.4.1 Data quality

A lack of case studies moving from research and development through to actual construction has led to theoretical models indicating potential benefits but few established projects. Similarly here the results are theoretical and would benefit from real data.

The quality of the model data for the assessment model was “troubled “by the uncertainty of the input data and could be improved by using statistical methods to account for this uncertainty (Hester et al. 2018).

Difficulties predicting waste pathways for an immature market. The potential benefits rely on wide scale adoption of reuse or the property owners willingness to recover and reuse materials.

5.5 Contribution to housing construction research

Existing research in the area is in the form of qualitative research, reviewing designers experience after projects have been completed, or discussing the barriers to adoption with the industry.

Quatntitative research compared the how design parameters affected outcome, often cost or material use. It was identified that research broadening the scope of these comparsions was required. This research addresses this by considering the impacts of several design parameters, across a larger number of sustainability issues.

It has been noted that construction design decisions often occur late in the design process. This tools presents a method for construction design decisions to be made early on. It includes factors that affect contractors, material suppliers and engineers and as such they should be included in the early stages of the design process.

These actors are required to supply information to the tool early in the process. Variability, lack of stability in cost, and supply chains challenges the adoption of the tool. As such, there is a strong argument that there should be greater collaboration between developers, contractors and the material supply chain.

Designing for modularity is useful where the core functions of a module are similar but a variety of output forms are needed. The basic functions identified in the conceptual design phase were fundamental to all buildings and as such modularity can be adopted across construction. Achieving the benefits of modularity requires off site manufacturing to mature. The step changes is comparable to that of Ford to Toyota. The benefits are not achieved by minimising the differences, but by optimising the similarities. Savings can be achieved by identifying the best panel size for the design, material choices and the business' capabilities; however, construction will always involve uncertainty as each project is different and assembly on site is subject to factors less controllable than within the factory.

Factories require significant investment and renting of buying the factory space often requires a long term commitment. The turbulent nature of the construction industry, with peak and troughs, means that there is significant risk of factories spending long periods inactive. However, investment could also help support a more steady supply rate. This would mean that jobs in the industry are more secure, that companies would be able to plan training.

5.5.1 Industry recommendations

5.5.1.1 Supply chain

Support certification of materials and process so that desingers have the information describing sustainability metrics: responsible sourcing and environmental assessment. The work is time consuming and expensive which can be prohibitive to small businesses.

Suppliers can support developers through collaboration. Developing product solutions as well as maintaining the sustainability of their products. Machining data was shown to be minimised when component sizes corresponded with module sizes. The car industry has a mature supply chain with just in time delivery of materials to factories. The delivery of material to the factory which do not require machining before being suitable for assembly also reduces handling as material can be delivered direct to assembly areas.

5.6 Assumptions

For the design process, it is assumed that all assembly occurs by hand because this allows the fundamentals of design to be applied before any automation brings additional benefits.

Set-up times assumed that all identical components are prepared as part of a single batch. Set up times were then divided among the number of components. Estimated cutting rates and set up times were provided by the equipment supplier (Smith 2013). Other estimates included rate of glue spreading for SIPs, and the setup and pouring times concrete moulds.

When the components were cut from the standard material size, but had different sizes, it was assumed that the machine set up happened twice.

The model used a sustainability framework which accepted degree of damage to the systems. McDonough and Braungart (2010) argued that minimising damage wasn’t enough and in his sustainability paradigm, the model as it stands is not applicable. However, sustainable functional requirements used could be replaced with social, economic and environmental goals: improved biodiversity, nutrient enrichment, jobs created and lives saved.

Prefabricated construction should be seen as an opening. Companies setting up off-site manufacture, for the first time, must commit financial capital to factory space, machinery and a skilled work force. Investing in the design of the building, and more importantly the associated production process could arguably be considered more important.

The research shows that optimal sustainable design properties are determined by the effect of the life cycle of construction activities: machining, assembly, disassembly and disposal. Conceptual design formulates the “what”, creating the basis for a building that works, embodied design devises the production, maintenance and end of life processes that ensure the “how” is achieved efficiently. This research has shown that wider issues affecting construction sustainability can be correlated with production efficiency.

5.7 LIMITATIONS

From the outset of the research it was recognised that in-use energy consumption is often the largest contrbuter to green house gas emissions throughout the lifetime of a house. As such, this tool can not be used on its own to design sustainable building. It should be part of a suite of tools which are used as part of the design process. The tool however, does assist the designer to consider the construction process, in a manner which has not been addressed elsewhere and as such it considered a valuable contribution to the field of sustainable construction.

Building performance during the in-use phase is affected by many factors beyond the fabric materials and layout. The arrangement and form of buildings with the same floor area can vary significantly, and the impact on the on the thermal coefficient will be large. The occupant behaviour has been shown to affect the energy consumption in the use phase. Houses often have long lifetimes and can be owned by a number of different householders, or the same householders will have different occupancy patterns across their life phases (working, retired, part time, parents).

Irrespective of building size, the aim of the research was to identify methods or guidance which will improve all housing designs. If the building does not function well, is built poorly, or cannot be adapted for changes in people's circumstances, the building will not achieve its expected life time.

A systematic design approach was applied to a building layout and was shown to be effective. Design solutions formulated were original and feasible and a manufacture and assembly process could be developed, in detail, from the tools available.

6 CONCLUSIONS

It is becoming increasingly clear that there must be a change from the status quo of construction activities to deal with their environmental and social impacts. At the same time, the demand for the industry to increase the output of housing risks the production of housing with low whole life sustainability that will be in-use for the next 60 years. Tools to support the sustainability of the construction to sustainability independantly of other construction issues, leading to sustainability acting in conflict with other design decisions. Integrating sustainability into a tool which designs the construction process enables sustainability to be placed at the centre of decision making.

A review of the sustainability issues affecting highlighted that while environmental issues were addressed within the exisitng tools, social issues were less well represented. Issues relating to the supply chain of construction materials were not represented in the tools. However, they have received attention and organisations have created methods for suppliers to document and have their supply chains certified. The downside of certification is that they only enable a binary assessment, which may be misleading. It is recommended that certifiers provide more nuanced methods of describing the degree to which their aims are delivered. The Green Print rating system offers a simple but effective model for such a system.

The tool was valuable for the creation of knowledge relating to the design space. The focus of the tool on manufacture, enabled highlighted the improved sustainability performance that can be achieved by strengthening the relationship between material suppliers and the manufacturers. The car industry have sophisticated supply chains driven by use of lean methods to reduce many types of waste. The supply of materials that meet the size requirements of the manufacturers can minimise machining, reduce handling and stock inventory, which leads to reduced material waste.

Where a company is creating a range of buildings through the use of modular design, the creation of a database can reduce the amount of design required by removing the need for reworking. A commitment by the company to to gather accurate data to replace the data developed from Boothroyd, and the generic data used in this work would develop the design tool presented here and provide a tool which can contribute to the management of workflow through a factory and on site, enabling lean design to be used. Material data from suppliers, assembling and machining times from the workstation and on site, and more detailed design information from structural engineers would improve the validity of the results presented here.

The results of the tool indicated that the design with open timber framed panels, using the largest panel size (2400 mm), without a structural frame is the most sustainable construction method. The research suggested that the cost of adoption is not prohibitive. As such, prefabricated construcion methods can epresent a sustainable alternative to traditional construction methods. However, the current economic landscape means that any company setting up prefabricated construction is at risk in the long term as the volatility of the housing market means that they may be left with capital assets which are not productive during economic downturns. Changes to the house building market which result in lower risk to innovative methods should be considered by the authorities. Market forecasts indicate that the long term need for new build housing is high, as such, maintaining a steady supply flow would support the sustainable improvements that adoption of the SCDP method could achieve.

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8 APPENDICES

A METRICS

A.1 Environmental Metrics

Climate change	kg CO2 eq. (100 yr)
Stratospheric ozone depletion	kg CFC-11 eq.
Ecotoxicity to land	kg 1,4 dichlorobenzene (1,4-DB) eq.
Eutrophication	kg phosphate (PO4) eq.
Acidification	kg sulfur dioxide (SO2) eq.
Photochemical ozone creation	(summer smog): kg ethene (C2H4) eq.
Photochemical ozone creation	(summer smog): kg ethene (C2H4) eq.
Human toxicity	kg 1,4 dichlorobenzene (1,4-DB) eq.
Ecotoxicity to water	kg 1,4 dichlorobenzene (1,4-DB)eq.
Fossil fuel depletion	tonnes of oil equivalent (toe)
Waste disposal	tonnes solid waste
Water extraction	m3 water extracted
Mineral resource extraction	tonnes of minerals extracted
Nuclear waste	mm3 high level waste

A.1.1 Embodied energy materials / Energy consumption /Climate change

Climate change was been chosen because it included aspects of both energy consumption and the embodied energy of materials.

Life cycle assessment of the building, will be undertaken including resource extraction, manufacture and assembly of building, maintenance and disposal of the building at end of life. The boundary of LCA is discussed further elsewhere.

A.1.2 Toxicity

Impacts to air and water have been combined in the ratings tables. Characterisation factors, expressed as Human Toxicity Potentials (HTP), are calculated using USES-LCA, as with Ecotoxicity, which describes fate, exposure and effects of toxic substances for an infinite time horizon. For each toxic substance HTPs are expressed using the reference unit, kg 1,4-dichlorobenzene (1,4-DB) equivalent.

Human toxicity: kg 1,4 dichlorobenzene (1,4-DB) eq. *

The BRE indicate that indoor air quality is not covered by this category.

A.1.3 Acid rain potential and Ozone depletion

Acid rain and ozone depletion are both significant environmental problems. Ozone depletion compounds are found in refrigerants, solvents and propellants. Acid rain is produced by the solution of sulphur dioxide and nitrous gases in rain water producing acid conditions. These will be measured using the LCA methods

A.1.4 Land footprint / resource scarcity

While some materials are highly effective and have low embodied carbon, they may be scarce, or also be required for other industries, this is represented resource scarcity. The requirement of sustainable development to enable future generations to meet their own means requires today's society to maintain a stock of a resource so that it is not diminished beyond recovery.

In the sustainable construction, the use of straw bales can be considered. At present straw is a by-product of grain production. It is used in several ways, as soil conditioner, bedding and more recently as insulation in construction. If straw was all diverted to use as insulation then the other use would have to find alternatives. This could lead greater environmental impacts over the extended system. How is the competition for the resource measured?

A.1.5 Waste: minimise recycle reuse

The impact of minimising waste will be measured in the LCA and so is not addressed separately.

A.1.6 Water on site

Water is used in traditional construction, to produce cement and concrete and to control dust on site. While it is expected that little water will be used within the prefabricated construction, including a measure of water will allow the comparison with traditional building methods to be made.

Green guide to specification offered a reliable, trustable and (for the business) transparent tool, reducing the scale of modelling required.

A.2 Economic Metrics

A.2.1 Cost

A.3 Social Metrics

A.3.1 Responsible sourcing

Accreditation	**Max credit**	**Environmental**	**Social**	**Performance**	**Links**
Forest Stewardship Council (FSC)	2	Resource management Environmental impact (pollution)	Employee conditions, Local peoples Legal compliance		https://www.fsc-uk.org/preview.fsc-principles-and-criteria-for-forest-stewardship-fsc-std-01-001-version-5-2.a-860.pdf
ems14001: 2004 Environment management system	1	Identifies, monitors and makes efforts to control the environmental impacts related to its activities.			https://www.iso.org/iso-14001-environmental-management.html
PEFC Programme for the Enforcement of Forestry Certification Also endorse Sustainable forestry initiative	3	Resource management Carbon impact	Legislation Chain of custody Workers rights		https://www.pefc.org/ https://www.pefc.org/resources/technical-documentation/pefc-international-standards-2010/2641-sustainable-forest-management-pefc-st-1003-2018 https://www.sfiprogram.org/pefc/
BES6001 accreditation The Framework Standard for Responsible Sourcing	2	Environmental impacts are measured, and accounted. No control measures or interventions are required	Workers rights		http://www.greenbooklive.com/filelibrary/responsible_sourcing/BES-6001--Issue-3.1.pdf
CARES Sustainable Constructional		Environmental management		Quality management	https://www.ukcares.com/downloads/general/C

Steel (SCS) Scheme (for reinforced concrete)					ARES_Sustainability_Information_Leaflet.pdf
ETI (Ethical Trading initiative)			Members commit to a code of practice which protects workers.		https://www.gov.uk/guidance/ethical-trading-initiative-eti https://www.ethicaltrade.org/
OHSAS18001 Occupational Health and Safety			To create safe., healthy working conditions for the employees.		https://www.bsigroup.com/en-GB/ohsas-18001-occupational-health-and-safety/
BBA Product approval and certification				Certification to show that a product is fit for its stated purpose. Certification is achieved following laboratory and field assessment of the product, and quality control assessment of the manufacturing process	https://www.bbacerts.co.uk/pac
ISO 9001				Quality management	

ISO19001 Quality management system				Identifies, monitors and makes efforts to control the environmental impacts related to its activities	https://asq.org/quality-resources/iso-9001
GRI Global Reporting initiative		The GRI offers a framework and methodology for the reporting of social, environmental and economic impacts.			https://www.globalreporting.org/

A.3.2 Health and Safety

The construction is split into four key phases based on when a risk assessment would be completed and actions taken. A: Manufacture of parts in factory & B: Assembly of parts in factory; C: Preparation of parts on site & & D: Assembly of parts on site; E: Maintenance; F: End of life.	Hazard events are considered and the product of the severity of accident and the likelihood of an incident is recorded. • Exposure to the elements • Exposure to toxic materials • Risk of injury (equipment) • Multiple activities in a small area • Handling • Risk of falling
The severity of the identified accidents are scored according to the level of notification to the HSE required. 1) Recordable incident (>3days incapacitated); 2) Reportable incident (7 days of work) 3) Death of a person	Likelihood is determined 1) Remote/ unlikely 2) Possible: could occur some time , 3) Probably: not surprised will occur several time 4) Likely: occur repeatedly/event only to be expected

A.3.3 Adaptability

The adaptability of buildings is particularly important, as a unique selling points (USP) promoted by Dwelle. Furthermore, improved adaptability and ease of maintenance will maximise the buildings lifetime.

There is a push for homes to be designed so that householders can remain in the home throughout their lifetime. This means that they should be able to extend the house to accommodate more people, or to remove them as the household shrinks. Room use should be changeable.

It is difficult to fully assess the impact over time because it is difficult to predict the life span of the building (Berardi 2013). Often buildings outlive their design life, through adaptation and refurbishment (Brand 1995). Extending the lifetime of the product reduces the need for replacement (Gosling, Sassi et al. 2013). An adaptable building is able to achieve this with "minimal waste production and material use" (Gosling, Sassi et al. 2013).

Buildings may be adapted to suit changing fashions, changing lifestyles such including growing families or reduced mobility (Gosling, Sassi et al. 2013). Changing climate drives the current Green Deal Initiative which looks to adapt existing UK housing stock to reduce the energy consumption and to improve resilience to the possible increased risk of overheating and long cold snaps (Semenov 2007). Given the projected climate over the next 60 years, it is vital that they either have the capacity to moderate these extreme conditions, or are to be adapted to do so in the future.

This adaptability is beneficial for the customer. Adaptable design can also be beneficial for the business, interchangeability of modules also the product range to be extended with less development time and lower costs (Gu, Hashemian et al. 2004)

B PRODUCT DESIGN

B.1 PRODUCT DESIGN SPECIFICATION

14/09/23	Competition best (SI 5/10)	This design(intent)
Thermal Performance	Passiv Haus A/V ratio ≤ $0.7m^2/m^3$ Typical values shown – walls, floors and roofs ≤ 0.15 W/m^2K Glazing should have been independently certified by the Passiv haus institute as suitable. A standard glazing unit (1.24 x 1.48m) should have a whole window UW value of ≤ 0.80 W/m^2K and achieve U value ≤ 0.85 W/m^2K once installed. Solar transmittance (g-values ≥ 0.5). psi (Ψ) value of ≤ 0.01 W/mK The resultant air leakage at 50 Pascals pressure must be no greater than 0.6 air changes per hour (0.6 ac/h @50 Pa). It is a requirement for Passiv haus certification that temperatures exceeding 25°C cannot occur in a building for more than 10% of the occupied year. The primary energy demand for heating, ventilation, hot water and domestic electricity is limited to 120 $kWh/(m^2a)$. As a guide, current construction prices for the PH15, 3 bed, 97 m^2 completed core shell with materials to complete the build from £98, 500.	Equal to or better than existing performance. Thermal performance at minimum must be significantly better than building regulations. (element values table A) Better than building regulation. U-value=0.15W/m2
	None	Structural Must meet worse case conditions for UK (not including extreme exposure location) (description) Moisture: building must be breathable as per building regulations. Meet building regulations No risk to occupants
Environment During in-use phase	It is a requirement for Passiv haus certification that temperatures exceeding 25°C cannot occur in a building for more than 10% of the occupied year. The resultant air leakage at 50 Pascals pressure must be no greater than 0.6 air changes per hour (0.6 ac/h	Building should function in the UK climate (temperate). Internal temperature should be maintained within a narrow range. Building is designed for residential use. Any internal moisture generated must be removed. Moisture created by occupants, bathroom, kitchen. Live loads, no high loads expected

14/09/23	Competition best (SI 5/10)	This design(intent)
	@50 Pa).	Adaptability, changes to structure.
During construction phase		Components/elements should be robust enough to survive transportable. Either all parts to be positioned without specialist equipment, or all parts to be positioned using equipment. Components can be assembled (onsite) in poor weather conditions. Components should be to be stored outside for short lengths of time.
Life in service	60years	60 years (for mortgage)
Maintenance		Surface materials will have a lower life time than the internal structure, which is protected by outer layers. These outer layers will require maintenance and replacement. Building systems will be replaced within lifetime of the build. It is assumed that values given in the literature are representative of when a typical householder would undertake the work. It is assumed that by undertaking the work all other components maintain protection.
		Heating systems and electric appliances are not considered as part of the design; however, the “infrastructure to the systems i.e. the pipes and wires etc. are included.
		Materials should be able to withstand wetting/ drying cycles.
Target product cost		£1200/m² approx. refers only to the build cost and not the life time cost.
Competition	Passiv Haus is considered represents comparable level design quality and thermal performance. Other competitors include: Huf Haus, IKEA Boklok. Other building methods considered suitable for high specification building include thin joint masonry, SIPS	
Shipping		Mainly UK based European freight should be considered
Packing (not included here.)	This may require removable handles or slings to be attached during manufacture, which are then removed once assembled.	Wrapped for transport to site. May be stored on site. Design should allow component to be easily handled manually or by equipment While the time spent awaiting assembly onsite will be minimised, it should be expected that the materials could be exposed to the elements for some time.
Quantity		Approximately 52 buildings from the factory each year.

14/09/23	Competition best (SI 5/10)	This design(intent)
Manufacturing facility	Wikihouse	Design based on freedom to design manufacturing method. However, costs must be reasonable for a start-up. Maintain a simple, flexible manufacturing facility.
Size	Not for comparison	A number of building sizes will be available in the range. The design is created by architect who determines sizes of spaces based on the internal furniture and desired layout. Other factors may include Constraints of transporting the panels may them lead to slight adjustment to the dimensions.
Weight	Modcell transport the timber frame as flat pack, then using a flying factory close to site, they build the closed panels minimising the transport	There are weight constraints related to transport. Lorries have weight limits of XXXX On site the weight of elements should reflect the proposed handling method. If a crane then large weights can be carried. If manual handling is prescribed then all elements should be able to be handled safely.
Aesthetics, appearance and finish.	Prefabricated panels minimise the amount of onsite tasks that are required.	Should be high quality and suggest sustainability? Confirmed by Building
Material properties	Large range in best materials, depends on function. Typical targets include minimize volume of material, minimize weight. Aesthetic value and	Must meet building standards. Values for off-gassing, fire resistance and xxx Must be ethically sourced Materials must widely available across the industry. Components materials, such as timber, glulam, oriented strand board (OSB) and plywood, and insulation products should be available from builder's merchants at standard sizes. Must be sourced in a responsible manner with respect to the environment, society and economy.
Product Life span	NHBC offer building warrantee for 10years. Housing lifetime is approximately 60year	It is anticipated that the design of the building will change to offer a degree of bespoke design.
Standards and	N/A	Building regulations Approved documents A-Z

14/09/23	Competition best (SI 5/10)	This design(intent)
specifications		Lifetime Homes
Ergonomics		For assembly enabling part to be easily handled is important, for health and safety.
Customer	Unknown	Unknown
Quality and reliability	NHBC offer building warrantee for 10years.	NHBC offer building warrantee for 10years.
Shelf life (storage)	N/A	N/A
Processes	N/A	N/A
Timescales		Maximise time in factory over time spent on site Promotion indicates approximately 8-10 weeks total time from order to delivery
Testing	Building inspector must sign of the construction. AS-built drawing must confirm actual construction. Minimum thermal performance is confirmed by drawings. Air change pressuristion test is under taken on selected building in a development and all unique properties.	Building inspectors need to sign off the construction Air tightness testing. Minimum to meet building regulations, but stricter target for Passiv Haus.
Safety Structural safety	In performance	In performance
Company constraints		The case study company is a start up company, which may lead to issues with finance terms.
Market constraints		Construction demand often reflects recession and boom characteristics. Many companies go bust during period of recession. For prefabrication businesses there is a long term commitment for rent and equipment. As such a continuous flow of products through the factory is required. Manufacturing components for future demand is difficult because buildings are large products, and components and elements have low value/volume ratio..
Patents literature and product data		Patents are not necessary but should be considered for any innovation. If the building is going to have longest lifetime feasible, then as built drawings should be available for future disassembly or adaptation.
Political and social implications		Housing is a vital part of community’s geographical structure. It has value beyond its functional utility.

14/09/23	Competition best (SI 5/10)	This design(intent)
Legal		Building inspectors
Installation		Transported for factory to site on the back of lorries (how many?) Assembled using xx people and a crane. Assembly of the shell took xx hours. It then took approximately xx weeks to complete Fast assembly in the factory and little assembly required on site. Minimise the time the building is not water tight.
Documentation	BIM management systems	Not completed Some drawings available. Full documentation of designs, options manufacture and construction method should be achieved. Occupant handbook should be available with clear sections for the occupier, tradespersons

Sustainable Design Requirements	Cost	Affordability is important for large scale infiltration of the market. However, the total price of a property is significantly affected by land cost.	Minimise cost per unit floor area of building
	Employment		Create skilled, well paid, secure employment. Invest in training.
	Local employment	Modcell have been involved with community projects, at which community stakeholders help insulate the panels.	Create employment where the houses are built, support the local economy.
	Embodied carbon	Earthen structures and timber structure can be closed system and carbon neutral.	Minimise the release of greenhouse gases, over the lifetime of the building.
	Acid rain potential	Most of acid rain potential is associated with sulphur from fossil fuel combustion.	Minimise the release of gases and particulates which contribute to acid rain potential.
	Ozone potential	It is feasible to select materials that have zero ozone potential for construction.	Minimise the release of chloro-fluoro-carbons.
	Resource Use	Renewable material >36%. Factory timber waste 8% (lower when reuse and recycling included) (WRAP). At Stuart Milne 80% of this waste is recycled or reused.	Renewable materials, minimising waste through design Use materials which aren't scarce To minimise timber waste in factory and continue to minimise through lean methods.
	Toxicity	"Natural" homes use only materials with no known toxicity to people	Minimise
	Water		Minimise use onsite and in the factory. Minimise embodied water in materials
	Adaptable	Portal frame methods allow the internal building to be rearranged with little damage to the fabric. Office buildings often have movable sections, and flooring.	
	Impact during construction (off site construction)		Construction on site impacts the local community through noise and dust produced on site. Vehicle movements to and from site from the delivery of vehicles cause issues. Secondly, off site assembly, improves the quality of the building and a better building with fewer defects is produced.
	Health and Safety	It is a legal requirement for the company and the entire workforce to take on duty of care.	
	Responsible sourcing		All materials will be traceable from cradle to grave. All employment practices, political associations, decision making will be completed ethically and with due regards to people and planet

Conceptual design Pahl and Beitz (1988)

Functional	**Environmental**
Provide natural daylight /Allow privacy	Moderate internal temperature
Secure	Control air movement (prevent draughts)
Offer space as desired	Remove pollutants (smells, moisture etc.)
Have separate compartment spaces as needed	Control humidity
Deliver electricity and water from outside to inside the home	Prevent moisture ingress
Remove waste water from the home	Prevent ingress of external noise
Provide sufficient daylight	

B.1.1 Existing product summary

Today, companies offering offsite solutions have a variety of backgrounds. Most are from construction, such as, Archihaus which is formed as a partnership between Architects and developers (Archihaus 2013). Redrow is a housing developer. Toyota is a large multinational, known in the United Kingdom for manufacturing vehicles, but, among other things, manufactures housing in Japan. However, Legal & General, a financial services company, announced in mid-2016 that they would build the world’s largest modular building factory, in Leeds, West Yorkshire, to take advantage of the government sponsored build-to rent scheme (Legal & General 2017).

The scale of production varies, too. Toyota produces 4000 houses per year across their three plants in Japan. Legal & General has not announced the scale of output, but it is likely to be in the thousands (Legal & General 2017). Huf Haus report that their output is limited to approximately 200 large houses per year. In the long term, the Archihaus expect their factory will have capacity for 500 houses per year, supplying the United Kingdom (Archihaus 2013).

The challenge for any business involved in factory production is to manage the demand such that the supply rate is balanced throughout the year. Archihaus have planning permission to build the factory and a housing development across the road, which ensures they have predictable demand as they become established (Archihaus 2013). Legal and General are using their investors’ money to build to rent, ensuring a continuous demand (Legal & General 2017). For Huf Haus, they manage their flow through the factory by limiting the number of houses they build, stating that they limit this in order maintain customer service.

If the prefabricated construction process is considered in terms of onsite and offsite then developers can be divided into those who undertake the offsite manufacture and those who use contractors to manufacture the buildings for them. Some developers, such as Redrow, purchase the panels from timber frame manufacturers and only manage the onsite construction. Panel system suppliers offer solutions based on their palette of materials. For example: the Tek Kingspan (Kingspan Group 2010) construction system using structurally insulated panels made of rigid poly-urethane insulation with oriented strand board (OSB) facing.

The degree of offsite prefabrication can range from just the fabrication of the structural frame of element panels through to completion of room modules. Where panels are used, companies manufacture a standard sized panel with small variations to allow for the building layout. Modcell use a 3.0*3.2m standard panel which can be handled. An Oxford supplier, Green Unit, has panels that are 2.5* 5.4m sections; they describe the panels . as light enough to be carried by two people. Kingspan Tex offers panels up to 1.22*7.50m which require installation using a crane (Kingspan Group 2010).

The prefabricated panels or modules are delivered to site from the factory. Huf Haus fabricate all the components in Germany, then transport them to site whether in Germany, in the UK or elsewhere. Unusually, Modcell prepares the components of the panel frames at their factory in Bath, and deliver them flat packed to a “flying factory” within 30miles of the development. In the flying factory, the panel frames are assembled and locally sourced straw bale insulation is installed. Volumetric module sizes are limited by transport and site access constraints.

Where the process is understood, lean can be achieved. Huf Haus, (in the Grand Designs programme) arrive on site with a transit van which has exactly enough fixing for the building and all the tools required. The team is skilled and thorough: at the end of the job the construction team cleaned the van from top to bottom before leaving site, a behaviour which is considered unusual in the UK.

C MODEL ASSUMPTIONS

C.1 MODEL ASSUMPTIONS

Stages	Fixed data values	
Material	Environmental impacts from EPD or Ccalc Offsite Waste volume is 10% Onsite Waste volume is 20 % Where materials are delivered prefabricated waste volume is 0%	The assembly of materials (already cut). Time assembled--> Toward time offsite Time assembled… energy demand off site … environmental impacts Cost of employment Cost of energy
Manufacture and assembly	Environmental impacts based on Green Guide Rating Labour cost in the factory is for general operative £12.12/hr	
Transport		Determined by panel and module size
Material Manufacture Assembly Transport	Labour cost in the factory is for general operative £12.12/hr	Glulam and steel are structural frames. The materials will be prefabricated by supplier.
Material Manufacture Assembly Transport	Environmental responsible sourcing, Labour cost in the factory is for general operative £12.12/hr	
Connect craning hooks to panel. Crane into position. Survey in position. Fix , seal using , and unwrap (if necessary)	Number of fixing points to crane based on weight of module. Time Taken per connector Speed of crane movement dependant on weight	
Assembly parts on site	Assume assembly ng onsite takes 1.5 times offsite assembly	
Machine parts off site	SIPS assembly, including gluing	
Disposal of materials	Cost supplied by local company	Collected from

D MATERIALS PALETTE

D.1 ENVIRONMENTAL SCORE

D.2 MATERIALS

D.3 MATERIAL DETAILS

D.3.1 Timber

Timber describes a large range of materials. In the United Kingdom woods used in construction include spruce and fir, with woods such as oak and sweet chestnut being used more rarely.

Timber used in the United Kingdom construction industry is often from outside the United Kingdom. The quality of timber is lower strong enough for use as a structural material. Methods to make timber materials stronger are used, such as laminated and ply.

British timber meets European Union Timber Regulations. The EUTR requires foresters and suppliers to maintain a chain of custody, identifying the type of tree, country of origin and volume along with other information.

Recycled wood, Plywood

Sustainable certification. PFC

Manufacturing treatment

Red cedar/ Larch (cladding) /OSB

Timber has several sustainable characteristics. If the rate of renewal is less than the rate at which timber is replaced, if the stock of trees is not carefully managed, then the timber is not sustainably sourced. It is a renewable resource, which at the end of its life can often be reused or recycled or incinerated. The Environment Agency have four grades of waste wood, covering virgin timber, mixed wood, treated wood suitable for incineration and hazardous wood (contaminated with copper, chrome of arsenic treatment or creosote).

D.3.2 Metals

In construction, metals are used as structural elements, fixing and connectors. They can also be used as a surface facing. The type and amount of material used is determined by the required strength, life time and aesthetic considerations.

Metals are finite. They require large amounts of energy to extract from their ores, and sometimes require toxic chemicals during processing. A market has developed for the recovery and recycling of metals because the “new” materials are more expensive to extract than reprocessing used metals. Table below details the impacts of virgin material and recycled material.

Table 54 Energy impact of metal processing

Metal	Iron	Steel (structural)	Zinc	Aluminium
Extraction	25	32.4MJ/Kg	72.44	224.1 MJ/Kg
Chemical				
Typical UK	25	30.9	59.8	157.1MJ/Kg
Recycling rate	-	59%	30%	33%
Recycling				Mostly recycling 17.9

Steel is available in the UK but the material produced is of higher specification than used for construction. As such, steel specificities could be shipped from China or other similar. Manufacture of the structural elements would be completed by a steel fabricator, offsite and it would be delivered to site ready for assembly.

D.3.3 External wall elements

1m² of external wall construction, to satisfy current Building Regulations, and a U value of 0.3 W/m²K. Where relevant, the specification will also include an internal wall finish.

Element Number	Element	Summary rating	Kg of CO2eq
1106164003	Cladding on Structurally Insulated Panels Canadian cedar cladding, breather membrane, 2 x 15mm OSB with 112mm rigid urethane insulation, to give 142mm overall thickness SIP system, plasterboard on battens, paint	A+	20.0
1106164004	Cladding on Structurally Insulated Panels Pre-treated softwood weatherboarding on timber battens, breather membrane, 2 x 15mm OSB with 112mm rigid urethane insulation, to give 142mm overall thickness SIP system, plasterboard on battens, paint	A+	1.7
806210048	Timber Framed Construction Canadian cedar weatherboarding, OSB/3 sheathing, timber frame with insulation, vapour control layer, plasterboard on battens, paint	A+	14
806210566	Timber Framed Construction UK produced natural slate on timber battens, breather membrane, OSB/3 sheathing, timber frame with insulation, vapour control layer, plasterboard on battens, pain	A+	35.0
806210057	Timber Framed Construction Canadian cedar weatherboarding, breather membrane, plywood (temperate EN 636-2) sheathing, timber frame with insulation, vapour control layer, plasterboard on battens, paint	A+	17.0
806210051	Timber Framed Construction Pre-treated softwood weatherboarding, breather membrane, OSB/3 sheathing, timber frame with insulation, vapour control layer, plasterboard on battens, paint	A+ E for photochemical ozone)	-3.2
806210566	Timber Framed Construction UK produced natural slate on timber battens, breather membrane, OSB/3 sheathing, timber frame with insulation, vapour control layer, plasterboard on battens, paint	A+	35.0
1206490017	Light Steel Framed Construction UK produced natural slate tiles on timber battens, breather membrane, OSB/3 sheathing, insulation, light steel frame, vapour control layer, plasterboard on battens, paint.	A+	47
1206490026	Light Steel Framed Construction Canadian Cedar boarding on timber battens, breather membrane, cement-bonded particle board sheathing, insulation, light steel frame, vapour control layer, plasterboard on battens, paint.	A+	55
1206490027	Light Steel Framed Construction Canadian cedar boarding on timber battens, breather membrane, no sheathing, insulation, light steel frame, vapour control layer, plasterboard on battens, paint	A+	30.0
806390025	Concrete Frame with Metal Stud Infill Brick faced non-loadbearing precast concrete sandwich panel, reinforced concrete frame, light steel studwork, plasterboard,	D	350.0

	paint		
806260689	Loadbearing Precast Concrete Systems Reconstructed stone faced precast concrete cladding panel, insulation, light steel studwork, plasterboard, paint	B	230
806530031	Loadbearing Precast Concrete Systems Sandstone faced precast concrete cladding panel, insulation, light steel studwork, plasterboard, paint	D	250

D.3.4 Ground floor construction

Functional unit for solid and suspended ground floors:

1m² ground floor based on a dwelling with a ground floor area of 40m² and exposed perimeter of 18m to satisfy England & Wales Building Regulations and a U value of 0.22 W/m²K. To include any repair, refurbishment or replacement over the 60-year study period. DPM must be continuous with the walls.

Element Number	Element	Summary rating	Kg of CO2eq (60years)
820470033	Suspended Timber Chipboard (P5) decking on timber joists with insulation, over 100mm 30% PFA oversite concrete (100% RCA)	A	33.0
820470035	Suspended Timber Chipboard (P5) decking on timber joists with insulation, over 100mm 30% PFA oversite concrete	A	32
820470076	Suspended Timber OSB/3 decking on timber joists with insulation, over 100mm 30% PFA oversite concrete (100% RCA)	A+	21
820470078	Suspended Timber OSB/3 decking on timber joists with insulation, over 100mm 50% GGBS oversite concrete (100% RCA)	A+	15
820470125	Suspended Timber Plywood (temperate, EN636-2) decking on timber joists with insulation, over 100mm 50% GGBS oversite concrete (100% RCA)	A	24
820140001	Suspended Concrete Chipboard (P5) decking on timber battens with insulation on grouted hollow precast prestressed concrete planks	A	60
820140017	Suspended Concrete Chipboard (P5) decking on timber battens with insulation on grouted hollow precast reinforced concrete planks	C	110.0
820144003	Suspended Concrete OSB/3 decking on timber battens on insulation on grouted hollow precast prestressed concrete planks	A	49.0
820140021	Suspended Concrete OSB/3 decking on timber battens on insulation on grouted hollow precast reinforced concrete planks	C	100.0
820140004	Suspended Concrete Plywood (temperate, EN636-2) on insulation on	B	58.0

Element Number	Element	Summary rating	Kg of CO2eq (60years)
	grouted hollow precast prestressed concrete planks		
820140007	Suspended Concrete Plywood (temperate, EN636-2) on insulation on grouted hollow precast reinforced concrete planks	D	110.0

D.3.5 Roof

Functional unit for Roofs for Domestic properties:

1m² of roof area (measured horizontally), to satisfy England & Wales Building Regulations, particularly a U value of 0.16 W/m²K (pitched) or 0.25 W/m²K (flat). Span of 8m to include a plasterboard ceiling and emulsion paint finish.

Element Number	Element	Summary rating	Kg of CO2eq (60years)
912410075	Pitched Roof Timber Construction Structurally insulated timber panel system with OSB/3 each side and pentane blown PU insulation, breather membrane, standing seam organic coated steel sheet	A+	59.0
	Pitched roof steel construction Structurally insulated timber panel system with OSB/3 each side and pentane blown PU insulation, breather membrane, standing seam organic coated steel sheet	A+	57.0
1212550003	Low Pitched roof (steel construction) Galvanised steel rafters and joists, double skin built up roof cladding (aluminium inner lining, insulation, mill finished aluminium standing seam outer skin)	A	95.0
1112410003	Pitched roof timber construction Timber trussed rafters and joists with insulation, OSB/3 deck, breather membrane, standing seam organic coated steel sheet.	A+	52.0
1212410011	Pitched roof timber construction Structurally insulated timber panel system with OSB/3 each side, roofing underlay, counter battens, battens, softwood timber boarding, polyester underlay, Code 5 100% recycled lead sheet	A+	41.0
812410027	Pitched roof timber construction Plasterboard, timber trussed rafters with insulation, roofing underlay, counter battens, battens and imported Spanish slates	A	53.0
1112690001	Pitched Roof SIP Construction 2 x 15mm OSB with 112mm rigid urethane insulation, to give 142mm overall thickness SIP system, breather membrane, counter battens, battens and UK produced clay plain tiles.	A+	49.0
1212690001	Pitched roof SIP construction 2 x 15mm OSB with 112mm rigid urethane insulation, to give 142mm overall thickness SIP system, breather membrane, counter battens, battens, plywood (temperate EN 636-2), building paper, Code 5 100% recycled lead sheet	A	42.0
812150015	Pitched Roof Steel Construction Galvanised steel rafters and joists with insulation, battens, breather membrane, plywood (temperate EN 636-2) decking, standing seam copper roof	A	72.0

Element Number	Element	Summary rating	Kg of CO2eq (60years)
812150008	Pitched Roof Steel Construction Galvanised steel rafters and joists with insulation, roofing underlay, counter battens, battens and UK produced slate	A	68.0

D.3.6 Internal walls

General domestic and non domestic construction:

1m² of internal wall or partitioning, to satisfy Building Regulations, and to include any repair, refurbishment or replacement over a 60 year study period.

Element Number	Element	Summary rating	Kg of CO2eq (60years)
809750005	Proprietary and demountable partitions Enamelled steel partition, mineral wool core	B	64
1209750003	Proprietary and demountable partitions Aluminium framed partitioning system, plasterboard panels with cardboard honeycomb core, paint	B	43
809760002	Framed partitions Galvanised steel stud, plasterboard, paint	A	28
809760054	Framed partitions Timber cassette internal wall panel with plywood (softwood) sheathing, plasterboard and paint	A	13
809760003	Framed Partitions Timber stud, plasterboard, paint	A+	15

D.3.7 Separating floor

Functional unit for Separating Floor (party floor). Housing only:

1m² of separating floor with a live loading of 1.5 kN/m² to satisfy England & Wales Building Regulations, in particular a minimum airborne sound insulation $D_{nT,w} + C_{tr}$ of 45 dB and impact sound insulation $L'_{nT,w}$ of 62 dB (source Approved Document E 2003) and a span of 5m.

Element Number	Element	Summary rating	Kg of CO2eq (60years)
829910234	Approved Document E: Floor type 3.1A: Platform floor - 18mm OSB/3 on plasterboard (total min. 25kg/m²) on 25mm min. mineral wool (80 kg/m³) on OSB/3 deck (20kg/m² min.) on timber frame floor structure with Ceiling Treatment A.	A+	-8.0
829910211	Robust Detail E-FT-3: Floating Floor Treatment (FFT1 with OSB/3 and gypsum based board (13.5kg/m²) with mineral wool quilt between battens) on Structure Option B and Ceiling Treatment C	A+	5.7
829560015	Panelised steel floor cassette, insulation with OSB/3 floor decking above and plasterboard and OSB/3 floating floor on timber battens. Plasterboard (2 layers with staggered joints) ceiling fixed to joists using resilient bars with paint	A	28.0
929560000	Robust detail E-FS-2: Floating Floor Treatment (FFT1 with 22mm min chipboard and gypsum based board (13.5kg/m2) with mineral wool quilt between battens) on 22mm (min) chipboard decking on Structure option D and ceiling Treatment B	A+	35.0

D.3.8 Traditional Construction

Element		Green Guide Rating	Environmental score
806170028	External wall Blockwork cavity wall Brickwork outer leaf, insulation, aircrete blockwork inner leaf, cement mortar, plaster, paint	A+	10
820100043	Ground floor Solid concrete Screed on insulation laid on solid 30% PFA concrete (100% RCA) floor on polyethylene DPM on blinded recycled aggregate sub-base	B-E D	3-0 1
812410006	Roof Pitched roof timber construction Timber trussed rafters and joists with insulation, roofing underlay, counterbattens, battens and UK produced clay plain tiles.	A+	10
809180022	Internal wall Masonry Partitions Aircrete blockwork with thin joint mortar, plaster, paint	A+	
807280048	Ceiling /Floor /Upper floor Chipboard decking on timber I joist	A+	10

Product system	Element	Component	Material	Vertical (varaible)	Horizontal (fixed or variable)	Thickness/diameter (fixed)	Vertical (cost)	Density (kg/m3)	Volume	Item cost /£ (cost from suupplier)	volume cost	supplier unit	item volume scalar (the product of the dimensions that donot change in manufacture)	Metric	Variable metric	metric unit cost	Purchase metric
Finish	**Cladding**	**Stone cladding**	**Z-shaped stone cladding**	1200	2500	40	1000	2700	120000000	122.50	3.06E-06	m2	40.00	m^2	3,000,000	0.0000408	
Finish	**Cladding**	**Timber cladding**	**Western Red Cedar**	5000	94	19	1000	380	8930000	2.44	1.37E-06	m	19.00	m2	470,000	0.0000052	1
Finish	**Cladding**	**Metal cladding**	**Zinc cladding**	1000	1000	0.7	1000	7135	700000	97.50	1.39E-04	M2	0.70	m^2	1,000,000	0.0000975	
Finish	**Lining**	**Drylining**	**Plasterboard**	2400	1200	12.5	2400	668	36000000	1.55	4.31E-08	sheets	12.5	m2	2,880,000	0.0000005	1000
Incidental	**Base**	**Frame**	**Steel base frame**	7000	4200	100	1	1	2940000000	938.00		UNIT	1	unit	1	938.0000000	
Incidental	**TF/SIP**	**Top plates; (sole)plates; headers & blockers**	**44x240mm SW**	2440	44	240	2440	600	25766400	3.75	1.46E-07	m	10560	m	2,440	0.0015369	1
Insulation	**Insulation**	**SIP Structural insulation**	**EPS density 20kg/m3**	2400	1200	160	2400	20	460800000	*41.91*	9.09E-08	m2	160	m2	2,880,000	0.0000146	1
Insulation	**Insulation**	**Blown Insulation**	**Warmcell**	1000	1000	240	1000	0.5	240000000	*1,000.00*		unit	240	m2	1,000,000	0.0010000	1000
Insulation	**Insulation**	**Insulation batts**	**Rockwool**	1200	600	240	1200	40	172800000	*10.50*	6.08E-08	sqm	240	m2	720,000	0.0000146	
Insulation	**Insulation**	**Insulation batts**	**Sheep wool**	1300	570	240	1000	30	177840000	18.23	1.03E-07	sqm	240	m2	741,000	0.0000246	
Panel	**TF/SIP**	**Panel Structural component**	**89x38mm SW battens**	2440	89	38	1000	600	8252080	1.88	2.27E-07	m	3382	m	2,440	0.0007684	1
Membrane	**TF/SIP**	**Breather membrane**	**Pro Clima Solitex WA**	50000	1500	1	1500	0.9	75000000	100.00	1.33E-06	Roll	1	m2	75,000,000	0.0000013	1
Membrane	**TF/SIP**	**Damp proof membrane**	**DPM**	50000	1500	1	1500	0.9	75000000	100.00	1.33E-06	Roll	1	m2	75,000,000	0.0000013	1
Membrane	**TF/SIP**	**Internal**	**Pro Clima Intello Plus**	50000	1500	1	1500	0.9	75000000	178.00	2.37E-06	Roll	1	m2	75,000,000	0.0000024	1
Panel	**TF/SIP**	**External battens**	**38x50mm treated SW battens**	2400	50	38	1000	600	4560000	2.50	5.48E-07	m	1900	m	2,400	0.0010417	1
Panel	**TF panel**	**Panel Structural component**	**240x45mm timber I-Joist**	1000	45	240	1000	600	10800000	4.54	4.54E+00	m	10800	m	1,000	0.0045400	1

Product system	Element	Component	Material	Vertical (varaible)	Horizontal (fixed or variable)	Thickness/diameter (fixed)	Vertical (cost)	Density (kg/m3)	Volume	Item cost /£ (cost from suupplier)	volume cost	supplier unit	item volume scalar (the product of the dimensions that donot change in manufacture)	Metric	Variable metric	metric unit cost	Purchase metric
Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1000	600	7286400	0.94	1.29E-07	m	3036	m	2,400	0.0003917	1
Panel	SIP Panel	Sheathing board	18mm 2440x1220 OSB3	2440	1220	18	2440	600	53582400	*15.54*	2.90E-07	sheets	18	m2	2,976,800	0.0000052	1
Panel	TF panel	I joist flange	240x45mm timber I-Joist flange (soft wood)	1000	45	45	1000	500	2025000	4.54	4.54E+00	N/A	2025	m	1,000	0.0045400	
Panel	TF panel	I joist web	240x45mm timber I-Joist web (fibre board)	1000	9	10	1000	900	90000	4.54	4.54E+00	N/A	90	m	1,000	0.0045400	
Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2440	600	25766400	3.75	1.46E-07	m	10560	m	2,440	0.0015369	1
Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2440	600	32744800	*10.20*	3.11E-07	sheets	11	m2	2,976,800	0.0000034	1
Structural	Structural portal	Structural component	90x240mm glulam	1000	90	240	1000	380	21600000	17.61	8.15E-07	m	21600	m	1,000	0.0176100	1
Structural	Structural portal	Structural component	Steel rsj beam 203*133	1000	133	203	1000	25.1	26999000	62.50	2.31E-06	m	26999	m	1,000	0.0625000	
Structural	cementitous	Concrete	Ready-mix Concrete	4000	7000	162	1000	2332	4536000000	*458.40*	1.01E-07	*unit*	*162.00*	m2	28,000,000	0.0000164	1
Structural	Brick	Brick	LBC COMMON BRICK 65MM	215	65	102.5	215	1900	1432437.5	273		390brick (60brick per m2	102.5	m2	13,975	0.0195349	1
Structural	Block	Block	TARMAC TOPLITE AERATED BLOCK 2.9N	440	215	100	440	1980	9460000	1.47		1 (10.25 per m2	21500	m2	94,600	0.0000155	1
Structure	Floor	Timber joist	Joist (47*220mm)	1000	47	225	1000	600	10575000	7.99	7.56E-07	m	10575	m	1,000	0.0079900	1
Surfacing	Floor	Floor boards	Timber floor boards	2400	600	22	1000	600	31680000	14.47	4.57E-07	m2	22	m2	1440000	0.0000100	1
Structural	Wall	Mortar brick	mortar brick	10	280	102.5	1000	2332	287000	1.34355	4.68E-06		102.5	m2	2800	0.0004798	1
Structural	Wall	Mortar block	mortar block	3	655	100	1000	2332	196500	1.91	9.72E-06		100	m2	1965	0.0009720	1
Lining	Internal lining	Plaster (wet-premixed)	Plaster (wet-premixed)	1000	1000	15	1	861.5	15000000	6.23	4.15E-07	25kg	15	m2	1000000	0.0000062	1
Roof	Traditional	Roof trusses	Roof trusses	1000	1000	1000	1	600	1000000000	1	1.00E-09	unit	1	unit	1	1.0000000	1
Roof	Traditional	Tiles	Tiles	268	165	25	1	1085.48	1105500	1.16	1.05E-06	unit	25	m2	44,220	0.0000262	1
Roof	Traditional	Tiles	Ridge tile								#DIV/0!						
Floor	Traditional	Joist hanger	Joist hanger	250	50	x	1	n/a	n/a	5.99	4.79E-04	unit	1	unit	1	5.9900000	1
Structure	Structure	Wall ties	Wall ties	225	n/a	n/a	1	'n/a	n/a	8.97	3.99E-02	50units	1	unit	1	8.9700000	1

Product system	Element	Component	Material	Manufacturer	Supplier	FSC	ems14001: 2004	pefc	Internal document env/other	BES6001	FSC	PEFC	BES6001	BS 8902	ETI	OHSAS18001	Other/ internal statement social	bba	ISO9001	Internal document quality	checked	Environmetal	Social/chain of cusytody	performance	Score x/3		lifetime
Finish	Cladding	Stone cladding	Z-shaped stone cladding	Taylor Maxwell	Taylor Maxwell	0	1	0	0		0	0	0	0	0	0	0	0	1	0		1	0	1	2.00		100
Finish	Cladding	Timber cladding	Western Red Cedar	N/A	Vincent Timber	1	1	1	0.5		1	1	0	0	0	0	0.5	0	0	0		1	1	0	2.00		50
Finish	Cladding	Metal cladding	Zinc cladding	ZM zinc	ZM zinc	0	1	0	0		0	0	0	0	0	1	0	0	1	0		1	1	1	3.00		80
Finish	Lining	Drylining	Plasterboard	Knauf	SIG Insulation	0	1	0	0		0	0	0	0	0	0	0	0	1	0		1	0	1	2.00		39
Incidental	Base	Frame	Steel base frame			0	1	0	0		0	0	0	0	0	1	0	0	1	0		1	1	1	3.00		100
Incidental	TF/SIP	Top plates; (sole)plates; headers & blockers	44x240mm SW	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		60
Insulation	Insulation	SIP Structural insulation	EPS density 20kg/m3		Travis Perkins	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0	0	0.00		100
Insulation	Insulation	Blown Insulation	Warmcell	Warmcel	Warmcel	0	1	0	0.5		0	0	0	0	0	0	0	1	1	0		1	0	1	2.00		
Insulation	Insulation	Insulation batts	Rockwool	Knauff	Travis Perkins	0	1	0	0	0.5	0	0	0.5	0	0	0	0	0	1	0		1	0.5	1	2.50		100
Insulation	Insulation	Insulation batts	Sheep wool	Thermafleece	Travis Perkins	0	1	0	0	0.5	0	0	0	0	0	1	1	0	1	0		1	1	1	3.00		100
Panel	TF/SIP	Panel Structural component	89x38mm SW battens	Wisa	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1			1	1	1	3.00		100
Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	Pro Clima	Penycoed	0	0	0	0		0	0	0	0	0	0	0	1	1	0		0	0	1	1.00		100
Membrane	TF/SIP	Damp proof membrane	DPM	Travis Perkins	Travis Perkins	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0	0	0.00		100
Membrane	TF/SIP	Internal	Pro Clima Intello Plus	Pro Clima	Penycoed	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0	0	0.00		100
Panel	TF/SIP	External battens	38x50mm treated SW battens	Booker Timber	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		60
Panel	TF panel	Panel Structural component	240x45mm timber I-Joist			5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		100

Product system	Element	Component	Material	Manufacturer	Supplier	FSC	ems14001: 2004	pefc	Internal document env/other	BES6001	FSC	PEFC	BES6001	BS 8902	ETI	OHSAS18001	Other/ internal statement social	bba	ISO9001	Internal document quality	checked	Environmetal	Social/chain of cusytody	performance	Score x/3		lifetime
Panel	TF/SIP	Internal battens	44x69mm SW battens	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		60
Panel	SIP Panel	Sheathing board	18mm 2440x1220 OSB3	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		100
Panel	TF panel	I joist flange	240x45mm timber I-Joist flange (soft wood)	N/A	N/A	5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		60
Panel	TF panel	I joist web	240x45mm timber I-Joist web (fibre board)	N/A	N/A	5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		60
Panel	TF panel	Panel boxing	240*44mm SW battens C16	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		100
Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		100
Structural	Structural portal	Structural component	90x240mm glulam	Steico	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0	0	1	0		1	1	1	3.00		60
Structural	Structural portal	Structural component	Steel rsj beam 203*133		Metals for u	0	0	0	0		0	0	0	0	0	0	0	0	0	0.5		0	0	0.5	0.50		60
Structural	cementitous	Concrete	Ready-mix Concrete	Agilia		0	1	0	0		0	0	0	1	0	1	1		1	0	0	1	1	1	3.00		100
Structural	Brick	Brick	LBC COMMON BRICK 65MM	London Brick	Jewson	0	1	0	0		0	0	0	1	0	1	1		1	0	0	1	1	1	3.00		100
Structural	Block	Block	TARMAC TOPLITE AERATED BLOCK 2.9N	Tarmac	Jewson	0	1	0	1		0	0	0	1	0	1	1		1	0	0	1	1	1	3.00		100
Structure	Floor	Timber joist	Joist (47*220mm)	Steico	Jewson	1	1	1	0		1	1	0	1	1	1	1	1	1	0	0	1	1	1	3.00		60
Surfacing	Floor	Floor boards	Timber floor boards	Steico		1	1	1	0		1	1	0	1	1	1	1	1	1	0	0	1	1	1	3.00		60
Structural	Wall	Mortar brick	mortar brick			5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		
Structural	Wall	Mortar block	mortar block			5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		30
Lining	Internal lining	Plaster (wet-premixed)	Plaster (wet-premixed)	British gypsum	Wickes	0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		50
Roof	Traditional	Roof trusses	Roof trusses		Howarth Timber	1	1	1	0		1	1	0	1	1	1	1	0	1	0	0	1	1	1	3.00		100
Roof	Traditional	Tiles	Tiles	Sandtoft		0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		100
Roof	Traditional	Tiles	Ridge tile			0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		100
Floor	Traditional	Joist hanger	Joist hanger		Wickes	0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		100
Structure	Structure	Wall ties	Wall ties		Jewson	0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		50

E PANEL DESIGN

E.1.1 Components

Product system	Element	Component	Material
Structural	Structural portal	Glulam	90x240mm glulam
Structural	Structural portal	Steel	Steel rsj beam 203*133
Panel	TF panel	I-joists	240x45mm timber I-Joist
Panel	TF panel	I joist flange	240x45mm timber I-Joist
Panel	TF panel	I joist web	240x45mm timber I-Joist web
Panel	SIP Panel	Structural board SIP	18mm 2440x1220 OSB3
Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3
Panel	TF panel	Panel structure C16 top and	240*44mm SW battens
Incidental	Fabric assembly	Top plates; (sole)plates;	44x240mm SW
Internal panel	TF panel	Structural stud	89x38mm SW battens
Panel	External panel faces	External battens	38x50mm treated SW battens
Panel	Internal panel faces	Internal battens	44x69mm SW battens
Insulation	Insulation	Warmcel	Blown material density xxx
Insulation	Insulation	Insulation batts	Rockwool
Insulation	Insulation	Insulation batts	Sheep wool
Insulation /	Insulation	SIP panel sandwich	EPS density 20kg/m3
Cladding	Cladding	Red Cedar	94x19mm Western Red Cedar
Cladding	Cladding	Zinc	4mm thick cladding jointed
Cladding	Cladding	Stone cladding	Taylor Maxwell z-shaped stone
Lining	Lining	Plasterboard	Board: square edge
Membrane	Membrane	Internal membrane	Pro Clima Intello Plus
Membrane	Membrane	Breather membrane	Pro Clima Solitex WA
Membrane	Membrane	Damp proof membrane	DPM

Summary of chosen volumetric design solution

Unit	Wall	Floor	Upper floor /ceiling	Internal wall
Ground floor Kitchen	2400*2400 4200*2400	2400*4200	2400*4200	4200*2400
Ground floor Hall	4600*2400 1000*2400	4600*1000	4600*1000	1000*2400
Ground floor lounge	3200*2400 4600*2400	3200*4600	3200*4600	3200*2400 4600*2400
First Floor Bathroom	1800*2400 2400*2400	1800*2400	1800*2400	1800*2400 2400*2400
First Floor Hall	900*2400 1800*2400 1000*2400 600*1000			
First Floor Bedroom 1	3200*2400 3700*2400	3200*3700	3200*3700	
First Floor Bedroom 2	2400*2400 3300*2400	2400*3300	2400*3300	

Materials: Panel width =600mm

Material	Number of pieces	Weight	Total weight
Wall			
I joist (90*sw90)	2	12.24	24.48
C16	2	3.8	7.6
Screw	16	0.002	0.032
OSB	1	15.55	15.55
nail fixings	60	0.001	0.06
insulation	1	<2.5	2.5
airtightness membrane	1	0.05	0.05
tacks	60	0.001	0.03
Roof			
I joist	2	21.42	42.84
C16	2	3.8	7.6
Screw	16	0.002	0.032
OSB	2	15.55	31.1
nail fixings	96	0.001	0.096
insulation	1	<2.5	2.5
OSB sheathing board	2	15.55	31.1
tacks	96	0.005	0.48
Floor			
I joist (90*sw90)	2	40.0	80
C16	2	3.8	7.6
Screw	16	0.002	0.032
OSB	1	15.552	15.6
nail fixings	96	0.001	0.10
insulation	1	<2.5	2.5
airtightness membrane	1	0.05	0.05
tacks	96	0.005	0.48

Materials: Panel width =1200mm

Material	Number of pieces	Weight	Total weight
Wall			
I joist (90*sw90)	3	12.24	36.72
C16	2	7.6	15.2
Screw	16	0.002	0.032
OSB sheathing board	1	15.55	15.55
nail fixings	96	0.001	0.10
insulation	2	<2.5	5
airtightness membrane	1	0.05	0.05
tacks	96	0.001	0.10
Roof			Total weight
I joist	3	21.42	64.26
C16	2	7.6	15.2
Screw	16	0.002	0.032
OSB sheathing board	2	31.10	62.10
nail fixings	150	0.001	0.15
insulation	2	<2.5	5.0
OSB sheathing board	2	31.104	62.10
tacks	150	0.001	0.15
Floor			
I joist (90*sw90)	2	40.0	80.0
C16	1	7.6	15.2
Screw	16	0.002	0.032
OSB sheathing board	2	31.104	62.21
nail fixings	108	0.001	0.108
insulation	1		
airtightness membrane	1	0.05	
tacks	96	0.005	0.48

F MANUFACTURE OF COMPONENTS

Product system	Element	Component	Material	Vertical (varible)	Horizontal (fixed or variable)	Thickness/diameter (fixed)	Vertical (cost)	Density (kg/m3)	Volume	Item cost /£ (cost from suupplier)	volume cost	supplier unit	item volume scalar (the product of the dimensions that donot change in manufacture)	Metric	Variable metric	metric unit cost	Purchase metric
Finish	**Cladding**	**Stone cladding**	**Z-shaped stone cladding**	1200	2500	40	1000	2700	120000000	122.50	3.06E-06	m2	40.00	m^2	3,000,000	0.0000408	
Finish	**Cladding**	**Timber cladding**	**Western Red Cedar**	5000	94	19	1000	380	8930000	2.44	1.37E-06	m	19.00	m2	470,000	0.0000052	1
Finish	**Cladding**	**Metal cladding**	**Zinc cladding**	1000	1000	0.7	1000	7135	700000	97.50	1.39E-04	M2	0.70	m^2	1,000,000	0.0000975	
Finish	**Lining**	**Drylining**	**Plasterboard**	2400	1200	12.5	2400	668	36000000	1.55	4.31E-08	sheets	12.5	m2	2,880,000	0.0000005	1000
Incidental	**Base**	**Frame**	**Steel base frame**	7000	4200	100	1	1	2940000000	938.00		UNIT	1	unit	1	938.0000000	
Incidental	**TF/SIP**	**Top plates; (sole)plates; headers & blockers**	**44x240mm SW**	2440	44	240	2440	600	25766400	3.75	1.46E-07	m	10560	m	2,440	0.0015369	1
Insulation	**Insulation**	**SIP Structural insulation**	**EPS density 20kg/m3**	2400	1200	160	2400	20	460800000	*41.91*	9.09E-08	m2	160	m2	2,880,000	0.0000146	1
Insulation	**Insulation**	**Blown Insulation**	**Warmcell**	1000	1000	240	1000	0.5	240000000	*1,000.00*		unit	240	m2	1,000,000	0.0010000	1000
Insulation	**Insulation**	**Insulation batts**	**Rockwool**	1200	600	240	1200	40	172800000	*10.50*	6.08E-08	sqm	240	m2	720,000	0.0000146	
Insulation	**Insulation**	**Insulation batts**	**Sheep wool**	1300	570	240	1000	30	177840000	18.23	1.03E-07	sqm	240	m2	741,000	0.0000246	
Panel	**TF/SIP**	**Panel Structural component**	**89x38mm SW battens**	2440	89	38	1000	600	8252080	1.88	2.27E-07	m	3382	m	2,440	0.0007684	1
Membrane	**TF/SIP**	**Breather membrane**	**Pro Clima Solitex WA**	50000	1500	1	1500	0.9	75000000	100.00	1.33E-06	Roll	1	m2	75,000,000	0.0000013	1
Membrane	**TF/SIP**	**Damp proof membrane**	**DPM**	50000	1500	1	1500	0.9	75000000	100.00	1.33E-06	Roll	1	m2	75,000,000	0.0000013	1
Membrane	**TF/SIP**	**Internal**	**Pro Clima Intello Plus**	50000	1500	1	1500	0.9	75000000	178.00	2.37E-06	Roll	1	m2	75,000,000	0.0000024	1
Panel	**TF/SIP**	**External battens**	**38x50mm treated SW battens**	2400	50	38	1000	600	4560000	2.50	5.48E-07	m	1900	m	2,400	0.0010417	1
Panel	**TF panel**	**Panel Structural component**	**240x45mm timber I-Joist**	1000	45	240	1000	600	10800000	4.54	4.54E+00	m	10800	m	1,000	0.0045400	1

Product system	Element	Component	Material	Vertical (varaible)	Horizontal (fixed or variable)	Thickness/diameter (fixed)	Vertical (cost)	Density (kg/m3)	Volume	Item cost /£ (cost from suuppier)	volume cost	supplier unit	item volume scalar (the product of the dimensions that donot change in manufacture)	Metric	Variable metric	metric unit cost	Purchase metric
Panel	**TF/SIP**	**Internal battens**	**44x69mm SW battens**	2400	69	44	1000	600	7286400	0.94	1.29E-07	m	3036	m	2,400	0.0003917	1
Panel	**SIP Panel**	**Sheathing board**	**18mm 2440x1220 OSB3**	2440	1220	18	2440	600	53582400	*15.54*	2.90E-07	sheets	18	m2	2,976,800	0.0000052	1
Panel	**TF panel**	**I joist flange**	**240x45mm timber I-Joist flange (soft wood)**	1000	45	45	1000	500	2025000	4.54	4.54E+00	N/A	2025	m	1,000	0.0045400	
Panel	**TF panel**	**I joist web**	**240x45mm timber I-Joist web (fibre board)**	1000	9	10	1000	900	90000	4.54	4.54E+00	N/A	90	m	1,000	0.0045400	
Panel	**TF panel**	**Panel boxing**	**240*44mm SW battens C16**	2440	240	44	2440	600	25766400	3.75	1.46E-07	m	10560	m	2,440	0.0015369	1
Panel	**TF panel**	**Sheathing board**	**11mm 2440x1220 OSB3**	2440	1220	11	2440	600	32744800	*10.20*	3.11E-07	sheets	11	m2	2,976,800	0.0000034	1
Structural	**Structural portal**	**Structural component**	**90x240mm glulam**	1000	90	240	1000	380	21600000	17.61	8.15E-07	m	21600	m	1,000	0.0176100	1
Structural	**Structural portal**	**Structural component**	**Steel rsj beam 203*133**	1000	133	203	1000	25.1	26999000	62.50	2.31E-06	m	26999	m	1,000	0.0625000	
Structural	**cementitous**	**Concrete**	**Ready-mix Concrete**	4000	7000	162	1000	2332	4536000000	*458.40*	1.01E-07	*unit*	*162.00*	m2	28,000,000	0.0000164	1
Structural	**Brick**	**Brick**	**LBC COMMON BRICK 65MM**	215	65	102.5	215	1900	1432437.5	273		390brick (60brick per m2	102.5	m2	13,975	0.0195349	1
Structural	**Block**	**Block**	**TARMAC TOPLITE AERATED BLOCK 2.9N**	440	215	100	440	1980	9460000	1.47		1 (10.25 per m2	21500	m2	94,600	0.0000155	1
Structure	**Floor**	**Timber joist**	**Joist (47*220mm)**	1000	47	225	1000	600	10575000	7.99	7.56E-07	m	10575	m	1,000	0.0079900	1
Surfacing	**Floor**	**Floor boards**	**Timber floor boards**	2400	600	22	1000	600	31680000	14.47	4.57E-07	m2	22	m2	1440000	0.0000100	1
Structural	**Wall**	**Mortar brick**	**mortar brick**	10	280	102.5	1000	2332	287000	1.34355	4.68E-06		102.5	m2	2800	0.0004798	1
Structural	**Wall**	**Mortar block**	**mortar block**	3	655	100	1000	2332	196500	1.91	9.72E-06		100	m2	1965	0.0009720	1
Lining	**Internal lining**	**Plaster (wet-premixed)**	**Plaster (wet-premixed)**	1000	1000	15	1	861.5	15000000	6.23	4.15E-07	25kg	15	m2	1000000	0.0000062	1
Roof	**Traditional**	**Roof trusses**	**Roof trusses**	1000	1000	1000	1	600	1000000000	1	1.00E-09	unit	1	unit	1	1.0000000	1
Roof	**Traditional**	**Tiles**	**Tiles**	268	165	25	1	1085.48	1105500	1.16	1.05E-06	unit	25	m2	44,220	0.0000262	1
Roof	**Traditional**	**Tiles**	**Ridge tile**								#DIV/0!						
Floor	**Traditional**	**Joist hanger**	**Joist hanger**	250	50	x	1	n/a	n/a	5.99	4.79E-04	unit	1	unit	1	5.9900000	1
Structure	**Structure**	**Wall ties**	**Wall ties**	225	n/a	n/a	1	'n/a	n/a	8.97	3.99E-02	50units	1	unit	1	8.9700000	1

Product system	Element	Component	Material	Manufacturer	Supplier	FSC	ems14001: 2004	pefc	Internal document env/other	BES6001	FSC	PEFC	BES6001	BS 8902	ETI	OHSAS18001	Other/ internal statement social	bba	ISO9001	Internal document quality	checked	Enviromnetal	Social/chain of cusytody	performance	Score x/3		lifetime
Finish	Cladding	Stone cladding	Z-shaped stone cladding	Taylor Maxwell	Taylor Maxwell	0	1	0	0		0	0	0	0	0	0	0	0	1	0		1	0	1	2.00		100
Finish	Cladding	Timber cladding	Western Red Cedar	N/A	Vincent Timber	1	1	1	0.5		1	1	0	0	0	0	0.5	0	0	0		1	1	0	2.00		50
Finish	Cladding	Metal cladding	Zinc cladding	ZM zinc	ZM zinc	0	1	0	0		0	0	0	0	0	1	0	0	1	0		1	1	1	3.00		80
Finish	Lining	Drylining	Plasterboard	Knauf	SIG Insulation	0	1	0	0		0	0	0	0	0	0	0	0	1	0		1	0	1	2.00		39
Incidental	Base	Frame	Steel base frame			0	1	0	0		0	0	0	0	0	1	0	0	1	0		1	1	1	3.00		100
Incidental	TF/SIP	Top plates; (sole)plates; headers & blockers	44x240mm SW	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		60
Insulation	Insulation	SIP Structural insulation	EPS density 20kg/m3		Travis Perkins	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0	0	0.00		100
Insulation	Insulation	Blown Insulation	Warmcell	Warmcel	Warmcel	0	1	0	0.5		0	0	0	0	0	0	0	1	1	0		1	0	1	2.00		
Insulation	Insulation	Insulation batts	Rockwool	Knauff	Travis Perkins	0	1	0	0	0.5	0	0	0.5	0	0	0	0	0	1	0		1	0.5	1	2.50		100
Insulation	Insulation	Insulation batts	Sheep wool	Thermafleece	Travis Perkins	0	1	0	0	0.5	0	0	0	0	0	1	1	0	1	0		1	1	1	3.00		100
Panel	TF/SIP	Panel Structural component	89x38mm SW battens	Wisa	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1			1	1	1	3.00		100
Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	Pro Clima	Penycoed	0	0	0	0		0	0	0	0	0	0	0	1	1	0		0	0	1	1.00		100
Membrane	TF/SIP	Damp proof membrane	DPM	Travis Perkins	Travis Perkins	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0	0	0.00		100
Membrane	TF/SIP	Internal	Pro Clima Intello Plus	Pro Clima	Penycoed	0	0	0	0		0	0	0	0	0	0	0	0	0	0		0	0	0	0.00		100
Panel	TF/SIP	External battens	38x50mm treated SW battens	Booker Timber	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		60
Panel	TF panel	Panel Structural component	240x45mm timber I-Joist			5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		100

Product system	Element	Component	Material	Manufacturer	Supplier	FSC	ems14001: 2004	pefc	Internal document env/other	BES6001	FSC	PEFC	BES6001	BS 8902	ETI	OHSAS18001	Other/ internal statement social	bba	ISO9001	Internal document quality	checked	Environmetal	Social/chain of cusytody	performance	Score x/3		lifetime
Panel	TF/SIP	Internal battens	44x69mm SW battens	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		60
Panel	SIP Panel	Sheathing board	18mm 2440x1220 OSB3	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		100
Panel	TF panel	I joist flange	240x45mm timber I-Joist flange (soft wood)	N/A	N/A	5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		60
Panel	TF panel	I joist web	240x45mm timber I-Joist web (fibre board)	N/A	N/A	5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		60
Panel	TF panel	Panel boxing	240*44mm SW battens C16	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		100
Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	N/A	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0.5	0	1	0		1	1	1	3.00		100
Structural	Structural portal	Structural component	90x240mm glulam	Steico	Travis Perkins	1	1	1	0.5		1	1	0	0	0	0	0	0	1	0		1	1	1	3.00		60
Structural	Structural portal	Structural component	Steel rsj beam 203*133		Metals for u	0	0	0	0		0	0	0	0	0	0	0	0	0	0.5		0	0	0.5	0.50		60
Structural	cementitous	Concrete	Ready-mix Concrete	Agilia		0	1	0	0		0	0	0	1	0	1	1		1	0	0	1	1	1	3.00		100
Structural	Brick	Brick	LBC COMMON BRICK 65MM	London Brick	Jewson	0	1	0	0		0	0	0	1	0	1	1		1	0	0	1	1	1	3.00		100
Structural	Block	Block	TARMAC TOPLITE AERATED BLOCK 2.9N	Tarmac	Jewson	0	1	0	1		0	0	0	1	0	1	1		1	0	0	1	1	1	3.00		100
Structure	Floor	Timber joist	Joist (47*220mm)	Steico	Jewson	1	1	1	0		1	1	0	1	1	1	1	1	1	0	0	1	1	1	3.00		60
Surfacing	Floor	Floor boards	Timber floor boards	Steico		1	1	1	0		1	1	0	1	1	1	1	1	1	0	0	1	1	1	3.00		60
Structural	Wall	Mortar brick	mortar brick			5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		
Structural	Wall	Mortar block	mortar block			5	5	5	5		5	5	0	5	5	5	5	5	5	5		1	1	1	3.00		30
Lining	Internal lining	Plaster (wet-premixed)	Plaster (wet-premixed)	British gypsum	Wickes	0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		50
Roof	Traditional	Roof trusses	Roof trusses		Howarth Timber	1	1	1	0		1	1	0	1	1	1	1	0	1	0	0	1	1	1	3.00		100
Roof	Traditional	Tiles	Tiles	Sandtoft		0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		100
Roof	Traditional	Tiles	Ridge tile			0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		100
Floor	Traditional	Joist hanger	Joist hanger		Wickes	0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		100
Structure	Structure	Wall ties	Wall ties		Jewson	0	1	0	0		0	0	0	1	0	1	1	0	1	0	0	1	1	1	3.00		50

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable		component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
600	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	2	10.90	21.79	0	1.00	0
1200	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	3	10.90	32.69	0	1.00	0
1800	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	4	10.90	43.58	0	1.00	0
1200	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	7286400	4	0.94	3.76	29145600	2.00	4
600	wall	Finish	Lining	Drylining	Plasterboard	600	4200	2520000	m2	18000000	1	0.78	0.78	18000000	3.00	2
2400	wall	Finish	Lining	Drylining	Plasterboard	1200	4200	5040000	m2	36000000	1	1.55	1.55	36000000	3.00	2
1200	wall	Finish	Lining	Drylining	Plasterboard	1200	4200	5040000	m2	54000000	1	2.33	2.33	54000000	3.00	2
1800	wall	Finish	Lining	Drylining	Plasterboard	1800	4200	7560000	m2	36000000	1	1.55	1.55	36000000	3.00	2
600	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	1349	1349	m	0	2	6.12	12.25	0	1.00	0
1200	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2177	2612400	m2	28736400	2	8.95	17.90	57472800	1.00	4
600	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2177	1306200	m2	14368200	2	4.48	8.95	28736400	1.00	4
1800	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	2177	3918600	m2	43104600	2	13.43	26.85	86209200	1.00	4
2400	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	2177	5224800	m2	57472800	2	17.90	35.81	114945600	1.00	4
600	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	1349	809400	m2	8903400	2	2.77	5.55	17806800	1.00	4
600	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	2	0.92	1.84	12672000	1.00	4
1200	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	1200	m	12672000	2	1.84	3.69	25344000	1.00	4
1800	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	1800	m	19008000	2	2.77	5.53	38016000	1.00	4
2400	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	2400	m	25344000	2	3.69	7.38	50688000	1.00	4
1200	wall	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	1200	4200	5040000	m2	5040000	1	11.96	11.96	5040000	1.00	1
600	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	600	1349	809400	m2	2428200	1	3.24	3.24	2428200	1.00	1
1200	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	1200	1349	1618800	m2	2428200	1	3.24	3.24	2428200	1.00	1
1800	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	1800	1349	2428200	m2	2428200	1	3.24	3.24	2428200	1.00	1
2400	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	2400	1349	3237600	m2	2428200	1	3.24	3.24	2428200	1.00	1
600	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2177	2177	m	0	2	9.88	19.77	0	1.00	0
600	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	1821600	2	0.235	0.47	3643200	2.00	4
2400	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	3643200	8	0.47	3.76	29145600	2.00	4
1800	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	5464800	6	0.71	4.23	32788800	2.00	4
600	upper floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	4200	1	4200	m	7286400	2	0.94	1.88	14572800	2.00	4
600	internal wall	Finish	Lining	Drylining	Plasterboard	600	2400	1440000	m2	18000000	1	0.78	0.78	18000000	3.00	2
1200	internal wall	Finish	Lining	Drylining	Plasterboard	1200	2400	2880000	m2	36000000	1	1.55	1.55	36000000	3.00	2
1800	internal wall	Finish	Lining	Drylining	Plasterboard	1800	2400	4320000	m2	54000000	1	2.33	2.33	54000000	3.00	2
2400	internal wall	Finish	Lining	Drylining	Plasterboard	2400	2400	5760000	m2	72000000	1	3.10	3.10	72000000	3.00	2
1200	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	1349	1618800	m2	17806800	2	5.55	11.09	35613600	1.00	4
1800	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	1349	2428200	m2	26710200	2	8.32	16.64	53420400	1.00	4
2400	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	1349	3237600	m2	35613600	2	11.09	22.19	71227200	1.00	4
1800	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	2400	4320000	m2	47520000	2	14.80	29.60	95040000	1.00	4
600	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	1349	809400	m2	14569200	2	4.54	9.08	29138400	1.00	4
1200	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	1349	1618800	m2	29138400	2	9.08	18.15	58276800	1.00	4

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
1200	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2177	2177	m	0	3	9.88	29.65	0	1.00	0
1800	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2177	2177	m	0	4	9.88	39.53	0	1.00	0
2400	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	5	10.90	54.48	0	1.00	0
600	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	1	2400	m	4560000	2	2.50	5.00	9120000	2.00	4
1200	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	1	2400	m	4560000	4	2.50	10.00	18240000	2.00	4
1800	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	1	2400	m	4560000	6	2.50	15.00	27360000	2.00	4
2400	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	1	2400	m	4560000	8	2.50	20.00	36480000	2.00	4
2400	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	2400	5760000	m2	63360000	2	19.74	39.47	126720000	1.00	4
600	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	2	4.93	9.87	31680000	1.00	4
1200	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	2880000	m2	31680000	2	9.87	19.74	63360000	1.00	4
600	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	2	4.93	9.87	31680000	1.00	4
600	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	2	0.92	1.84	12672000	1.00	4
2400	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	2400	m	25344000	2	3.69	7.38	50688000	1.00	4
1800	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	1800	m	19008000	2	2.77	5.53	38016000	1.00	4
1200	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	1200	m	12672000	2	1.84	3.69	25344000	1.00	4
1800	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	1349	1349	m	0	4	6.12	24.50	0	1.00	0
600	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	2177	1	2177	m	4136300	2	2.27	4.54	8272600	2.00	4
1200	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	2177	1	2177	m	4136300	4	2.27	9.07	16545200	2.00	4
1800	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	2177	1	2177	m	4136300	6	2.27	13.61	24817800	2.00	4
2400	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	2177	1	2177	m	4136300	8	2.27	18.14	33090400	2.00	4
1200	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	2880000	m2	31680000	2	9.87	19.74	63360000	1.00	4
1800	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	2400	4320000	m2	47520000	2	14.80	29.60	95040000	1.00	4
2400	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	2400	5760000	m2	63360000	2	19.74	39.47	126720000	1.00	4
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	4200	2520000	m2	27720000	2	8.63	17.27	55440000	1.00	4
600	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	2	4.93	9.87	31680000	1.00	4
1200	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	2880000	m2	31680000	2	9.87	19.74	63360000	1.00	4
2400	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	2400	m	25344000	2	3.69	7.38	50688000	1.00	4
600	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	2	0.92	1.84	12672000	1.00	4
1200	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	1200	m	12672000	2	1.84	3.69	25344000	1.00	4
1800	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	1800	m	19008000	2	2.77	5.53	38016000	1.00	4
2400	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2177	2177	m	0	5	9.88	49.42	0	1.00	0
2400	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	1349	1349	m	0	5	6.12	30.62	0	1.00	0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	7286400	2	0.94	1.88	14572800	2.00	4

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
1200	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	7286400	4	0.94	3.76	29145600	2.00	4
1800	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	7286400	6	0.94	5.64	43718400	2.00	4
2400	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	7286400	8	0.94	7.52	58291200	2.00	4
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	1800	4200	7560000	m2	2520000	1	5.98	5.98	2520000	1.00	1
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	1800	2177	3918600	m2	5040000	1	11.96	11.96	5040000	1.00	1
600	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	2	4.93	9.87	31680000	1.00	4
1200	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	2880000	m2	31680000	2	9.87	19.74	63360000	1.00	4
600	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	2	0.92	1.84	12672000	1.00	4
1200	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	1200	m	12672000	2	1.84	3.69	25344000	1.00	4
1800	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	1800	m	19008000	2	2.77	5.53	38016000	1.00	4
2400	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	2400	m	25344000	2	3.69	7.38	50688000	1.00	4
1800	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	4	10.90	43.58	0	1.00	0
2400	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	5	10.90	54.48	0	1.00	0
600	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	2	10.90	21.79	0	1.00	0
1200	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	3	10.90	32.69	0	1.00	0
600	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	1349	1	1349	m	2563100	2	1.41	2.81	5126200	2.00	4
1200	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	1349	1	1349	m	2563100	4	1.41	5.62	10252400	2.00	4
1800	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	1349	1	1349	m	2563100	6	1.41	8.43	15378600	2.00	4
2400	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	1349	1	1349	m	2563100	8	1.41	11.24	20504800	2.00	4
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	1200	4200	5040000	m2	2880000	1	6.84	6.84	2880000	1.00	1
600	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	600	2400	1440000	m2	1440000	1	1.92	1.92	1440000	1.00	1
1800	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	1200	2400	2880000	m2	2880000	1	3.84	3.84	2880000	1.00	1
1200	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	1800	2400	4320000	m2	4320000	1	5.76	5.76	4320000	1.00	1
2400	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	2400	2400	5760000	m2	5760000	1	7.68	7.68	5760000	1.00	1
600	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	600	2177	1306200	m2	1306200	1	1.74	1.74	1306200	1.00	1
1800	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	1200	2177	2612400	m2	2612400	1	3.48	3.48	2612400	1.00	1
1200	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	1800	2177	3918600	m2	3918600	1	5.22	5.22	3918600	1.00	1
2400	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	2400	2177	5224800	m2	5224800	1	6.97	6.97	5224800	1.00	1
600	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	600	2400	1440000	m2	2880000	1	6.84	6.84	2880000	1.00	1
1200	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	1200	2400	2880000	m2	2880000	1	6.84	6.84	2880000	1.00	1
1800	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	1800	2400	4320000	m2	2880000	1	6.84	6.84	2880000	1.00	1
2400	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	2400	1349	3237600	m2	2880000	1	6.84	6.84	2880000	1.00	1
600	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2177	1306200	m2	14368200	2	4.48	8.95	28736400	1.00	4
1200	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2177	2612400	m2	28736400	2	8.95	17.90	57472800	1.00	4
600	wall	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	1200	4200	5040000	m2	1618800	1	3.84	3.84	1618800	1.00	1

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
600	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	2	10.90	21.79	0	1.00	2
600	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	2	16.80	33.60	0	1.00	2
600	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	2	20.88	41.77	0	1.00	2
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	2	10.90	21.79	31680000	1.00	1
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	3700	2220000	m2	24420000	2	16.80	33.60	48840000	1.00	1
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	4600	2760000	m2	30360000	2	20.88	41.77	60720000	1.00	1
600	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	0	2	0.00	0.01	0	2.00	2
600	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	3700	1	3700	m	0	2	0.00	0.01	0	2.00	2
600	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	4600	1	4600	m	0	2	0.00	0.01	0	2.00	2
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	2	10.90	21.79	31680000	1.00	2
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	3700	2220000	m2	24420000	2	16.80	33.60	48840000	1.00	2
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	4600	2760000	m2	30360000	2	20.88	41.77	60720000	1.00	2
600	**ceiling**	Finish	Lining	Drylining	Plasterboard	600	2400	1440000	m2	18720000	1	10.90	10.90	18720000	3.00	1
600	**ceiling**	Finish	Lining	Drylining	Plasterboard	600	3700	2220000	m2	28860000	1	16.80	16.80	28860000	3.00	1
600	**ceiling**	Finish	Lining	Drylining	Plasterboard	600	4600	2760000	m2	35880000	1	20.88	20.88	35880000	3.00	1
600	**upper floor**	Finish	Lining	Drylining	Plasterboard	600	2400	1440000	m2	32760000	1	1.41	1.41	32760000	3.00	1
600	**upper floor**	Finish	Lining	Drylining	Plasterboard	600	4600	2760000	m2	35880000	1	1.54	1.54	35880000	3.00	1
600	**upper floor**	Finish	Lining	Drylining	Plasterboard	600	3700	2220000	m2	28860000	1	1.24	1.24	28860000	3.00	1
600	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	1	0.92	0.92	6336000	1.00	1
600	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	1	0.92	0.92	6336000	1.00	1
600	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	1	0.92	0.92	6336000	1.00	1
600	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	1	0.00	0.00	0	1.00	1
600	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	1	0.00	0.00	0	1.00	1
600	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	1	0.00	0.00	0	1.00	1
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	1	4.93	4.93	15840000	1.00	1
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	4600	2760000	m2	30360000	1	9.46	9.46	30360000	1.00	1
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	3700	2220000	m2	24420000	1	7.61	7.61	24420000	1.00	1
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	1	4.93	4.93	15840000	1.00	1
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	4600	2760000	m2	30360000	1	9.46	9.46	30360000	1.00	1
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	3700	2220000	m2	24420000	1	7.61	7.61	24420000	1.00	1
600	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	2	0.92	1.84	12672000	1.00	2
600	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	2	0.92	1.84	12672000	1.00	2
600	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	600	1	600	m	6336000	2	0.92	1.84	12672000	1.00	2
600	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	3	10.90	32.69	0	1.00	2
600	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	2	0.00	0.00	0	1.00	2
600	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	1	0.00	0.00	0	1.00	2
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	1	4.93	4.93	15840000	1.00	2
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	4600	2760000	m2	30360000	1	9.46	9.46	30360000	1.00	2

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	3700	2220000	m2	24420000	1	7.61	7.61	24420000	1.00	2
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	2400	1440000	m2	15840000	1	4.93	4.93	15840000	1.00	2
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	4600	2760000	m2	30360000	1	9.46	9.46	30360000	1.00	2
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	600	3700	2220000	m2	24420000	1	7.61	7.61	24420000	1.00	2
1200	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	3	0.00	0.00	0	1.00	3
1200	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	3	0.00	0.00	0	1.00	3
1200	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	3	0.00	0.00	0	1.00	3
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	1440000	m2	7920000	2	2.47	4.93	15840000	1.00	1
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	3700	2220000	m2	7920000	2	2.47	4.93	15840000	1.00	1
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	4600	2760000	m2	7920000	2	2.47	4.93	15840000	1.00	1
1200	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	105600	4	0.01	0.05	422400	2.00	2
1200	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	3700	1	3700	m	162800	4	0.02	0.08	651200	2.00	2
1200	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	4600	1	4600	m	202400	4	0.03	0.10	809600	2.00	2
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	1440000	m2	7920000	2	2.47	4.93	15840000	1.00	2
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	3700	2220000	m2	7920000	2	2.47	4.93	15840000	1.00	2
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	4600	2760000	m2	7920000	2	2.47	4.93	15840000	1.00	2
1200	**ceiling**	Finish	Lining	Drylining	Plasterboard	1200	2400	1440000	m2	9360000	1	0.40	0.40	9360000	3.00	1
1200	**ceiling**	Finish	Lining	Drylining	Plasterboard	1200	3700	2220000	m2	9360000	1	0.40	0.40	9360000	3.00	1
1200	**ceiling**	Finish	Lining	Drylining	Plasterboard	1200	4600	2760000	m2	9360000	1	0.40	0.40	9360000	3.00	1
1200	**upper floor**	Finish	Lining	Drylining	Plasterboard	1200	2400	1440000	m2	9360000	1	0.40	0.40	9360000	3.00	1
1200	**upper floor**	Finish	Lining	Drylining	Plasterboard	1200	4600	2760000	m2	9360000	1	0.40	0.40	9360000	3.00	1
1200	**upper floor**	Finish	Lining	Drylining	Plasterboard	1200	3700	2220000	m2	9360000	1	0.40	0.40	9360000	3.00	1
1200	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	600	m	12672000	0	1.84	0.00	0	1.00	2
1200	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	600	m	12672000	0	1.84	0.00	0	1.00	2
1200	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	600	m	12672000	0	1.84	0.00	0	1.00	2
1200	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	0	0.00	0.00	0	1.00	3
1200	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	0	0.00	0.00	0	1.00	3
1200	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	0	0.00	0.00	0	1.00	3
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	1440000	m2	7920000	1	2.47	2.47	7920000	1.00	2
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	4600	2760000	m2	7920000	1	2.47	2.47	7920000	1.00	2
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	3700	2220000	m2	7920000	1	2.47	2.47	7920000	1.00	2
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	1440000	m2	7920000	1	2.47	2.47	7920000	1.00	2
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	4600	2760000	m2	7920000	1	2.47	2.47	7920000	1.00	2
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	3700	2220000	m2	7920000	1	2.47	2.47	7920000	1.00	2
1200	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	600	m	12672000	2	1.84	3.69	25344000	1.00	2
1200	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	600	m	12672000	2	1.84	3.69	25344000	1.00	2
1200	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1200	1	600	m	12672000	2	1.84	3.69	25344000	1.00	2
1200	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	3	0.00	0.00	0	1.00	2
1200	**floor**	Panel	TF panel	component	timber I-Joist	1	4600	4600	m	0	3	0.00	0.00	0	1.00	2

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
1200	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	3	0.00	0.00	0	1.00	2
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	1440000	m2	7920000	2	2.47	4.93	15840000	1.00	2
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	4600	2760000	m2	7920000	2	2.47	4.93	15840000	1.00	2
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	3700	2220000	m2	7920000	2	2.47	4.93	15840000	1.00	2
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	2400	1440000	m2	7920000	2	2.47	4.93	15840000	1.00	2
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	4600	2760000	m2	7920000	2	2.47	4.93	15840000	1.00	2
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1200	3700	2220000	m2	7920000	2	2.47	4.93	15840000	1.00	2
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	3	0.00	0.00	0	1.00	4
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	3	0.00	0.00	0	1.00	4
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	3	0.00	0.00	0	1.00	4
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	2400	1440000	m2	11880000	2	3.70	7.40	23760000	1.00	1
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	3700	2220000	m2	11880000	2	3.70	7.40	23760000	1.00	1
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	4600	2760000	m2	11880000	2	3.70	7.40	23760000	1.00	1
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	105600	6	0.01	0.08	633600	2.00	2
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	3700	1	3700	m	162800	6	0.02	0.13	976800	2.00	2
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	4600	1	4600	m	202400	6	0.03	0.16	1214400	2.00	2
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	2400	1440000	m2	11880000	2	3.70	7.40	23760000	1.00	2
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	3700	2220000	m2	11880000	2	3.70	7.40	23760000	1.00	2
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	4600	2760000	m2	11880000	2	3.70	7.40	23760000	1.00	2
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	1800	2400	1440000	m2	14040000	1	0.60	0.60	14040000	3.00	1
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	1800	3700	2220000	m2	14040000	1	0.60	0.60	14040000	3.00	1
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	1800	4600	2760000	m2	14040000	1	0.60	0.60	14040000	3.00	1
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	1800	2400	1440000	m2	14040000	1	0.60	0.60	14040000	3.00	1
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	1800	4600	2760000	m2	14040000	1	0.60	0.60	14040000	3.00	1
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	1800	3700	2220000	m2	14040000	1	0.60	0.60	14040000	3.00	1
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	600	m	19008000	0	2.77	0.00	0	1.00	2
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	600	m	19008000	0	2.77	0.00	0	1.00	2
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	600	m	19008000	0	2.77	0.00	0	1.00	2
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	4	0.00	0.00	0	1.00	4
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	4	0.00	0.00	0	1.00	4
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	4	0.00	0.00	0	1.00	4
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	2400	1440000	m2	11880000	1	3.70	3.70	11880000	1.00	2
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	4600	2760000	m2	11880000	1	3.70	3.70	11880000	1.00	2
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	3700	2220000	m2	11880000	1	3.70	3.70	11880000	1.00	2
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	2400	1440000	m2	11880000	1	3.70	3.70	11880000	1.00	2
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	4600	2760000	m2	11880000	1	3.70	3.70	11880000	1.00	2
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	3700	2220000	m2	11880000	1	3.70	3.70	11880000	1.00	2
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	600	m	19008000	2	2.77	5.53	38016000	1.00	2
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	600	m	19008000	2	2.77	5.53	38016000	1.00	2

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	1800	1	600	m	19008000	2	2.77	5.53	38016000	1.00	2
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	4	0.00	0.00	0	1.00	2
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	4	0.00	0.00	0	1.00	2
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	4	0.00	0.00	0	1.00	2
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	2400	1440000	m2	11880000	2	3.70	7.40	23760000	1.00	2
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	4600	2760000	m2	11880000	2	3.70	7.40	23760000	1.00	2
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	3700	2220000	m2	11880000	2	3.70	7.40	23760000	1.00	2
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	2400	1440000	m2	11880000	2	3.70	7.40	23760000	1.00	2
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	4600	2760000	m2	11880000	2	3.70	7.40	23760000	1.00	2
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	1800	3700	2220000	m2	11880000	2	3.70	7.40	23760000	1.00	2
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	3	0.00	0.00	0	1.00	5
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	3	0.00	0.00	0	1.00	5
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	3	0.00	0.00	0	1.00	5
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	2400	1440000	m2	15840000	2	4.93	9.87	31680000	1.00	1
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	3700	2220000	m2	15840000	2	4.93	9.87	31680000	1.00	1
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	4600	2760000	m2	15840000	2	4.93	9.87	31680000	1.00	1
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	1	2400	m	105600	8	0.01	0.11	844800	2.00	2
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	3700	1	3700	m	162800	8	0.02	0.17	1302400	2.00	2
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	4600	1	4600	m	202400	8	0.03	0.21	1619200	2.00	2
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	2400	1440000	m2	15840000	2	4.93	9.87	31680000	1.00	2
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	3700	2220000	m2	15840000	2	4.93	9.87	31680000	1.00	2
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	4600	2760000	m2	15840000	2	4.93	9.87	31680000	1.00	2
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	2400	1440000	m2	18720000	1	0.81	0.81	18720000	3.00	1
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	3700	2220000	m2	18720000	1	0.81	0.81	18720000	3.00	1
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	4600	2760000	m2	18720000	1	0.81	0.81	18720000	3.00	1
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	2400	1440000	m2	18720000	1	0.81	0.81	18720000	3.00	1
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	4600	2760000	m2	18720000	1	0.81	0.81	18720000	3.00	1
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	3700	2220000	m2	18720000	1	0.81	0.81	18720000	3.00	1
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	600	m	25344000	0	3.69	0.00	0	1.00	2
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	600	m	25344000	0	3.69	0.00	0	1.00	2
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	600	m	25344000	0	3.69	0.00	0	1.00	2
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	5	0.00	0.00	0	1.00	5
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	5	0.00	0.00	0	1.00	5
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	5	0.00	0.00	0	1.00	5
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	2400	1440000	m2	15840000	1	4.93	4.93	15840000	1.00	2
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	4600	2760000	m2	15840000	1	4.93	4.93	15840000	1.00	2
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	3700	2220000	m2	15840000	1	4.93	4.93	15840000	1.00	2
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	2400	1440000	m2	15840000	1	4.93	4.93	15840000	1.00	2

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
2400	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	4600	2760000	m2	15840000	1	4.93	4.93	15840000	1.00	2
2400	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	3700	2220000	m2	15840000	1	4.93	4.93	15840000	1.00	2
2400	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	600	m	25344000	2	3.69	7.38	50688000	1.00	2
2400	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	600	m	25344000	2	3.69	7.38	50688000	1.00	2
2400	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2400	1	600	m	25344000	2	3.69	7.38	50688000	1.00	2
2400	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	2400	2400	m	0	5	0.00	0.00	0	1.00	2
2400	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	4600	4600	m	0	5	0.00	0.00	0	1.00	2
2400	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1	3700	3700	m	0	5	0.00	0.00	0	1.00	2
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	2400	1440000	m2	15840000	2	4.93	9.87	31680000	1.00	2
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	4600	2760000	m2	15840000	2	4.93	9.87	31680000	1.00	2
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	3700	2220000	m2	15840000	2	4.93	9.87	31680000	1.00	2
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	2400	1440000	m2	15840000	2	4.93	9.87	31680000	1.00	2
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	4600	2760000	m2	15840000	2	4.93	9.87	31680000	1.00	2
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	3700	2220000	m2	15840000	2	4.93	9.87	31680000	1.00	2
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	3200	2400	7680000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4600	2400	11040000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4600	400	1840000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	ceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4600	400	1840000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	internal	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	3200	2400	7680000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	internal	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4600	2400	11040000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4600	2400	11040000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	1000	2400	2400000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	ceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4600	1000	4600000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4600	1000	4600000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	1000	2400	2400000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4000	2400	9600000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	900	2400	2160000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4600	1000	4600000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	upperceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	4600	1000	4600000	m2	1618800	1	0.50	0.50	1618800	1.00	1
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	3200	2400	7680000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	3700	2400	8880000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	3200	2400	7680000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	3700	2400	8880000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	3700	3200	11840000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	upperfloor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	3700	3200	11840000	m2	1618800	1	0.50	0.50	1618800	1.00	1
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	3300	2400	7920000	m2	1618800	2	0.50	1.01	3237600	1.00	1
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	200	600	120000	m	1618800	2	0.24	0.47	3237600	1.00	1
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	400	600	240000	m	1618800	2	0.24	0.47	3237600	1.00	1
600	floor	Panel	TF	Panel boxing	240*44mm SW battens C16	400	600	240000	m	1618800	2	0.24	0.47	3237600	1.00	1

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
600	ceiling	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	internal	Panel	**TF**	Panel boxing	240*44mm SW battens C16	200	600	**120000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	internal	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	ceiling	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	floor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	internalwall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	300	600	**180000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	floor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	upperceiling	Panel	**TF**	Panel boxing	240*44mm SW battens C16	400	600	**240000**	**m**	**1618800**	1	**0.24**	**0.24**	**1618800**	**1.00**	**1**
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	200	600	**120000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	100	600	**60000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	internalwall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	200	600	**120000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	internalwall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	100	600	**60000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	floor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	100	600	**60000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	upperfloor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	100	600	**60000**	**m**	**1618800**	1	**0.24**	**0.24**	**1618800**	**1.00**	**1**
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	300	600	**180000**	**m**	**1618800**	2	**0.24**	**0.47**	**3237600**	**1.00**	**1**
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	200	600	**120000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	internal	Panel	TF/SIP	Internal battens	44x69mm SW battens	200	600	**120000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	internal	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	300	600	**180000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	upperceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	400	600	**240000**	**m**	**1618800**	1	**0.21**	**0.21**	**1618800**	**2.00**	**1**
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	200	600	**120000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	100	600	**60000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	200	600	**120000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	100	600	**60000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	100	600	**60000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**
600	upperfloor	Panel	TF/SIP	Internal battens	44x69mm SW battens	100	600	**60000**	**m**	**1618800**	1	**0.21**	**0.21**	**1618800**	**2.00**	**1**

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable	item volume scalar (the product of the dimensions that donot change in	component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	300	600	**180000**	**m**	**1618800**	2	**0.21**	**0.42**	**3237600**	**2.00**	**1**

	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	length	width	depth	length	width	depth	length	width	number of width cuts (length run)	cutting length	remainder board	number of length cuts (width run)	cutting width	cutting width	remainder board
Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
600	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400	600	0	0	0	0	0	0	0	0	0	0
1200	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400	1200	0	0	0	0	0	0	0	0	0	0
1800	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400	1800	0	0	0	0	0	0	0	0	0	0
1200	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	2400	69	44	0	0	0	0	0	0	0	0	0
600	wall	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	600	13	0	0	0	0	0	2	0	0	0
2400	wall	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	1200	13	0	0	0	0	0	0	0	0	0
1200	wall	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	1800	13	0	600	0	0	0	1	0	0	1200
1800	wall	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	1200	13	0	1200	0	0	0	0	0	0	0
600	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1349	45	90	1349	600	0	0	0	0	0	0	0	0	0	0
1200	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2177	1200	11	0	957	1	1220	263	1	1220	0	0
600	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2177	600	11	0	957	1	1220	263	1	1220	0	0
1800	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2177	1800	11	0	957	1	1220	263	1	1220	0	1220
2400	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2177	2400	11	0	957	1	1220	263	1	1220	0	1220
600	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	600	11	0	129	1	1220	1091	2	1220	13420	20
600	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	360	1	240	2400	0	0	0	0
1200	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	0	1	240	2400	0	0	0	0
1800	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	0	1	240	1800	0	0	0	0
2400	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	2160	1	240	40	0	240	0	0
1200	wall	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	50000	1500	1	4200	1200	1	0	0	11	16500	3800	1	16500	16500	300
600	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	1349	1800	1	0	0	37	0	0	1	55500	0	1500
1200	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	1349	1800	1	0	0	37	0	0	1	55500	0	1500
1800	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	1349	1800	1	0	0	37	0	0	1	55500	0	1500
2400	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	1349	1800	1	0	0	37	0	0	1	55500	0	1500
600	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2177	45	90	2177	600	0	0	0	0	0	0	0	0	0	0
600	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	600	69	44	0	0	4	276	0	0	276	0	0
2400	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1200	69	44	0	0	2	138	0	0	138	0	0
1800	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1800	69	44	0	0	1	69	600	0	69	0	0
600	upper floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	2400	69	44	0	0	0	0	0	0	0	0	0
600	internal wall	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	600	13	0	0	0	0	0	2	0	0	0
1200	internal wall	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	1200	13	0	0	0	0	0	0	0	0	0
1800	internal wall	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	1800	13	0	600	0	0	0	1	0	0	1200
2400	internal wall	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	2400	13	0	1200	0	0	0	1	0	0	2400
1200	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	11	0	0	1	1220	1091	1	1220	13420	20
1800	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1800	11	0	129	1	1220	1091	1	1220	0	1220
2400	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	2400	11	0	1180	1	1220	1091	1	1220	0	1220
1800	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	1800	11	0	580	1	1220	40	1	1220	0	1220
600	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	600	18	0	129	1	1220	1091	2	1220	13420	20
1200	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	18	0	0	1	1220	1091	1	1220	13420	20

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
1200	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2177	45	90	2177	1200	0	0	0	0	0	0	0	0	0	0
1800	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2177	45	90	2177	1800	0	0	0	0	0	0	0	0	0	0
2400	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400	2400	0	0	0	0	0	0	0	0	0	0
600	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	2400	50	38	0	0	0	0	0	0	0	0	0
1200	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	2400	50	38	0	0	0	0	0	0	0	0	0
1800	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	2400	50	38	0	0	0	0	0	0	0	0	0
2400	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	2400	50	38	0	0	0	0	0	0	0	0	0
2400	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	2400	11	0	1180	1	1220	40	1	1220	0	1220
600	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
1200	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	1200	11	0	1180	1	1220	40	1	1220	13420	20
600	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
600	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	360	1	240	2400	0	0	0	0
2400	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	0	1	240	2400	0	0	0	0
1800	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	1560	1	240	1800	0	0	0	0
1200	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	960	1	240	2400	0	0	0	0
1800	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1349	45	90	1349	1800	0	0	0	0	0	0	0	0	0	0
600	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	2177	50	38	0	0	1	50	223	0	50	0	0
1200	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	2177	50	38	0	0	1	50	223	0	50	0	0
1800	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	2177	50	38	0	0	1	50	223	0	50	0	0
2400	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	2177	50	38	0	0	1	50	223	0	50	0	0
1200	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	1200	11	0	1180	1	1220	40	1	1220	13420	20
1800	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	1800	11	0	1180	1	1220	40	1	1220	0	1220
2400	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	2400	11	0	1180	1	1220	40	1	1220	0	1220
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	4200	600	11	1760	2980	1	1220	0	1	0	0	0
600	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
1200	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	1200	11	0	1180	1	1220	40	1	1220	13420	20
2400	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	2160	1	240	40	0	240	0	0
600	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	0	1	240	2400	0	0	0	0
1200	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	960	1	240	2400	0	0	0	0
1800	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	1560	1	240	1800	0	0	0	0
2400	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2177	45	90	2177	2400	0	0	0	0	0	0	0	0	0	0
2400	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1349	45	90	1349	2400	0	0	0	0	0	0	0	0	0	0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	2400	69	44	0	0	0	0	0	0	0	0	0

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
1200	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	2400	69	44	0	0	0	0	0	0	0	0	0
1800	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	2400	69	44	0	2331	0	0	0	0	0	0	0
2400	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	2400	69	44	0	0	0	0	0	0	0	0	0
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	50000	1500	1	4200	600	1	0	2700	11	16500	3800	1	16500	0	0
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	50000	1500	1	4200	1200	1	0	2700	11	16500	3800	1	16500	0	0
600	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	0	1	1220	40	1	1220	0	0
1200	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	1200	11	0	0	1	1220	40	1	1220	13420	20
600	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	360	1	240	2400	0	0	0	0
1200	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	0	2	480	40	0	480	0	0
1800	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	0	1	240	640	0	240	0	0
2400	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	0	1	240	40	0	240	0	0
1800	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400	1800	0	0	0	0	0	0	0	0	0	0
2400	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400	2400	0	0	0	0	0	0	0	0	0	0
600	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400	600	0	0	0	0	0	0	0	0	0	0
1200	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400	1200	0	0	0	0	0	0	0	0	0	0
600	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	1349	50	38	0	0	1	50	1051	0	50	0	0
1200	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	1349	50	38	0	0	1	50	1051	0	50	0	0
1800	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	1349	50	38	0	0	1	50	1051	0	50	0	0
2400	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	2400	50	38	1349	50	38	0	0	1	50	1051	0	50	0	0
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	50000	1500	1	2400	1200	1	0	0	20	30000	2000	1	30000	30000	300
600	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	2400	600	1	0	0	20	30000	2000	2	30000	30000	300
1800	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	2400	1200	1	0	0	20	30000	2000	1	30000	30000	300
1200	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	2400	1800	1	0	300	20	30000	2000	1	30000	0	1500
2400	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	2400	2400	1	0	900	20	30000	2000	1	30000	0	1500
600	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	2177	600	1	0	0	22	33000	2106	2	33000	33000	300
1800	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	2177	1200	1	0	0	22	33000	2106	1	33000	33000	300
1200	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	2177	1800	1	0	300	22	33000	2106	1	33000	0	1500
2400	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	50000	1500	1	2177	2400	1	0	900	22	33000	2106	1	33000	0	1500
600	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	50000	1500	1	2400	1200	1	0	0	20	30000	2000	1	30000	30000	300
1200	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	50000	1500	1	2400	1200	1	0	0	20	30000	2000	1	30000	30000	300
1800	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	50000	1500	1	2400	1200	1	0	0	20	30000	2000	1	30000	30000	300
2400	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	50000	1500	1	2400	1200	1	0	0	20	30000	2000	1	30000	30000	300
600	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2177	600	11	0	0	1	1220	263	1	1220	0	0
1200	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2177	1200	11	0	0	1	1220	263	1	1220	13420	20
600	wall	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	50000	1500	1	1349	1200	1	0	0	37	55500	87	1	55500	55500	300

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
600	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400	600	0	0	0	0	0	0	0	0	0	0
600	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	3700	45	90	3700	600	0	0	0	0	0	0	0	0	0	0
600	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	4600	45	90	4600	600	0	0	0	0	0	0	0	0	0	0
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	45	90	2400	600	11	0	0	0	0	0	1	0	0	585
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3700	45	90	3700	600	11	0	0	0	0	0	1	0	0	585
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4600	45	90	4600	600	11	0	0	0	0	0	1	0	0	585
600	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	1	45	90	1	2400	0	0	0	0	0	0	0	0	0	0
600	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	1	45	90	1	3700	0	0	0	0	0	0	0	0	0	0
600	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	1	45	90	1	4600	0	0	0	0	0	0	0	0	0	0
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2400	45	90	2400	600	11	0	0	0	0	0	1	0	0	585
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3700	45	90	3700	600	11	0	0	0	0	0	1	0	0	585
600	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4600	45	90	4600	600	11	0	0	0	0	0	1	0	0	585
600	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	600	13	0	0	0	0	0	2	0	0	0
600	**ceiling**	Finish	Lining	Drylining	Plasterboard	3700	1200	13	3700	600	13	0	0	0	0	0	1	0	0	0
600	**ceiling**	Finish	Lining	Drylining	Plasterboard	4600	1200	13	4600	600	13	0	0	0	0	0	1	0	0	0
600	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	4200	600	13	1800	3000	1	1200	0	2	0	15000	0
600	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	4600	600	13	2200	3400	1	1200	0	2	0	15000	0
600	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	3700	600	13	1300	2500	1	1200	0	2	0	15000	0
600	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	360	1	240	2400	0	0	0	0
600	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	360	4	960	40	0	960	0	0
600	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	360	4	960	40	0	960	0	0
600	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	600	0	0	0	0	0	0	0	0	0	0
600	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600	600	0	0	0	0	0	0	0	0	0	0
600	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	600	0	0	0	0	0	0	0	0	0	0
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	4600	600	11	2160	3380	1	1220	0	1	0	0	0
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	3700	600	11	1260	2480	1	1220	0	1	0	0	0
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	4600	600	11	2160	3380	1	1220	0	1	0	0	0
600	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	3700	600	11	1260	2480	1	1220	0	1	0	0	0
600	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	360	4	960	40	0	960	0	0
600	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	360	1	240	2400	0	0	0	0
600	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	600	240	44	0	360	1	240	2400	0	0	0	0
600	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	2400	45	90	2400		0	0	0	0	0	0	0	0	0	0
600	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600		0	0	0	0	0	0	0	0	0	0
600	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700		0	0	0	0	0	0	0	0	0	0
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	4600	600	11	2160	3380	1	1220	0	2	0	13420	20

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	3700	600	11	1260	2480	1	1220	0	2	0	13420	20
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	4600	600	11	2160	3380	1	1220	0	2	0	13420	20
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	3700	600	11	1260	2480	1	1220	0	2	0	13420	20
1200	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	600	0	0	0	0	0	0	0	0	0	0
1200	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	600	0	0	0	0	0	0	0	0	0	0
1200	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600	600	0	0	0	0	0	0	0	0	0	0
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1	2400	44	0	0	2400	165600	0	1	165600	0	2346
1200	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1	3700	44	0	0	2400	165600	0	1	165600	0	3657
1200	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1	4600	44	0	0	2400	165600	0	1	165600	0	4554
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1200	600	13	0	0	2	2400	0	2	2400	30000	0
1200	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1200	600	13	0	0	2	2400	0	1	2400	0	0
1200	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1200	600	13	0	0	2	2400	0	1	2400	0	0
1200	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1200	600	13	0	0	2	2400	0	2	2400	30000	0
1200	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1200	600	13	0	0	2	2400	0	2	2400	30000	0
1200	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1200	600	13	0	0	2	2400	0	2	2400	30000	0
1200	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	960	2	480	40	0	480	0	0
1200	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	960	2	480	40	0	480	0	0
1200	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	960	2	480	40	0	480	0	0
1200	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	600	0	0	0	0	0	0	0	0	0	0
1200	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600	600	0	0	0	0	0	0	0	0	0	0
1200	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	600	0	0	0	0	0	0	0	0	0	0
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	2	2440	26840	20
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	1	2440	0	0
1200	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	960	2	480	40	0	480	0	0
1200	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	960	2	480	40	0	480	0	0
1200	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1200	240	44	0	960	2	480	40	0	480	0	0
1200	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	0	0	0	0	0	0	0	0	0	0	0
1200	**floor**	Panel	TF panel	component	timber I-Joist	1000	45	240	4600	0	0	0	0	0	0	0	0	0	0	0

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
1200	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	0	0	0	0	0	0	0	0	0	0	0
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	2	2440	26840	20
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	2	2440	26840	20
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	2	2440	26840	20
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	2	2440	26840	20
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	2	2440	26840	20
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1200	600	11	0	0	2	2440	40	2	2440	26840	20
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	600	0	0	0	0	0	0	0	0	0	0
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	600	0	0	0	0	0	0	0	0	0	0
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600	600	0	0	0	0	0	0	0	0	0	0
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1	2400	44	0	0	2400	165600	0	1	165600	0	2346
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1	3700	44	0	0	2400	165600	0	1	165600	0	3657
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1	4600	44	0	0	2400	165600	0	1	165600	0	4554
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1800	600	13	0	600	1	1200	600	2	1200	15000	0
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1800	600	13	0	600	1	1200	600	1	1200	0	0
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1800	600	13	0	600	1	1200	600	1	1200	0	0
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1800	600	13	0	600	1	1200	600	2	1200	15000	0
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1800	600	13	0	600	1	1200	600	2	1200	15000	0
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	1800	600	13	0	600	1	1200	600	2	1200	15000	0
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	1560	1	240	640	0	240	0	0
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	1560	1	240	640	0	240	0	0
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	1560	1	240	640	0	240	0	0
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	600	0	0	0	0	0	0	0	0	0	0
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600	600	0	0	0	0	0	0	0	0	0	0
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	600	0	0	0	0	0	0	0	0	0	0
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	2	1220	13420	20
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	1	1220	0	0
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	1560	1	240	640	0	240	0	0
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	1560	1	240	640	0	240	0	0

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	1800	240	44	0	1560	1	240	640	0	240	0	0
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	0	0	0	0	0	0	0	0	0	0	0
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600	0	0	0	0	0	0	0	0	0	0	0
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	0	0	0	0	0	0	0	0	0	0	0
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	2	1220	13420	20
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	2	1220	13420	20
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	2	1220	13420	20
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	2	1220	13420	20
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	2	1220	13420	20
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1800	600	11	0	580	1	1220	640	2	1220	13420	20
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	600	0	0	0	0	0	0	0	0	0	0
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	600	0	0	0	0	0	0	0	0	0	0
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600	600	0	0	0	0	0	0	0	0	0	0
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1	2400	44	0	0	2400	165600	0	1	165600	0	2346
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1	3700	44	0	0	2400	165600	0	1	165600	0	3657
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1	4600	44	0	0	2400	165600	0	1	165600	0	4554
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	600	13	0	1200	0	0	0	2	0	0	0
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	600	13	0	1200	0	0	0	1	0	0	0
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	600	13	0	1200	0	0	0	1	0	0	0
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	600	13	0	1200	0	0	0	2	0	0	0
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	600	13	0	1200	0	0	0	2	0	0	0
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	2400	1200	13	2400	600	13	0	1200	0	0	0	2	0	0	0
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	2160	1	240	40	0	240	0	0
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	2160	1	240	40	0	240	0	0
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	2160	1	240	40	0	240	0	0
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	600	0	0	0	0	0	0	0	0	0	0
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600	600	0	0	0	0	0	0	0	0	0	0
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	600	0	0	0	0	0	0	0	0	0	0
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	1	1220	0	0
2400	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	2160	1	240	40	0	240	0	0
2400	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	2160	1	240	40	0	240	0	0
2400	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2440	240	44	2400	240	44	0	2160	1	240	40	0	240	0	0
2400	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	2400	0	0	0	0	0	0	0	0	0	0	0
2400	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	4600	0	0	0	0	0	0	0	0	0	0	0
2400	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	1000	45	240	3700	2400	0	0	0	0	0	0	0	0	0	0
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	2400	600	11	0	1180	1	1220	40	2	1220	13420	20
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	ceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	internal	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	internal	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	ceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	upperceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	upperfloor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2440	1220	11	1349	1200	1	0	0	1	1220	1091	1	1220	13420	20
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	floor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
600	ceiling	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	internal	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	internal	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	ceiling	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	floor	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	internalwall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	floor	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	upperceiling	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	internalwall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	internalwall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	floor	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	upperfloor	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	2440	240	44	1349	1200	1	0	960	1	240	1091	1	240	0	1200
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	internal	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	internal	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	upperceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173
600	upperfloor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	cut travel	width
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2400	69	44	1349	1200	1	0	1131	1	69	1051	1	69	0	1173

	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	output sheets	mm	(m/min)	cutting time (seconds)	number	seconds	seconds		£ 0.01		£ 0.00			m3		900
Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
600	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
1200	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	33.3
1800	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1200	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	5	0	0	0	5	15.41	3.08	12.33	£ -	0.00	£ 0.01	0.05	£ 0.01	0.0073	0.94	45.0
600	wall	Finish	Lining	Drylining	Plasterboard	5	0	0	0	5	15.41	3.08	3.08	£ -	0.00	£ 0.01	0.01	£ 0.01	0.0180	0.78	112.5
2400	wall	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0360	1.55	112.5
1200	wall	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0540	2.33	112.5
1800	wall	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0360	1.55	112.5
600	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
1200	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0000	8.95	19.6
600	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0000	4.48	21.4
1800	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0000	13.43	23.7
2400	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0575	17.90	23.7
600	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	9	2440	0	878	9	15.41	99.31	198.62	£ 0.02	0.04	£ 0.43	0.85	£ 0.45	0.0089	2.77	21.4
600	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	0.92	52.9
1200	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	1.84	64.3
1800	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	2.77	64.3
2400	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	480	0	173	5	15.41	37.64	75.28	£ 0.01	0.01	£ 0.16	0.32	£ 0.17	0.0253	3.69	64.3
1200	wall	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	12	33000	0	11880	12	15.41	991.28	991.28	£ 0.21	0.21	£ 4.26	4.26	£ 4.47	0.0050	11.96	180.0
600	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	38	55500	0	19980	38	15.41	526.20	526.20	£ 0.11	0.11	£ 2.26	2.26	£ 2.37	0.0024	3.24	300.0
1200	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	38	55500	0	19980	38	15.41	526.20	526.20	£ 0.11	0.11	£ 2.26	2.26	£ 2.37	0.0024	3.24	300.0
1800	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	38	55500	0	19980	38	15.41	526.20	526.20	£ 0.11	0.11	£ 2.26	2.26	£ 2.37	0.0024	3.24	300.0
2400	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	38	55500	0	19980	38	15.41	526.20	526.20	£ 0.11	0.11	£ 2.26	2.26	£ 2.37	0.0024	3.24	300.0
600	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	8	552	0	199	8	15.41	26.77	53.53	£ 0.01	0.01	£ 0.12	0.23	£ 0.12	0.0018	0.24	75.0
2400	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	6	276	0	99	6	15.41	19.13	153.03	£ 0.00	0.03	£ 0.08	0.66	£ 0.09	0.0036	0.47	22.5
1800	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	5	138	0	50	5	15.41	13.02	78.11	£ 0.00	0.01	£ 0.06	0.34	£ 0.06	0.0055	0.71	30.0
600	upper floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	5	0	0	0	5	15.41	3.08	6.16	£ -	0.00	£ 0.01	0.03	£ 0.01	0.0073	0.94	75.0
600	internal wall	Finish	Lining	Drylining	Plasterboard	5	0	0	0	5	15.41	3.08	3.08	£ -	0.00	£ 0.01	0.01	£ 0.01	0.0180	0.78	112.5
1200	internal wall	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0360	1.55	112.5
1800	internal wall	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0540	2.33	112.5
2400	internal wall	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0720	3.10	112.5
1200	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0178	5.55	19.6
1800	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0267	8.32	23.7
2400	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0356	11.09	23.7
1800	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0000	14.80	23.7
600	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	9	2440	0	878	9	15.41	99.31	198.62	£ 0.02	0.04	£ 0.43	0.85	£ 0.45	0.0146	4.54	21.4
1200	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0291	9.08	19.6

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
1200	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	33.3
1800	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
2400	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
600	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	0	0	0	5	15.41	3.08	6.16	£ -	0.00	£ 0.01	0.03	£ 0.01	0.0046	2.50	150.0
1200	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	0	0	0	5	15.41	3.08	12.33	£ -	0.00	£ 0.01	0.05	£ 0.01	0.0046	2.50	75.0
1800	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	0	0	0	5	15.41	3.08	18.49	£ -	0.00	£ 0.01	0.08	£ 0.01	0.0046	2.50	50.0
2400	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	0	0	0	5	15.41	3.08	24.66	£ -	0.00	£ 0.01	0.11	£ 0.01	0.0046	2.50	37.5
2400	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0634	19.74	23.7
600	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	9	2440	0	878	9	15.41	99.31	198.62	£ 0.02	0.04	£ 0.43	0.85	£ 0.45	0.0158	4.93	21.4
1200	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0317	9.87	19.6
600	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	9	2440	0	878	9	15.41	99.31	198.62	£ 0.02	0.04	£ 0.43	0.85	£ 0.45	0.0158	4.93	21.4
600	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	0.92	52.9
2400	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	3.69	64.3
1800	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	2.77	64.3
1200	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	1.84	64.3
1800	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
600	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	100	0	36	5	15.41	10.28	20.56	£ 0.00	0.00	£ 0.04	0.09	£ 0.05	0.0041	2.27	150.0
1200	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	100	0	36	5	15.41	10.28	41.13	£ 0.00	0.01	£ 0.04	0.18	£ 0.05	0.0041	2.27	75.0
1800	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	100	0	36	5	15.41	10.28	61.69	£ 0.00	0.01	£ 0.04	0.27	£ 0.05	0.0041	2.27	50.0
2400	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	100	0	36	5	15.41	10.28	82.26	£ 0.00	0.01	£ 0.04	0.35	£ 0.05	0.0041	2.27	37.5
1200	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0317	9.87	19.6
1800	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0475	14.80	23.7
2400	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0634	19.74	23.7
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	1220	0	439	5	15.41	90.92	181.84	£ 0.02	0.04	£ 0.39	0.78	£ 0.41	0.0000	8.63	21.4
600	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	9	2440	0	878	9	15.41	99.31	198.62	£ 0.02	0.04	£ 0.43	0.85	£ 0.45	0.0158	4.93	21.4
1200	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0317	9.87	19.6
2400	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	480	0	173	5	15.41	37.64	75.28	£ 0.01	0.01	£ 0.16	0.32	£ 0.17	0.0253	3.69	64.3
600	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	0.92	52.9
1200	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	1.84	64.3
1800	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	2.77	64.3
2400	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	5	0	0	0	5	15.41	3.08	6.16	£ -	0.00	£ 0.01	0.03	£ 0.01	0.0073	0.94	75.0

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
1200	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	5	0	0	0	5	15.41	3.08	12.33	£ -	0.00	£ 0.01	0.05	£ 0.01	0.0073	0.94	45.0
1800	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	5	0	0	0	5	15.41	3.08	18.49	£ -	0.00	£ 0.01	0.08	£ 0.01	0.0073	0.94	30.0
2400	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	5	0	0	0	5	15.41	3.08	24.66	£ -	0.00	£ 0.01	0.11	£ 0.01	0.0073	0.94	22.5
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	12	33000	0	11880	12	15.41	991.28	991.28	£ 0.21	0.21	£ 4.26	4.26	£ 4.47	0.0000	5.98	180.0
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	12	33000	0	11880	12	15.41	991.28	991.28	£ 0.21	0.21	£ 4.26	4.26	£ 4.47	0.0000	11.96	180.0
600	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0000	4.93	21.4
1200	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0317	9.87	19.6
600	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	240	0	86	5	15.41	20.36	40.72	£ 0.00	0.01	£ 0.09	0.18	£ 0.09	0.0000	0.92	52.9
1200	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	6	960	0	346	6	15.41	60.17	120.34	£ 0.01	0.02	£ 0.26	0.52	£ 0.27	0.0127	1.84	64.3
1800	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	480	0	173	5	15.41	37.64	75.28	£ 0.01	0.01	£ 0.16	0.32	£ 0.17	0.0190	2.77	64.3
2400	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	480	0	173	5	15.41	37.64	75.28	£ 0.01	0.01	£ 0.16	0.32	£ 0.17	0.0253	3.69	64.3
1800	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
2400	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
600	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
1200	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	33.3
600	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	100	0	36	5	15.41	10.28	20.56	£ 0.00	0.00	£ 0.04	0.09	£ 0.05	0.0026	1.41	150.0
1200	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	100	0	36	5	15.41	10.28	41.13	£ 0.00	0.01	£ 0.04	0.18	£ 0.05	0.0026	1.41	75.0
1800	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	100	0	36	5	15.41	10.28	61.69	£ 0.00	0.01	£ 0.04	0.27	£ 0.05	0.0026	1.41	50.0
2400	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	5	100	0	36	5	15.41	10.28	82.26	£ 0.00	0.01	£ 0.04	0.35	£ 0.05	0.0026	1.41	37.5
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	21	60000	0	21600	21	15.41	1029.31	1029.31	£ 0.22	0.22	£ 4.42	4.42	£ 4.64	0.0029	6.84	180.0
600	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	22	60000	0	21600	22	15.41	982.52	982.52	£ 0.21	0.21	£ 4.22	4.22	£ 4.43	0.0014	1.92	300.0
1800	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	21	60000	0	21600	21	15.41	1029.31	1029.31	£ 0.22	0.22	£ 4.42	4.42	£ 4.64	0.0029	3.84	300.0
1200	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	21	60000	0	21600	21	15.41	1029.31	1029.31	£ 0.22	0.22	£ 4.42	4.42	£ 4.64	0.0043	5.76	300.0
2400	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	21	60000	0	21600	21	15.41	1029.31	1029.31	£ 0.22	0.22	£ 4.42	4.42	£ 4.64	0.0058	7.68	300.0
600	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	24	66000	0	23760	24	15.41	990.64	990.64	£ 0.21	0.21	£ 4.26	4.26	£ 4.47	0.0013	1.74	300.0
1800	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	23	66000	0	23760	23	15.41	1033.71	1033.71	£ 0.22	0.22	£ 4.44	4.44	£ 4.66	0.0026	3.48	300.0
1200	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	23	66000	0	23760	23	15.41	1033.71	1033.71	£ 0.22	0.22	£ 4.44	4.44	£ 4.66	0.0039	5.22	300.0
2400	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	23	66000	0	23760	23	15.41	1033.71	1033.71	£ 0.22	0.22	£ 4.44	4.44	£ 4.66	0.0052	6.97	300.0
600	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	21	60000	0	21600	21	15.41	1029.31	1029.31	£ 0.22	0.22	£ 4.42	4.42	£ 4.64	0.0029	6.84	450.0
1200	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	21	60000	0	21600	21	15.41	1029.31	1029.31	£ 0.22	0.22	£ 4.42	4.42	£ 4.64	0.0029	6.84	180.0
1800	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	21	60000	0	21600	21	15.41	1029.31	1029.31	£ 0.22	0.22	£ 4.42	4.42	£ 4.64	0.0029	6.84	900.0
2400	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	21	60000	0	21600	21	15.41	1029.31	1029.31	£ 0.22	0.22	£ 4.42	4.42	£ 4.64	0.0029	6.84	900.0
600	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0000	4.48	21.4
1200	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0287	8.95	19.6
600	wall	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	38	111000	0	39960	38	15.41	1051.98	1051.98	£ 0.22	0.22	£ 4.52	4.52	£ 4.75	0.0016	3.84	450.0

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
600	ceiling	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	ceiling	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	ceiling	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	0	0	0	2	15.41	7.71	15.41	£ -	0.00	£ 0.03	0.07	£ 0.03	0.0000	10.90	21.4
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	0	0	0	2	15.41	7.71	15.41	£ -	0.00	£ 0.03	0.07	£ 0.03	0.0000	16.80	21.4
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	0	0	0	2	15.41	7.71	15.41	£ -	0.00	£ 0.03	0.07	£ 0.03	0.0001	20.88	21.4
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	75.0
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	75.0
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	75.0
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	0	0	0	3	15.41	5.14	10.27	£ -	0.00	£ 0.02	0.04	£ 0.02	0.0000	10.90	21.4
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	0	0	0	3	15.41	5.14	10.27	£ -	0.00	£ 0.02	0.04	£ 0.02	0.0000	16.80	21.4
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	0	0	0	3	15.41	5.14	10.27	£ -	0.00	£ 0.02	0.04	£ 0.02	0.0001	20.88	21.4
600	ceiling	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0187	10.90	112.5
600	ceiling	Finish	Lining	Drylining	Plasterboard	2	0	0	0	2	15.41	7.71	7.71	£ -	0.00	£ 0.03	0.03	£ 0.03	0.0000	16.80	112.5
600	ceiling	Finish	Lining	Drylining	Plasterboard	2	0	0	0	2	15.41	7.71	7.71	£ -	0.00	£ 0.03	0.03	£ 0.03	0.0001	20.88	112.5
600	upper floor	Finish	Lining	Drylining	Plasterboard	3	1200	0	432	3	15.41	149.14	149.14	£ 0.03	0.03	£ 0.64	0.64	£ 0.67	0.0328	1.41	112.5
600	upper floor	Finish	Lining	Drylining	Plasterboard	3	1200	0	432	3	15.41	149.14	149.14	£ 0.03	0.03	£ 0.64	0.64	£ 0.67	0.0359	1.54	112.5
600	upper floor	Finish	Lining	Drylining	Plasterboard	3	1200	0	432	3	15.41	149.14	149.14	£ 0.03	0.03	£ 0.64	0.64	£ 0.67	0.0289	1.24	112.5
600	upper floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	2	240	0	86	2	15.41	50.91	50.91	£ 0.01	0.01	£ 0.22	0.22	£ 0.23	0.0000	0.92	52.9
600	upper floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	1920	0	691	5	15.41	141.32	141.32	£ 0.03	0.03	£ 0.61	0.61	£ 0.64	0.0063	0.92	52.9
600	upper floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	5	1920	0	691	5	15.41	141.32	141.32	£ 0.03	0.03	£ 0.61	0.61	£ 0.64	0.0063	0.92	52.9
600	upper floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	upper floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	upper floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	446.91	£ 0.09	0.09	£ 1.92	1.92	£ 2.01	0.0000	4.93	21.4
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	1220	0	439	2	15.41	227.31	227.31	£ 0.05	0.05	£ 0.98	0.98	£ 1.02	0.0001	9.46	21.4
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	1220	0	439	2	15.41	227.31	227.31	£ 0.05	0.05	£ 0.98	0.98	£ 1.02	0.0000	7.61	21.4
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0158	4.93	21.4
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	1220	0	439	2	15.41	227.31	227.31	£ 0.05	0.05	£ 0.98	0.98	£ 1.02	0.0001	9.46	21.4
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	1220	0	439	2	15.41	227.31	227.31	£ 0.05	0.05	£ 0.98	0.98	£ 1.02	0.0000	7.61	21.4
600	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	6	1920	0	691	6	15.41	117.77	235.54	£ 0.02	0.05	£ 0.51	1.01	£ 0.53	0.0063	0.92	52.9
600	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	240	0	86	3	15.41	33.94	67.87	£ 0.01	0.01	£ 0.15	0.29	£ 0.15	0.0000	0.92	52.9
600	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	240	0	86	3	15.41	33.94	67.87	£ 0.01	0.01	£ 0.15	0.29	£ 0.15	0.0000	0.92	52.9
600	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	39.1
600	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	178.76	£ 0.04	0.04	£ 0.77	0.77	£ 0.81	0.0158	4.93	21.4
600	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	1220	0	439	5	15.41	90.92	90.92	£ 0.02	0.02	£ 0.39	0.39	£ 0.41	0.0304	9.46	21.4

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
600	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	1220	0	439	5	15.41	90.92	90.92	£ 0.02	0.02	£ 0.39	0.39	£ 0.41	0.0244	7.61	21.4
600	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	178.76	£ 0.04	0.04	£ 0.77	0.77	£ 0.81	0.0158	4.93	21.4
600	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	1220	0	439	5	15.41	90.92	90.92	£ 0.02	0.02	£ 0.39	0.39	£ 0.41	0.0304	9.46	21.4
600	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	1220	0	439	5	15.41	90.92	90.92	£ 0.02	0.02	£ 0.39	0.39	£ 0.41	0.0244	7.61	21.4
1200	ceiling	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	33.3
1200	ceiling	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	33.3
1200	ceiling	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	33.3
1200	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	4880	0	1757	3	15.41	590.74	1181.47	£ 0.13	0.25	£ 2.54	5.08	£ 2.66	0.0000	2.47	19.6
1200	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	4880	0	1757	3	15.41	590.74	1181.47	£ 0.13	0.25	£ 2.54	5.08	£ 2.66	0.0000	2.47	19.6
1200	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	4880	0	1757	3	15.41	590.74	1181.47	£ 0.13	0.25	£ 2.54	5.08	£ 2.66	0.0000	2.47	19.6
1200	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	2402	331200	0	119232	2402	15.41	49.65	198.58	£ 0.01	0.04	£ 0.21	0.85	£ 0.22	0.0001	0.01	45.0
1200	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	2402	331200	0	119232	2402	15.41	49.65	198.58	£ 0.01	0.04	£ 0.21	0.85	£ 0.22	0.0002	0.02	45.0
1200	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	2402	331200	0	119232	2402	15.41	49.65	198.58	£ 0.01	0.04	£ 0.21	0.85	£ 0.22	0.0002	0.03	45.0
1200	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4	4880	0	1757	4	15.41	443.05	886.11	£ 0.09	0.19	£ 1.90	3.81	£ 2.00	0.0000	2.47	19.6
1200	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4	4880	0	1757	4	15.41	443.05	886.11	£ 0.09	0.19	£ 1.90	3.81	£ 2.00	0.0000	2.47	19.6
1200	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4	4880	0	1757	4	15.41	443.05	886.11	£ 0.09	0.19	£ 1.90	3.81	£ 2.00	0.0000	2.47	19.6
1200	ceiling	Finish	Lining	Drylining	Plasterboard	4	4800	0	1728	4	15.41	435.85	435.85	£ 0.09	0.09	£ 1.87	1.87	£ 1.97	0.0094	0.40	112.5
1200	ceiling	Finish	Lining	Drylining	Plasterboard	3	4800	0	1728	3	15.41	581.14	581.14	£ 0.12	0.12	£ 2.50	2.50	£ 2.62	0.0000	0.40	112.5
1200	ceiling	Finish	Lining	Drylining	Plasterboard	3	4800	0	1728	3	15.41	581.14	581.14	£ 0.12	0.12	£ 2.50	2.50	£ 2.62	0.0000	0.40	112.5
1200	upper floor	Finish	Lining	Drylining	Plasterboard	4	4800	0	1728	4	15.41	435.85	435.85	£ 0.09	0.09	£ 1.87	1.87	£ 1.97	0.0094	0.40	112.5
1200	upper floor	Finish	Lining	Drylining	Plasterboard	4	4800	0	1728	4	15.41	435.85	435.85	£ 0.09	0.09	£ 1.87	1.87	£ 1.97	0.0094	0.40	112.5
1200	upper floor	Finish	Lining	Drylining	Plasterboard	4	4800	0	1728	4	15.41	435.85	435.85	£ 0.09	0.09	£ 1.87	1.87	£ 1.97	0.0094	0.40	112.5
1200	upper floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	4	960	0	346	4	15.41	90.25	0.00	£ 0.02	0.00	£ 0.39	0.00	£ 0.41	0.0127	1.84	0.0
1200	upper floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	4	960	0	346	4	15.41	90.25	0.00	£ 0.02	0.00	£ 0.39	0.00	£ 0.41	0.0127	1.84	0.0
1200	upper floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	4	960	0	346	4	15.41	90.25	0.00	£ 0.02	0.00	£ 0.39	0.00	£ 0.41	0.0127	1.84	0.0
1200	upper floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	0.0
1200	upper floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	0.0
1200	upper floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	0.0
1200	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4	4880	0	1757	4	15.41	443.05	443.05	£ 0.09	0.09	£ 1.90	1.90	£ 2.00	0.0000	2.47	19.6
1200	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4	4880	0	1757	4	15.41	443.05	443.05	£ 0.09	0.09	£ 1.90	1.90	£ 2.00	0.0000	2.47	19.6
1200	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4	4880	0	1757	4	15.41	443.05	443.05	£ 0.09	0.09	£ 1.90	1.90	£ 2.00	0.0000	2.47	19.6
1200	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	6	4880	0	1757	6	15.41	295.37	295.37	£ 0.06	0.06	£ 1.27	1.27	£ 1.33	0.0079	2.47	19.6
1200	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4	4880	0	1757	4	15.41	443.05	443.05	£ 0.09	0.09	£ 1.90	1.90	£ 2.00	0.0000	2.47	19.6
1200	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	4	4880	0	1757	4	15.41	443.05	443.05	£ 0.09	0.09	£ 1.90	1.90	£ 2.00	0.0000	2.47	19.6
1200	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	4	960	0	346	4	15.41	90.25	180.51	£ 0.02	0.04	£ 0.39	0.78	£ 0.41	0.0127	1.84	64.3
1200	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	4	960	0	346	4	15.41	90.25	180.51	£ 0.02	0.04	£ 0.39	0.78	£ 0.41	0.0127	1.84	64.3
1200	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	4	960	0	346	4	15.41	90.25	180.51	£ 0.02	0.04	£ 0.39	0.78	£ 0.41	0.0127	1.84	64.3
1200	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	33.3
1200	floor	Panel	TF panel	component	timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	33.3

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
1200	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	33.3
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	6	4880	0	1757	6	15.41	295.37	590.74	£ 0.06	0.13	£ 1.27	2.54	£ 1.33	0.0079	2.47	19.6
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	6	4880	0	1757	6	15.41	295.37	590.74	£ 0.06	0.13	£ 1.27	2.54	£ 1.33	0.0079	2.47	19.6
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	6	4880	0	1757	6	15.41	295.37	590.74	£ 0.06	0.13	£ 1.27	2.54	£ 1.33	0.0079	2.47	19.6
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	6	4880	0	1757	6	15.41	295.37	590.74	£ 0.06	0.13	£ 1.27	2.54	£ 1.33	0.0079	2.47	19.6
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	6	4880	0	1757	6	15.41	295.37	590.74	£ 0.06	0.13	£ 1.27	2.54	£ 1.33	0.0079	2.47	19.6
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	6	4880	0	1757	6	15.41	295.37	590.74	£ 0.06	0.13	£ 1.27	2.54	£ 1.33	0.0079	2.47	19.6
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0000	3.70	23.7
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0000	3.70	23.7
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0000	3.70	23.7
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2402	331200	0	119232	2402	15.41	49.65	297.87	£ 0.01	0.06	£ 0.21	1.28	£ 0.22	0.0001	0.01	30.0
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2402	331200	0	119232	2402	15.41	49.65	297.87	£ 0.01	0.06	£ 0.21	1.28	£ 0.22	0.0002	0.02	30.0
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2402	331200	0	119232	2402	15.41	49.65	297.87	£ 0.01	0.06	£ 0.21	1.28	£ 0.22	0.0002	0.03	30.0
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	595.87	£ 0.06	0.13	£ 1.28	2.56	£ 1.34	0.0000	3.70	23.7
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	595.87	£ 0.06	0.13	£ 1.28	2.56	£ 1.34	0.0000	3.70	23.7
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	595.87	£ 0.06	0.13	£ 1.28	2.56	£ 1.34	0.0000	3.70	23.7
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	3	2400	0	864	3	15.41	293.14	293.14	£ 0.06	0.06	£ 1.26	1.26	£ 1.32	0.0140	0.60	112.5
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	2	2400	0	864	2	15.41	439.71	439.71	£ 0.09	0.09	£ 1.89	1.89	£ 1.98	0.0000	0.60	112.5
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	2	2400	0	864	2	15.41	439.71	439.71	£ 0.09	0.09	£ 1.89	1.89	£ 1.98	0.0000	0.60	112.5
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	3	2400	0	864	3	15.41	293.14	293.14	£ 0.06	0.06	£ 1.26	1.26	£ 1.32	0.0140	0.60	112.5
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	3	2400	0	864	3	15.41	293.14	293.14	£ 0.06	0.06	£ 1.26	1.26	£ 1.32	0.0140	0.60	112.5
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	3	2400	0	864	3	15.41	293.14	293.14	£ 0.06	0.06	£ 1.26	1.26	£ 1.32	0.0140	0.60	112.5
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	0.00	£ 0.01	0.00	£ 0.27	0.00	£ 0.28	0.0190	2.77	0.0
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	0.00	£ 0.01	0.00	£ 0.27	0.00	£ 0.28	0.0190	2.77	0.0
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	0.00	£ 0.01	0.00	£ 0.27	0.00	£ 0.28	0.0190	2.77	0.0
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	3.70	23.7
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	3.70	23.7
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	3.70	23.7
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	178.76	£ 0.04	0.04	£ 0.77	0.77	£ 0.81	0.0119	3.70	23.7
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	3.70	23.7
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	3.70	23.7
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	125.47	£ 0.01	0.02	£ 0.27	0.54	£ 0.28	0.0190	2.77	64.3
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	125.47	£ 0.01	0.02	£ 0.27	0.54	£ 0.28	0.0190	2.77	64.3

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	125.47	£ 0.01	0.02	£ 0.27	0.54	£ 0.28	0.0190	2.77	64.3
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	47.4
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0119	3.70	23.7
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0119	3.70	23.7
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0119	3.70	23.7
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0119	3.70	23.7
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0119	3.70	23.7
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0119	3.70	23.7
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0000	4.93	23.7
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0000	4.93	23.7
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0000	4.93	23.7
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2402	331200	0	119232	2402	15.41	49.65	397.16	£ 0.01	0.08	£ 0.21	1.71	£ 0.22	0.0001	0.01	22.5
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2402	331200	0	119232	2402	15.41	49.65	397.16	£ 0.01	0.08	£ 0.21	1.71	£ 0.22	0.0002	0.02	22.5
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	2402	331200	0	119232	2402	15.41	49.65	397.16	£ 0.01	0.08	£ 0.21	1.71	£ 0.22	0.0002	0.03	22.5
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	595.87	£ 0.06	0.13	£ 1.28	2.56	£ 1.34	0.0000	4.93	23.7
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	595.87	£ 0.06	0.13	£ 1.28	2.56	£ 1.34	0.0000	4.93	23.7
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	595.87	£ 0.06	0.13	£ 1.28	2.56	£ 1.34	0.0000	4.93	23.7
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0187	0.81	112.5
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	2	0	0	0	2	15.41	7.71	7.71	£ -	0.00	£ 0.03	0.03	£ 0.03	0.0000	0.81	112.5
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	2	0	0	0	2	15.41	7.71	7.71	£ -	0.00	£ 0.03	0.03	£ 0.03	0.0000	0.81	112.5
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0187	0.81	112.5
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0187	0.81	112.5
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	3	0	0	0	3	15.41	5.14	5.14	£ -	0.00	£ 0.02	0.02	£ 0.02	0.0187	0.81	112.5
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	0.00	£ 0.01	0.00	£ 0.27	0.00	£ 0.28	0.0253	3.69	0.0
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	0.00	£ 0.01	0.00	£ 0.27	0.00	£ 0.28	0.0253	3.69	0.0
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	0.00	£ 0.01	0.00	£ 0.27	0.00	£ 0.28	0.0253	3.69	0.0
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	4.93	23.7
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	4.93	23.7
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	4.93	23.7
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	178.76	£ 0.04	0.04	£ 0.77	0.77	£ 0.81	0.0158	4.93	23.7

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
2400	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	4.93	23.7
2400	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	3	2440	0	878	3	15.41	297.94	297.94	£ 0.06	0.06	£ 1.28	1.28	£ 1.34	0.0000	4.93	23.7
2400	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	125.47	£ 0.01	0.02	£ 0.27	0.54	£ 0.28	0.0253	3.69	64.3
2400	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	125.47	£ 0.01	0.02	£ 0.27	0.54	£ 0.28	0.0253	3.69	64.3
2400	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	3	480	0	173	3	15.41	62.74	125.47	£ 0.01	0.02	£ 0.27	0.54	£ 0.28	0.0253	3.69	64.3
2400	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	0	0	0	0	0	0.00	0.00	0.00	£ -	0.00	£ -	0.00	£ -	0.0000	0.00	45.0
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0158	4.93	23.7
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0158	4.93	23.7
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0158	4.93	23.7
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0158	4.93	23.7
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0158	4.93	23.7
2400	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	5	2440	0	878	5	15.41	178.76	357.52	£ 0.04	0.08	£ 0.77	1.54	£ 0.81	0.0158	4.93	23.7
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	ceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	internal	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	internal	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	ceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	upperceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	446.91	£ 0.09	0.09	£ 1.92	1.92	£ 2.01	0.0016	0.50	21.4
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	upperfloor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	446.91	£ 0.09	0.09	£ 1.92	1.92	£ 2.01	0.0016	0.50	21.4
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	2	2440	0	878	2	15.41	446.91	893.81	£ 0.09	0.19	£ 1.92	3.84	£ 2.01	0.0016	0.50	21.4
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	floor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
600	ceiling	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	internal	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	internal	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	ceiling	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	floor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	internalwall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	floor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	upperceiling	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	94.11	£ 0.02	0.02	£ 0.40	0.40	£ 0.42	0.0016	0.24	52.9
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	internalwall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	internalwall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	floor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	upperfloor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	94.11	£ 0.02	0.02	£ 0.40	0.40	£ 0.42	0.0016	0.24	52.9
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	2	480	0	173	2	15.41	94.11	188.21	£ 0.02	0.04	£ 0.40	0.81	£ 0.42	0.0016	0.24	52.9
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	internal	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	internal	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	upperceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	32.55	£ 0.01	0.01	£ 0.14	0.14	£ 0.15	0.0016	0.21	75.0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0
600	upperfloor	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	32.55	£ 0.01	0.01	£ 0.14	0.14	£ 0.15	0.0016	0.21	75.0

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)		Labour cost (machining)	total labour cost	TotalManufacture cost	Piece volume	Material price (per piece)	Machinery Set up (shared across all pieces)
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	2	138	0	50	2	15.41	32.55	65.09	£ 0.01	0.01	£ 0.14	0.28	£ 0.15	0.0016	0.21	75.0

	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	£ 15.47	material density	component mass	total mass
Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
600	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	4.86	9.72
1200	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.14	600	4.86	14.58
1800	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	4.86	19.44
1200	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.19	600.00	4.37184	17.48736
600	wall	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	12.024	12.024
2400	wall	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	24.048	24.048
1200	wall	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	36.072	36.072
1800	wall	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	24.048	24.048
600	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	2.731725	5.46345
1200	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	17.24184	34.48368
600	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	8.62092	17.24184
1800	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	25.86276	51.72552
2400	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	34.48368	68.96736
600	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	5.34204	10.68408
600	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	7.6032
1200	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	7.6032	15.2064
1800	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	11.4048	22.8096
2400	roof gable	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	15.2064	30.4128
1200	wall	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	£ 0.77	0.90	0.004536	0.004536
600	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.00218538	0.00218538
1200	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.00218538	0.00218538
1800	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.00218538	0.00218538
2400	roof gable	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.00218538	0.00218538
600	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	4.408425	8.81685
600	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	1.09296	2.18592
2400	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.10	600.00	2.18592	17.48736
1800	internal wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.13	600.00	3.27888	19.67328
600	upper floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	4.37184	8.74368
600	internal wall	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	12.024	12.024
1200	internal wall	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	24.048	24.048
1800	internal wall	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	36.072	36.072
2400	internal wall	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	48.096	48.096
1200	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	10.68408	21.36816
1800	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	16.02612	32.05224
2400	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	21.36816	42.73632
1800	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	28.512	57.024
600	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	8.74152	17.48304
1200	roof gable	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	17.48304	34.96608

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
1200	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.14	600	4.408425	13.225275
1800	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	4.408425	17.6337
2400	internal wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	4.86	24.3
600	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.64	600.00	2.736	5.472
1200	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.32	600.00	2.736	10.944
1800	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.21	600.00	2.736	16.416
2400	wall	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.16	600.00	2.736	21.888
2400	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	38.016	76.032
600	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	19.008
1200	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	19.008	38.016
600	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	19.008
600	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	7.6032
2400	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	15.2064	30.4128
1800	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	11.4048	22.8096
1200	internal wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	7.6032	15.2064
1800	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	2.731725	10.9269
600	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.64	600.00	2.48178	4.96356
1200	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.32	600.00	2.48178	9.92712
1800	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.21	600.00	2.48178	14.89068
2400	roof	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.16	600.00	2.48178	19.85424
1200	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	19.008	38.016
1800	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	28.512	57.024
2400	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	38.016	76.032
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	16.632	33.264
600	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	19.008
1200	internal wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	19.008	38.016
2400	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	15.2064	30.4128
600	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	7.6032
1200	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	7.6032	15.2064
1800	roof	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	11.4048	22.8096
2400	roof	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	4.408425	22.042125
2400	roof gable	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	2.731725	13.658625
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	4.37184	8.74368

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
1200	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.19	600.00	4.37184	17.48736
1800	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.13	600.00	4.37184	26.23104
2400	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.10	600.00	4.37184	34.97472
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	£ 0.77	0.90	0.002268	0.002268
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	£ 0.77	0.90	0.004536	0.004536
600	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	19.008
1200	wall	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	19.008	38.016
600	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	7.6032
1200	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	7.6032	15.2064
1800	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	11.4048	22.8096
2400	wall	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	15.2064	30.4128
1800	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	4.86	19.44
2400	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	4.86	24.3
600	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	4.86	9.72
1200	wall	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.14	600	4.86	14.58
600	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.64	600.00	1.53786	3.07572
1200	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.32	600.00	1.53786	6.15144
1800	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.21	600.00	1.53786	9.22716
2400	roof gable	Panel	TF/SIP	External battens	38x50mm treated SW battens	£ 0.16	600.00	1.53786	12.30288
1200	roof gable	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	£ 0.77	0.90	0.002592	0.002592
600	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.001296	0.001296
1800	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.002592	0.002592
1200	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.003888	0.003888
2400	wall	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.005184	0.005184
600	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.00117558	0.00117558
1800	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.00235116	0.00235116
1200	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.00352674	0.00352674
2400	roof	Membrane	TF/SIP	Breather membrane	Pro Clima Solitex WA	£ 1.29	0.90	0.00470232	0.00470232
600	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	£ 1.93	0.90	0.002592	0.002592
1200	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	£ 0.77	0.90	0.002592	0.002592
1800	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	£ 3.87	0.90	0.002592	0.002592
2400	roof	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	£ 3.87	0.90	0.002592	0.002592
600	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	8.62092	17.24184
1200	roof	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	17.24184	34.48368
600	wall	Membrane	TF/SIP	Internal membrane	Pro Clima Intello Plus	£ 1.93	0.90	0.00145692	0.00145692

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
600	ceiling	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	4.86	9.72
600	ceiling	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	7.4925	14.985
600	ceiling	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	9.315	18.63
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	19.008
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	14.652	29.304
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	18.216	36.432
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600	4.86	9.72
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600	7.4925	14.985
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600	9.315	18.63
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	19.008
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	14.652	29.304
600	ceiling	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	18.216	36.432
600	ceiling	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	12.50496	12.50496
600	ceiling	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	19.27848	19.27848
600	ceiling	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	23.96784	23.96784
600	upper floor	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	21.88368	21.88368
600	upper floor	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	23.96784	23.96784
600	upper floor	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	19.27848	19.27848
600	upper floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	3.8016
600	upper floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	3.8016
600	upper floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	3.8016
600	upper floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	4.86	4.86
600	upper floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	9.315	9.315
600	upper floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	7.4925	7.4925
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	9.504
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	18.216	18.216
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	14.652	14.652
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	9.504
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	18.216	18.216
600	upper floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	14.652	14.652
600	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	7.6032
600	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	7.6032
600	floor	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	3.8016	7.6032
600	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	4.86	14.58
600	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	9.315	18.63
600	floor	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.17	600	7.4925	7.4925
600	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	9.504
600	floor	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	18.216	18.216

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	14.652	14.652
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	9.504	9.504
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	18.216	18.216
600	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	14.652	14.652
1200	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.14	600	4.86	14.58
1200	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.14	600	7.4925	22.4775
1200	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.14	600	9.315	27.945
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.19	600.00	0.06336	0.25344
1200	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.19	600.00	0.09768	0.39072
1200	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.19	600.00	0.12144	0.48576
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**ceiling**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	6.25248	6.25248
1200	**ceiling**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	6.25248	6.25248
1200	**ceiling**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	6.25248	6.25248
1200	**upper floor**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	6.25248	6.25248
1200	**upper floor**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	6.25248	6.25248
1200	**upper floor**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	6.25248	6.25248
1200	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ -	600.00	7.6032	0
1200	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ -	600.00	7.6032	0
1200	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ -	600.00	7.6032	0
1200	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ -	600	4.86	0
1200	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ -	600	9.315	0
1200	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ -	600	7.4925	0
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	4.752
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	4.752
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	4.752
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	4.752
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	4.752
1200	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	4.752
1200	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	7.6032	15.2064
1200	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	7.6032	15.2064
1200	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	7.6032	15.2064
1200	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.14	600	4.86	14.58
1200	**floor**	Panel	TF panel	component	timber I-Joist	£ 0.14	600	9.315	27.945

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
1200	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.14	600	7.4925	22.4775
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1200	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.08	600.00	4.752	9.504
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	4.86	14.58
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	7.4925	22.4775
1800	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	9.315	27.945
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.13	600.00	0.06336	0.38016
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.13	600.00	0.09768	0.58608
1800	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.13	600.00	0.12144	0.72864
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	9.37872	9.37872
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	9.37872	9.37872
1800	**ceiling**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	9.37872	9.37872
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	9.37872	9.37872
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	9.37872	9.37872
1800	**upper floor**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	9.37872	9.37872
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ -	600.00	11.4048	0
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ -	600.00	11.4048	0
1800	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ -	600.00	11.4048	0
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	4.86	19.44
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	9.315	37.26
1800	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	7.4925	29.97
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	7.128
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	7.128
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	7.128
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	7.128
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	7.128
1800	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	7.128
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	11.4048	22.8096
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	11.4048	22.8096

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
1800	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	11.4048	22.8096
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	4.86	19.44
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	9.315	37.26
1800	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.20	600	7.4925	29.97
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
1800	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	7.128	14.256
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	4.86	14.58
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	7.4925	22.4775
2400	**ceiling**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	9.315	27.945
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.10	600.00	0.06336	0.50688
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.10	600.00	0.09768	0.78144
2400	**ceiling**	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.10	600.00	0.12144	0.97152
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**ceiling**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	12.50496	12.50496
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	12.50496	12.50496
2400	**ceiling**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	12.50496	12.50496
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	12.50496	12.50496
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	12.50496	12.50496
2400	**upper floor**	Finish	Lining	Drylining	Plasterboard	£ 0.48	668.00	12.50496	12.50496
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ -	600.00	15.2064	0
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ -	600.00	15.2064	0
2400	**upper floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ -	600.00	15.2064	0
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	4.86	24.3
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	9.315	46.575
2400	**upper floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	7.4925	37.4625
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	9.504
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	9.504
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	9.504
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	9.504

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	9.504
2400	**upper floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	9.504
2400	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	15.2064	30.4128
2400	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	15.2064	30.4128
2400	**floor**	Panel	TF panel	Panel boxing	240*44mm SW battens C16	£ 0.28	600.00	15.2064	30.4128
2400	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	4.86	24.3
2400	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	9.315	46.575
2400	**floor**	Panel	TF panel	Panel Structural component	240x45mm timber I-Joist	£ 0.19	600	7.4925	37.4625
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
2400	**floor**	Panel	TF panel	Sheathing board	11mm 2440x1220 OSB3	£ 0.10	600.00	9.504	19.008
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	ceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	internal	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	internal	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	ceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	upperceiling	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	0.97128
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	internalwall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	floor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	upperfloor	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	0.97128
600	wall	Panel	TF/SIP	Sheathing board	11mm 2440x1220 OSB3	£ 0.09	600.00	0.97128	1.94256
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	wall	Panel	**TF**	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	floor	Panel	**TF**	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
600	ceiling	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	internal	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	internal	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	ceiling	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	floor	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	internalwall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	floor	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	upperceiling	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	0.97128
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	internalwall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	internalwall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	floor	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	upperfloor	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	0.97128
600	wall	Panel	TF	Panel boxing	240*44mm SW battens C16	£ 0.23	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	internal	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	internal	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	ceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	upperceiling	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	0.97128
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	internalwall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	floor	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256
600	upperfloor	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	0.97128

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	Labour cost (set up adjusted per piece)	material density	component mass	total mass
600	wall	Panel	TF/SIP	Internal battens	44x69mm SW battens	£ 0.32	600.00	0.97128	1.94256

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	assembly width	Assembly length	component dimension variable		component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
Panel size	Panel type	Product system	Element	Component	Material	assembly width	Assembly length	component dimension variable		component volume	Number in assembly	component cost	Total cost	Total assembly volume	maintenance	cutting numbers
600	ceiling	Insulation	Insulation	Blown Insulation	Warmcell	600	4200	2520000	m2	0	0	0.00E+00	0.00	0	0	1
600	ceiling	Insulation	Insulation	Insulation batts	Rockwool	600	4200	2520000	m2	604800000	1	3.68E+01	36.75	604800000	0	1
600	ceiling	Insulation	Insulation	Insulation batts	Sheep wool	600	4200	2520000	m2	604800000	1	6.20E+01	62.00	604800000	0	1
600	floor	Insulation	Insulation	Blown Insulation	Warmcell	600	4200	2520000	m2	0	0	0.00E+00	0.00	0	0	1
600	floor	Insulation	Insulation	Insulation batts	Rockwool	600	4200	2520000	m2	604800000	1	3.68E+01	36.75	604800000	0	1
600	floor	Insulation	Insulation	Insulation batts	Sheep wool	600	4200	2520000	m2	604800000	1	6.20E+01	62.00	604800000	0	1
600	roof	Insulation	Insulation	Blown Insulation	Warmcell	600	2177	1306200	m2	0	0	0.00E+00	0.00	0	0	1
600	roof	Insulation	Insulation	Insulation batts	Rockwool	600	2177	1306200	m2	313488000	1	1.90E+01	19.05	313488000	0	1
600	roof	Insulation	Insulation	Insulation batts	Sheep wool	600	2177	1306200	m2	313488000	1	3.21E+01	32.13	313488000	0	1
600	roof gable	Insulation	Insulation	Blown Insulation	Warmcell	600	1349	809400	m2	0	0	0.00E+00	0.00	0	0	1
600	roof gable	Insulation	Insulation	Insulation batts	Rockwool	600	1349	809400	m2	194256000	1	1.18E+01	11.80	194256000	0	1
600	roof gable	Insulation	Insulation	Insulation batts	Sheep wool	600	1349	809400	m2	194256000	1	1.99E+01	19.91	194256000	0	1
600	upper floor	Insulation	Insulation	Blown Insulation	Warmcell	600	4200	2520000	m2	0	0	0.00E+00	0.00	0	0	1
600	upper floor	Insulation	Insulation	Insulation batts	Rockwool	600	4200	2520000	m2	604800000	1	3.68E+01	36.75	604800000	0	1
600	upper floor	Insulation	Insulation	Insulation batts	Sheep wool	600	4200	2520000	m2	604800000	1	6.20E+01	62.00	604800000	0	1
600	wall	Insulation	Insulation	Blown Insulation	Warmcell	600	2400	1440000	m2	0	0	0.00E+00	0.00	0	0	1
600	wall	Insulation	Insulation	Blown Insulation	Warmcell	600	2400	1440000	m2	0	0	0.00E+00	0.00	0	0	1
600	wall	Insulation	Insulation	Insulation batts	Rockwool	600	2400	1440000	m2	345600000	1	2.10E+01	21.00	345600000	0	1
600	wall	Insulation	Insulation	Insulation batts	Sheep wool	600	2400	1440000	m2	345600000	1	3.54E+01	35.43	345600000	0	1
1200	ceiling	Insulation	Insulation	Blown Insulation	Warmcell	1200	4200	5040000	m2	0	0	0.00E+00	0.00	0	0	1
1200	ceiling	Insulation	Insulation	Insulation batts	Rockwool	1200	4200	5040000	m2	1209600000	1	7.35E+01	73.50	1209600000	0	1
1200	ceiling	Insulation	Insulation	Insulation batts	Sheep wool	1200	4200	5040000	m2	1209600000	1	1.24E+02	123.99	1209600000	0	1
1200	floor	Insulation	Insulation	Blown Insulation	Warmcell	1200	4200	5040000	m2	0	0	0.00E+00	0.00	0	0	1
1200	floor	Insulation	Insulation	Insulation batts	Rockwool	1200	4200	5040000	m2	1209600000	1	7.35E+01	73.50	1209600000	0	1
1200	floor	Insulation	Insulation	Insulation batts	Sheep wool	1200	4200	5040000	m2	1209600000	1	1.24E+02	123.99	1209600000	0	1
1200	roof	Insulation	Insulation	Blown Insulation	Warmcell	1200	2177	2612400	m2	0	0	0.00E+00	0.00	0	0	1
1200	roof	Insulation	Insulation	Insulation batts	Rockwool	1200	2177	2612400	m2	626976000	1	3.81E+01	38.10	626976000	0	1
1200	roof	Insulation	Insulation	Insulation batts	Sheep wool	1200	2177	2612400	m2	626976000	1	6.43E+01	64.27	626976000	0	1
1200	roof gable	Insulation	Insulation	Blown Insulation	Warmcell	1200	1349	1618800	m2	0	0	0.00E+00	0.00	0	0	1
1200	roof gable	Insulation	Insulation	Insulation batts	Rockwool	1200	1349	1618800	m2	388512000	1	2.36E+01	23.61	388512000	0	1
1200	roof gable	Insulation	Insulation	Insulation batts	Sheep wool	1200	1349	1618800	m2	388512000	1	3.98E+01	39.83	388512000	0	1
1200	upper floor	Insulation	Insulation	Blown Insulation	Warmcell	1200	4200	5040000	m2	0	0	0.00E+00	0.00	0	0	1
1200	upper floor	Insulation	Insulation	Insulation batts	Rockwool	1200	4200	5040000	m2	1209600000	1	7.35E+01	73.50	1209600000	0	1
1200	upper floor	Insulation	Insulation	Insulation batts	Sheep wool	1200	4200	5040000	m2	1209600000	1	1.24E+02	123.99	1209600000	0	1
1200	wall	Insulation	Insulation	Blown Insulation	Warmcell	1200	2400	2880000	m2	0	0	0.00E+00	0.00	0	0	1
1200	wall	Insulation	Insulation	Blown Insulation	Warmcell	1200	2400	2880000	m2	0	0	0.00E+00	0.00	0	0	1
1200	wall	Insulation	Insulation	Insulation batts	Rockwool	1200	2400	2880000	m2	691200000	1	4.20E+01	42.00	691200000	0	1
1200	wall	Insulation	Insulation	Insulation batts	Sheep wool	1200	2400	2880000	m2	691200000	1	7.09E+01	70.85	691200000	0	1
1800	ceiling	Insulation	Insulation	Blown Insulation	Warmcell	1800	4200	7560000	m2	0	0	0.00E+00	0.00	0	0	1
1800	ceiling	Insulation	Insulation	Insulation batts	Rockwool	1800	4200	7560000	m2	1814400000	1	1.10E+02	110.25	1814400000	0	1
1800	ceiling	Insulation	Insulation	Insulation batts	Sheep wool	1800	4200	7560000	m2	1814400000	1	1.86E+02	185.99	1814400000	0	1
1800	floor	Insulation	Insulation	Blown Insulation	Warmcell	1800	4200	7560000	m2	0	0	0.00E+00	0.00	0	0	1
1800	floor	Insulation	Insulation	Insulation batts	Rockwool	1800	4200	7560000	m2	1814400000	1	1.10E+02	110.25	1814400000	0	1
1800	floor	Insulation	Insulation	Insulation batts	Sheep wool	1800	4200	7560000	m2	1814400000	1	1.86E+02	185.99	1814400000	0	1
1800	roof	Insulation	Insulation	Blown Insulation	Warmcell	1800	2177	3918600	m2	0	0	0.00E+00	0.00	0	0	1
1800	roof	Insulation	Insulation	Insulation batts	Rockwool	1800	2177	3918600	m2	940464000	1	5.71E+01	57.15	940464000	0	1
1800	roof	Insulation	Insulation	Insulation batts	Sheep wool	1800	2177	3918600	m2	940464000	1	9.64E+01	96.40	940464000	0	1
1800	roof gable	Insulation	Insulation	Blown Insulation	Warmcell	1800	1349	2428200	m2	0	0	0.00E+00	0.00	0	0	1
1800	roof gable	Insulation	Insulation	Insulation batts	Rockwool	1800	1349	2428200	m2	582768000	1	3.54E+01	35.41	582768000	0	1
1800	roof gable	Insulation	Insulation	Insulation batts	Sheep wool	1800	1349	2428200	m2	582768000	1	5.97E+01	59.74	582768000	0	1
1800	upper floor	Insulation	Insulation	Blown Insulation	Warmcell	1800	4200	7560000	m2	0	0	0.00E+00	0.00	0	0	1
1800	upper floor	Insulation	Insulation	Insulation batts	Rockwool	1800	4200	7560000	m2	1814400000	1	1.10E+02	110.25	1814400000	0	1
1800	upper floor	Insulation	Insulation	Insulation batts	Sheep wool	1800	4200	7560000	m2	1814400000	1	1.86E+02	185.99	1814400000	0	1
1800	wall	Insulation	Insulation	Blown Insulation	Warmcell	1800	2400	4320000	m2	0	0	0.00E+00	0.00	0	0	1
1800	wall	Insulation	Insulation	Blown Insulation	Warmcell	1800	2400	4320000	m2	0	0	0.00E+00	0.00	0	0	1
1800	wall	Insulation	Insulation	Insulation batts	Rockwool	1800	2400	4320000	m2	1036800000	1	6.30E+01	63.00	1036800000	0	1
1800	wall	Insulation	Insulation	Insulation batts	Sheep wool	1800	2400	4320000	m2	1036800000	1	1.06E+02	106.28	1036800000	0	1
2400	ceiling	Insulation	Insulation	Blown Insulation	Warmcell	2400	4200	10080000	m2	0	0	0.00E+00	0.00	0	0	1
2400	ceiling	Insulation	Insulation	Insulation batts	Rockwool	2400	4200	10080000	m2	2419200000	1	1.47E+02	147.00	2419200000	0	1
2400	ceiling	Insulation	Insulation	Insulation batts	Sheep wool	2400	4200	10080000	m2	2419200000	1	2.48E+02	247.99	2419200000	0	1
2400	floor	Insulation	Insulation	Blown Insulation	Warmcell	2400	4200	10080000	m2	0	0	0.00E+00	0.00	0	0	1
2400	floor	Insulation	Insulation	Insulation batts	Rockwool	2400	4200	10080000	m2	2419200000	1	1.47E+02	147.00	2419200000	0	1
2400	floor	Insulation	Insulation	Insulation batts	Sheep wool	2400	4200	10080000	m2	2419200000	1	2.48E+02	247.99	2419200000	0	1
2400	roof	Insulation	Insulation	Blown Insulation	Warmcell	2400	2177	5224800	m2	0	0	0.00E+00	0.00	0	0	1
2400	roof	Insulation	Insulation	Insulation batts	Rockwool	2400	2177	5224800	m2	1253952000	1	7.62E+01	76.20	1253952000	0	1
2400	roof	Insulation	Insulation	Insulation batts	Sheep wool	2400	2177	5224800	m2	1253952000	1	1.29E+02	128.54	1253952000	0	1
2400	roof gable	Insulation	Insulation	Blown Insulation	Warmcell	2400	1349	3237600	m2	0	0	0.00E+00	0.00	0	0	1
2400	roof gable	Insulation	Insulation	Insulation batts	Rockwool	2400	1349	3237600	m2	777024000	1	4.72E+01	47.22	777024000	0	1
2400	roof gable	Insulation	Insulation	Insulation batts	Sheep wool	2400	1349	3237600	m2	777024000	1	7.97E+01	79.65	777024000	0	1
2400	upper floor	Insulation	Insulation	Blown Insulation	Warmcell	2400	4200	10080000	m2	0	0	0.00E+00	0.00	0	0	1
2400	upper floor	Insulation	Insulation	Insulation batts	Rockwool	2400	4200	10080000	m2	2419200000	1	1.47E+02	147.00	2419200000	0	1
2400	upper floor	Insulation	Insulation	Insulation batts	Sheep wool	2400	4200	10080000	m2	2419200000	1	2.48E+02	247.99	2419200000	0	1
2400	wall	Insulation	Insulation	Blown Insulation	Warmcell	2400	2400	5760000	m2	0	0	0.00E+00	0.00	0	0	1
2400	wall	Insulation	Insulation	Blown Insulation	Warmcell	2400	2400	5760000	m2	0	0	0.00E+00	0.00	0	0	1
2400	wall	Insulation	Insulation	Insulation batts	Rockwool	2400	2400	5760000	m2	1382400000	1	8.40E+01	84.00	1382400000	0	1
2400	wall	Insulation	Insulation	Insulation batts	Sheep wool	2400	2400	5760000	m2	1382400000	1	1.42E+02	141.71	1382400000	0	1
600	**internal wall**	Insulation	Insulation	Insulation batts	Sheep wool	600	2400	1440000	m2	345600000	1	3.54E+01	35.43	345600000	0	1
1200	**internal wall**	Insulation	Insulation	Insulation batts	Sheep wool	1200	2400	2880000	m2	691200000	1	3.54E+01	35.43	345600000	0	1
1800	**internal wall**	Insulation	Insulation	Insulation batts	Sheep wool	1800	2400	4320000	m2	1036800000	1	3.54E+01	35.43	345600000	0	1
2400	**internal wall**	Insulation	Insulation	Insulation batts	Sheep wool	2400	2400	5760000	m2	1382400000	1	3.54E+01	35.43	345600000	0	1

Panel size	Panel type	Product system	Element	Component	Horizontal (fixed or variable)	width	depth	length	width	depth	length	width	number of width cuts (length run)	cutting length	remainder board	number of length cuts (width run)	cutting width	cutting width	remainder board	output sheets	mm	(m/min)	cutting time (seconds)	number	seconds	seconds		£ 0.02	
Panel size	Panel type	Product system	Element	Component	Material	purchase size			manufactured piece			Piece larger than standard size (the extra bit)				length left after components cut		cut travel	width		total cutting travel distance	cutting /travel rate		whole pieces	loading	Per item timing		Per item Power cost (not including setup cost)	
600	ceiling	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
600	ceiling	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	600	240	600.00	0.00	1	600	0	0	0	0	2	600	0.167	216.0	2	16.41	116.2	116.2	£ 0.03	£ 0.029
600	ceiling	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	600	240	300.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	17.41	111.3	111.3	£ 0.03	£ 0.028
600	floor	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
600	floor	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	600	240	600.00	0.00	1	600	0	0	0	0	2	600	0.167	216.0	2	19.41	117.7	117.7	£ 0.03	£ 0.029
600	floor	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	600	240	300.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	20.41	112.8	112.8	£ 0.03	£ 0.028
600	roof	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
600	roof	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	2177	600	240	977.00	0.00	1	600	0	0	0	0	2	600	0.167	216.0	2	22.41	119.2	119.2	£ 0.03	£ 0.029
600	roof	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2177	600	240	877.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	23.41	114.3	114.3	£ 0.03	£ 0.028
600	roof gable	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
600	roof gable	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	1349	600	240	149.00	0.00	1	600	0	0	0	0	2	600	0.167	216.0	2	25.41	120.7	120.7	£ 0.03	£ 0.029
600	roof gable	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	1349	600	240	49.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	26.41	115.8	115.8	£ 0.03	£ 0.028
600	upper floor	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
600	upper floor	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	600	240	600.00	0.00	1	600	0	0	0	0	2	600	0.167	216.0	2	28.41	122.2	122.2	£ 0.03	£ 0.029
600	upper floor	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	600	240	300.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	29.41	117.3	117.3	£ 0.03	£ 0.028
600	wall	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
600	wall	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
600	wall	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	2400	600	240	0.00	0.00	1	600	0	0	0	0	2	600	0.167	216.0	2	32.41	124.2	124.2	£ 0.03	£ 0.029
600	wall	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2400	600	240	1100.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	34.41	119.8	119.8	£ 0.03	£ 0.028
1200	ceiling	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1200	ceiling	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	1200	240	600.00	0.00	1	600	0	1	0	1200	2	600	0.167	216.0	2	37.41	126.7	126.7	£ 0.03	£ 0.029
1200	ceiling	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	1200	240	300.00	60.00	1	570	0	1	0	1140	2	570	0.167	205.2	2	38.41	121.8	121.8	£ 0.03	£ 0.028
1200	floor	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1200	floor	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	1200	240	600.00	0.00	1	600	0	1	0	1200	2	600	0.167	216.0	2	40.41	128.2	128.2	£ 0.03	£ 0.029
1200	floor	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	1200	240	300.00	60.00	1	570	0	1	0	1140	2	570	0.167	205.2	2	41.41	123.3	123.3	£ 0.03	£ 0.028
1200	roof	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1200	roof	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	2177	1200	240	977.00	0.00	1	600	0	1	0	1200	2	600	0.167	216.0	2	43.41	129.7	129.7	£ 0.03	£ 0.029
1200	roof	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2177	1200	240	877.00	60.00	1	570	0	1	0	1140	2	570	0.167	205.2	2	44.41	124.8	124.8	£ 0.03	£ 0.028
1200	roof gable	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1200	roof gable	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	1349	1200	240	149.00	0.00	1	600	0	1	0	1200	2	600	0.167	216.0	2	46.41	131.2	131.2	£ 0.03	£ 0.029
1200	roof gable	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	1349	1200	240	49.00	60.00	1	570	0	1	0	1140	2	570	0.167	205.2	2	47.41	126.3	126.3	£ 0.03	£ 0.028
1200	upper floor	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1200	upper floor	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	1200	240	600.00	0.00	1	600	0	1	0	1200	2	600	0.167	216.0	2	49.41	132.7	132.7	£ 0.03	£ 0.029
1200	upper floor	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	1200	240	300.00	60.00	1	570	0	1	0	1140	2	570	0.167	205.2	2	50.41	127.8	127.8	£ 0.03	£ 0.028
1200	wall	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1200	wall	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1200	wall	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	2400	1200	240	0.00	0.00	1	600	0	1	0	1200	2	600	0.167	216.0	2	53.41	134.7	134.7	£ 0.03	£ 0.029
1200	wall	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2400	1200	240	1100.00	60.00	1	570	0	1	0	1140	2	570	0.167	205.2	2	55.41	130.3	130.3	£ 0.03	£ 0.028
1800	ceiling	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1800	ceiling	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	1800	240	600.00	0.00	1	600	0	1	0	1800	2	600	0.167	216.0	2	58.41	137.2	137.2	£ 0.03	£ 0.029
1800	ceiling	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	1800	240	300.00	90.00	1	570	0	1	0	1710	2	570	0.167	205.2	2	59.41	132.3	132.3	£ 0.03	£ 0.028
1800	floor	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1800	floor	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	1800	240	600.00	0.00	1	600	0	1	0	1800	2	600	0.167	216.0	2	61.41	138.7	138.7	£ 0.03	£ 0.029
1800	floor	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	1800	240	300.00	90.00	1	570	0	1	0	1710	2	570	0.167	205.2	2	62.41	133.8	133.8	£ 0.03	£ 0.028
1800	roof	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1800	roof	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	2177	1800	240	977.00	0.00	1	600	0	1	0	1800	2	600	0.167	216.0	2	64.41	140.2	140.2	£ 0.03	£ 0.029
1800	roof	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2177	1800	240	877.00	90.00	1	570	0	1	0	1710	2	570	0.167	205.2	2	65.41	135.3	135.3	£ 0.03	£ 0.028
1800	roof gable	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1800	roof gable	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	1349	1800	240	149.00	0.00	1	600	0	1	0	1800	2	600	0.167	216.0	2	67.41	141.7	141.7	£ 0.03	£ 0.029
1800	roof gable	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	1349	1800	240	49.00	90.00	1	570	0	1	0	1710	2	570	0.167	205.2	2	68.41	136.8	136.8	£ 0.03	£ 0.028
1800	upper floor	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1800	upper floor	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	1800	240	600.00	0.00	1	600	0	1	0	1800	2	600	0.167	216.0	2	70.41	143.2	143.2	£ 0.03	£ 0.029
1800	upper floor	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	1800	240	300.00	90.00	1	570	0	1	0	1710	2	570	0.167	205.2	2	71.41	138.3	138.3	£ 0.03	£ 0.028
1800	wall	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1800	wall	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
1800	wall	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	2400	1800	240	0.00	0.00	1	600	0	1	0	1800	2	600	0.167	216.0	2	74.41	145.2	145.2	£ 0.03	£ 0.029
1800	wall	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2400	1800	240	1100.00	90.00	1	570	0	1	0	1710	2	570	0.167	205.2	2	76.41	140.8	140.8	£ 0.03	£ 0.028
2400	ceiling	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
2400	ceiling	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	2400	240	600.00	0.00	1	600	0	1	0	2400	2	600	0.167	216.0	2	79.41	147.7	147.7	£ 0.03	£ 0.029
2400	ceiling	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	2400	240	300.00	120.00	1	570	0	1	0	2280	2	570	0.167	205.2	2	80.41	142.8	142.8	£ 0.03	£ 0.028
2400	floor	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
2400	floor	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	2400	240	600.00	0.00	1	600	0	1	0	2400	2	600	0.167	216.0	2	82.41	149.2	149.2	£ 0.03	£ 0.029
2400	floor	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	2400	240	300.00	120.00	1	570	0	1	0	2280	2	570	0.167	205.2	2	83.41	144.3	144.3	£ 0.03	£ 0.028
2400	roof	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
2400	roof	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	2177	2400	240	977.00	0.00	1	600	0	1	0	2400	2	600	0.167	216.0	2	85.41	150.7	150.7	£ 0.03	£ 0.029
2400	roof	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2177	2400	240	877.00	120.00	1	570	0	1	0	2280	2	570	0.167	205.2	2	86.41	145.8	145.8	£ 0.03	£ 0.028
2400	roof gable	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
2400	roof gable	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	1349	2400	240	149.00	0.00	1	600	0	1	0	2400	2	600	0.167	216.0	2	88.41	152.2	152.2	£ 0.03	£ 0.029
2400	roof gable	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	1349	2400	240	49.00	120.00	1	570	0	1	0	2280	2	570	0.167	205.2	2	89.41	147.3	147.3	£ 0.03	£ 0.028
2400	upper floor	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
2400	upper floor	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	4200	2400	240	600.00	0.00	1	600	0	1	0	2400	2	600	0.167	216.0	2	91.41	153.7	153.7	£ 0.03	£ 0.029
2400	upper floor	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	4200	2400	240	300.00	120.00	1	570	0	1	0	2280	2	570	0.167	205.2	2	92.41	148.8	148.8	£ 0.03	£ 0.028
2400	wall	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
2400	wall	Insulation	Insulation	Blown Insulation	Warmcell	1000	1000	240		0																	0.0		£ -
2400	wall	Insulation	Insulation	Insulation batts	Rockwool	1200	600	240	2400	2400	240	0.00	0.00	1	600	0	1	0	2400	2	600	0.167	216.0	2	95.41	155.7	155.7	£ 0.03	£ 0.029
2400	wall	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2400	2400	240	1100.00	120.00	1	570	0	1	0	2280	2	570	0.167	205.2	2	97.41	151.3	151.3	£ 0.03	£ 0.028
600	**internal wall**	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2400	600	240	1100.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	34.41	119.8	119.8	£ 0.03	£ 0.028
1200	**internal wall**	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2400	1200	240	1100.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	56.41	130.8	130.8	£ 0.03	£ 0.028
1800	**internal wall**	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2400	1800	240	1100.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	77.41	141.3	141.3	£ 0.03	£ 0.028
2400	**internal wall**	Insulation	Insulation	Insulation batts	Sheep wool	1300	570	240	2400	2400	240	1100.00	30.00	1	570	0	1	0	570	2	570	0.167	205.2	2	98.41	151.8	151.8	£ 0.03	£ 0.028

G ASSEMBLY OF COMPONENTS, PANELS AND MODULES

Constraint lifting	Kg limit			
	1person	2person	3person	4person
Panel weight	20	40	60	80
Manual Crane	1000			

		open closed volumetric	number of panels	weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
600	Floor panel	o	11	195.5	2	240	480	1500	100	15	735	8085	134.75
600	Wall panels	o	72	122.9	2	240	480	1500	100	15	735	52920	882
600	Upper floor	o	11	486.0	4	240	960	1500	100	15	1215	13365	222.75
600	Ceiling panels	o	11	901.2	4	240	960	1500	100	15	1215	13365	222.75
	Roof trusses		12	58.2	4	240	960	1500	100	15	1215	14580	243
600	Roof panels	o	22	523.0	2	240	480	1500	100	15	735	16170	269.5
	Internal		37	293.0		240	0	1500	100	15	255	9435	157.25

		number of units	weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)	
1200	Floor panel	6	0	2	240	240	57600	1500	100	15	57855	0	0
	Wall panels	38	0	2	240	240	57600	1500	100	15	57855	0	0
	Ceiling panels	6.00	0	2	240	240	57600	1500	100	15	57855	0	0
	Upper floor	6	0	2	240		0						
	Roof trusses	12	100	2	240	240	57600	1500	100	15	57855	5785500	96425
	Roof panels	12	0	2	240	240	57600	1500	100	15	57855	0	0
	Internal	20	5.72E+02										

		open closed volumetric	number of panels	weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
600	Floor panel	o	12	195.5	2	240	480	1500	100	15	975	11700	195
600	Wall panels	o	36	122.9	2	240	480	1500	100	15	975	35100	585
600	Upper floor	o	12	486.0	4	240	960	1500	100	15	1935	23220	387
600	Ceiling panels	o	12	901.2	4	240	960	1500	100	15	1935	23220	387
	Roof trusses		12	58.2	4	240	960	1500	100	15	1935	23220	387
600	Roof panels	o	22	523.0	2	240	480	1500	100	15	975	21450	358
	Internal		37	293.0		240	0	1500	100	15	255	9435	157.25

		number of units	weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
1200	Floor panel	6	0	2	240	480	1500	80	18.75	978.75	5872.5	98
	Wall panels	20	0	2	240	480	1500	80	18.75	978.75	19575	327
	Ceiling panels	12	0	2	240	480	1500	80	18.75	978.75	11745	196
	First floor wall panels		0	2	240	480	1500	80	18.75	978.75	0	0
	Roof trusses	12	100	2	240	480	1500	80	18.75	978.75	11745	196
	Roof panels	12	0	2	240	480	1500	80	18.75	978.75	11745	196
	Internal	20										

Total		time
	600	2132
	1200	5785500
	1800	774
	2400	562

Volumetric

	Volume	open closed volumetric	number of units	weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
600	1	v	9		8	240	1920	1000	25	40	1960	17640	294
	Roof trusses	p	12		4	240	960	1000	25	40	1935	23220	387
												Total	681

		number of units	weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
1200	Floor panel	6	0	2	240	480	1000	80	18.75	978.75	5872.5	98
	Roof trusses	12	100	2	240	480	1000	80	18.75	978.75	11745	196
											Total	294

volumetric assembly in factory

	Volume	open closed volumetric	number of units	weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
	1	v	36.00		2	240	480	1500	25	60	540	19440	324
	2	v	20.00		2	240	480	1500	25	60	1935	38700	645
	3	v	20.00		2	240	480	1500	25	60	540	10800	180
	4	v	16.00		2	240	480	1500	25	60	1936	30976	516.26667
	5	v	14.00		2	240	480	1500	25	60	540	7560	126
	6	v	20.00		2	240	480	1500	25	60	1937	38740	645.66667
	7	v	15.00		2	240	480	1500	25	60	540	8100	135
	8	v	15.00		2	240	480	1500	25	60	1938	29070	484.5
	9	v	23.00		2	240	480	1500	25	60	540	12420	207
												mins	**3263.43**
												hours	**54.39**
												days	**6.80**
												sec	195806

	Volume	open closed volumetric	number of units	weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
	1	v	20.00		2	240	480	500	25	20	500	10000	166.6667
	2	v	12.00		2	240	480	500	25	20	1935	23220	387
	3	v	12.00		2	240	480	500	25	20	500	6000	100
	4	v	8.00		2	240	480	500	25	20	1936	15488	258.1333
	5	v	8.00		2	240	480	500	25	20	500	4000	66.66667
	6	v	10.00		2	240	480	500	25	20	1937	19370	322.8333
	7	v	9.00		2	240	480	500	25	20	500	4500	75
	8	v	9.00		2	240	480	500	25	20	1938	17442	290.7
	9	v	12.00		2	240	480	500	25	20	500	6000	100
												mins	**1767**
												days	**3.68125**
												sec	106020

volumetric assembly in factory 2 person

	Volume	open closed volumetric	number of units	weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
	1	v	36.00		0	240	0	1500	25	60	60	2160	36
	2	v	20.00		0	240	0	1500	25	60	1935	38700	645
	3	v	20.00		0	240	0	1500	25	60	60	1200	20
	4	v	16.00		0	240	0	1500	25	60	1936	30976	516.26667
	5	v	14.00		0	240	0	1500	25	60	60	840	14
	6	v	20.00		0	240	0	1500	25	60	1937	38740	645.66667
	7	v	15.00		0	240	0	1500	25	60	60	900	15
	8	v	15.00		0	240	0	1500	25	60	1938	29070	484.5
	9	v	23.00		0	240	0	1500	25	60	60	1380	23
												mins	**2399.43**
			179.00									**hours**	**39.99**
												days	**5.00**

		number of units	weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
1800	Floor panel	4	540	2	240	480	1500	60	25	985	4925	83
	Wall panels	25	540	2	240	480	1500	60	25	985	14775	247
	Ceiling panels	4	720	2	240	480	1500	60	25	985	8865	148
	First floor wall panels	4	540	2	240	480	1500	60	25	985	0	0
	Roof trusses		100	2	240	480	1500	60	25	985	8865	148
	Roof panels	8	720	2	240	480	1500	60	25	985	8865	148
	Internal	14	8.52E+02									

		number of units	weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
	Floor panel	5	540	2	240	480	1500	60	25	985	4925	83
	Wall panels	15	540	2	240	480	1500	60	25	985	14775	247
	Ceiling panels	9	720	2	240	480	1500	60	25	985	8865	148
	First floor wall panels		540	2	240	480	1500	60	25	985	0	0
	Roof trusses	9	100	2	240	480	1500	60	25	985	8865	148
	Roof panels	9	720	2	240	480	1500	60	25	985	8865	148
	Internal	14	8.52E+02									

		number of units	weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
2400	Floor pane	3		2	240	480	1500	50	30	990	2970	50
	Wall panel	19		2	240	480	1500	50	30	990	9900	165
	Ceiling par	19.00		2	240	480	1500	50	30	990	8910	149
	First floor	3.00		2	240	480	1500	50	30	990	0	0
	Roof trusses			2	240	480	1500	50	30	990	5940	99
	Roof panel	6.00		2	240	480	1500	50	30	990	5940	99
	Internal	11.00	1.17E+03									

		number of units	weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
	Floor pane	3		2	240	480	1500	50	30	990	2970	50
	Wall panel	10		2	240	480	1500	50	30	990	9900	165
	Ceiling par	9		2	240	480	1500	50	30	990	8910	149
	First floor wall panels			2	240	480	1500	50	30	990	0	0
	Roof truss	6		2	240	480	1500	50	30	990	5940	99
	Roof panel	6		2	240	480	1500	50	30	990	5940	99
	Internal	11										

		weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
Floor panel	5	540	2	240	480	1000	60	25	985	4925	83
Roof trusses	9	100	2	240	480	1000	60	25	985	8865	148
										Total	231

		weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
Floor pane	5	540	2	240	480	1000	60	25	985	4925	83
Roof truss	9	100	2	240	480	1000	60	25	985	8865	148
										Total	231

	Volume	open closed volumetric	number of units	weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
	1	v	14.00		2	240	480	500	25	20	500	7000	116.6667
	2	v	7.00		2	240	480	500	25	20	1935	13545	225.75
	3	v	7.00		2	240	480	500	25	20	500	3500	58.33333
	4	v	7.00		2	240	480	500	25	20	1936	13552	225.8667
	5	v	6.00		2	240	480	500	25	20	500	3000	50
	6	v	8.00		2	240	480	500	25	20	1937	15496	258.2667
	7	v	5.00		2	240	480	500	25	20	500	2500	41.66667
	8	v	5.00		2	240	480	500	25	20	1938	9690	161.5
	9	v	9.00		2	240	480	500	25	20	500	4500	75
												mins	**1213.05**
												days	**2.527188**
												sec	72783

	Volume	open closed volumetric	number of units	weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
	1	v	10.00		2	240	480	500	25	20	500	5000	83.333333
	2	v	6.00		2	240	480	500	25	20	1935	11610	193.5
	3	v	6.00		2	240	480	500	25	20	500	3000	50
	4	v	6.00		2	240	480	500	25	20	1936	11616	193.6
	5	v	4.00		2	240	480	500	25	20	500	2000	33.333333
	6	v	6.00		2	240	480	500	25	20	1937	11622	193.7
	7	v	5.00		2	240	480	500	25	20	500	2500	41.666667
	8	v	5.00		2	240	480	500	25	20	1938	9690	161.5
	9	v	7.00		2	240	480	500	25	20	500	3500	58.333333
												mins	**1008.9667**
												days	**2.1020139**
												sec	60538

Assembly of a panel
The panel is simple a box fully filled with insulation. Two or more I joists form the height of the box, and C16 timbers form the end. I joists are repeated at 600mm centres.
Thick board, typically OSB, is fixed to the frame structure, typically nailed.
The board is turned over, if insulation is as batts then then batts are installed by placing them into the spaces. If insulation is blown then this happens after the second facing is attached.
The second facing is either airtightness membrane or internal boarding, dependant on intended use.
At present no electrical conduit, cladding connectors or other attachments are connected. to the faces of the board
In the first case the board will be attached to each other and the sole plates using nails. Alternative solution could be proprietry panel connectors.

Panel	**Wall panel 2.4m*0.6m**		**2400**	**600**								
Item	**Item name**	**Item name**	**Number of items**	**Symettry**			**Size**	**Thickness**	**Weight**	**Chamfer**	**One hand/ two hand**	**Total weight of parts**
				α	**β**	**Total**	**mm**		**/kg**			
1	240x45mm timber I-Joist flange (soft wood)	I joist	2	180	180	360	2400	240	12.24	None	two hand	24.48
2	240*44mm SW battens C16	C16	2	180	180	360	600	44	38.016	None	two hand	76.03
3	Screw	Screw	16	360	0	360	60	5	0.002			0.03
4	11mm 2440x1220 OSB3	OSB sheathing board	1	180	180	360	2400	18	15.552	None	two person	15.55
4a												0.00
5	Nail fixings	Nail fixings	60	360	0	360	60	<2	0.001		one hand	0.06
10	38x50mm treated SW battens	Cladding fixing batten(1)	2	180	180	360	2400	1	0.00456	None	Two hand	0.01
11	Screw	Screw	16	360	0	360	60	5	0.002			0.03
12	38x50mm treated SW battens	Cladding fixing batten (2)	2	180	180	360	600	1	0.018	None	Two hand	0.04
13	Screw	Screw	16	360	0	360	60	5	0.002			0.03
14	Western Red Cedar	Cladding	4	180	180	360	2400	19	1.628832	None	Two hand	6.52
15	Screw	Screw	16	360	0	360	60	5	0.002			0.03
6	Rockwool	Insulation	2	180	180	360	600	240	<2.5	None	Two hand	
7	Pro Clima Intello Plus	Airtightness membrane	1	360	90	450	2400	1	0.05	None	Two person	0.05
8	Tacks	Tacks	60	360	0	360	60	<2	0.001	None	One hand (multiples)	0.06
9	Tape	Tape	2	180	180	360	2400	1	0	None	Two hand	0.00
	44x69mm SW battens	Internal battens (vertical)	2	180	180	360	2400	38	2.736	None	Two hand	5.47
	44x69mm SW battens	Internal battens (horizontal)	2	180	180	360	500	38	0.57	None	Two hand	1.14
	Plasterboard	Plasterboard	1	180	180	360	2400	12.5	24.048	None	two person	24.05
	Total		**207**									**122.92**

Item	Item name		Number of items	Manual handling code	Handling time per item	Manual Insertion code	Insertion time per item	Total operation time	Figures for min. parts	Description	Total Part efficiency (Ea)
					s		s			Description	0.01
1	I joist		2	95	4	00	1.5	,	1	Place in to frame	
2	C16		2	95	4	00	1.5	11	0	Place along bottom and top of frame	
3	Screw		16	10	1.5	92	5	104	0	Screw timber and I joist together	
4	OSB sheathing board		1	95	4	00	1.5	5.5	0	Add	
4a											
5	Nail fixings		60	10	1.5	91	7	510	0	Nail fixings are inserted from above. Easy clearance	
10	Cladding fixing batten(1)		2	95	4	00	1.5	11	1	ix to the OSB prior to turning over (5-6	
11	Screw		16	10	1.5	92	5	104	0	Screw timber and I joist together	
12	Cladding fixing batten (2)		2	95	4	00	1.5	11	0	Fix to the OSB prior to turning over	
13	Screw		16	10	1.5	92	5	104	0	Screw timber and I joist together	
14	Cladding		4	95	4	00	1.5	22	1	Fix to the OSB prior to turning over	
15	Screw		16	10	1.5	92	5	104	0	Screw timber and I joist together	
6	Insulation		2	91	3	01	2.5	11	1	Turn over and insert	
7	Airtightness membrane		1	92	2	06	5.5	7.5	1	Lay over	
8	Tacks		60	11	1.8	91	7	528	0	Staple fixings are inserted from above . Easy clear ance	
9	Tape		2	92	1.8	91	7	17.6	0	Fix membrane	onsite
	Internal battens (vertical)		2	95	4	00	1.5	11	1	Fix to membrane and Joist	
	Internal battens (horizontal)		2								
	Plasterboard		1	95	4	00	1.5	5.5	1	Fix to battens	
	Total		**202**					**1550.6**	5		

Acquisition times for large size of components (booth royd pg 119)							Custom assembly					
Item	Item name		Number of items	Average distance to location of parts	Code	Size of largest part	Weight	Times	Total acquisition time		Total weight	
				m								
1	I joist		2	>3	50	2400	12.24	12.41	24.82		12.24	
2	C16		2	>3	50	600mm	38.016	12.41	24.82		38.016	
3	Screw		16	>3	04	5	0.002	0.84	13.44		0.002	
4	OSB sheathing board		1	>3	50	2400	15.552	40.8	40.8		15.552	
5	Nail fixings		60	>3	04	5	0.001	0.84	50.4		0.001	
6	Lift and turn over board			>3	53	2400	65.811	50.07	0		<2.5	
7	Insulation		2	>3	50	2400	<2.5	14.41	28.82		0.05	
8	Airtightness membrane		1	>3	50	2400	0.05	12.41	12.41		0.001	
9	Tacks		60	>3	04	15	0.001	0.84	50.4		0	
10	Cladding fixing batten(1)		2	>3	50	2400	0.00456	12.41	24.82		0.00456	
11	Screw		16	>3	04	5	0.002	0.84	13.44		0.002	
12	Cladding fixing batten (2)		2	>3	50	600	0.018	12.41	24.82		0.018	
13	Screw		16	>3	04	5	0.002	0.84	13.44		0.002	
14	Cladding		8	>3	50	2400	1.628832	12.41	99.28		1.628832	
15	Screw		32	>3	04	5	0.002	0.84	26.88		0.002	
	Total							**184.78**	**448.59**		**67.519392**	

Panel	Floor panel 4200m*600m		4200	600								
Item	Item name		Number of items	Symettry			Size	Thickness	Weight	Chamfer	Handling	wieght
				α	β	total	mm					
1	I joist		2	180	180	360	4200	240	21.42	None	Two handed	42.84
2	C16		2	180	180	360	600	38	8.208	None	Two handed	16.42
3	Screw		16	360	0	360	60	5	0.002	None	One handed	0.03
4	OSB sheathing board		5	180	180	360	4200	18	27.216	None	Two handed	136.08
5	Nail fixings		96	360	0	360	60	<2	0.001	None	One handed	0.10
6	Insulation		2	180	180	360	2400	240	<2.5	None	Two handed	
7	OSB sheathing board		5	180	180	360	2400	18	0.001	None	Two handed	0.01
8	Tacks		96	360	0	360	60	<2	0.0005	None	One handed	0.05
panel	Floor panel											195.52
Item	Item name		Number of items	Manual handling code	Handling time per item	Manual Insertion code	Insertion time per item	Total operation time	Figures for min. parts	Description		
					s		s					
1	I joist		2	95	4	00	1.5	11	1	Place in to frame		
2	C16		2	95	4	00	1.5	11	0	Place along bottom and top of frame		
3	Screw		16	10	1.5	92	5	104	0	Fix c16 timbers in place		
4	OSB sheathing board		5	95	4	00	1.5	27.5	0	Add		
5	Nail fixings		96	10	1.5	91	7	816	0	Nail fixings are inserted from above . Easy clear ance		
6	Insulation		2	91	3	01	2.5	11	1	Turn over and insert		
7	OSB sheathing board		5	95	4	00	1.5	27.5	0	Add		
8	Tacks		96	11	1.8	91	7	844.8	0	Staple fixings are inserted from above. Easy clearance		
	Total		**224**					**1852.8**	**2**			
Acquisition times for large size of components							**Custom assembly**					
Item	Item name		Number of items	Average distance to location of parts	Code	Size of largest part	Weight	Times	Total acquisition time		Total weight	
				m		in						
1	I joist		2	>3	50	>65	21.42	12.41	24.82		42.84	
2	C16		2	>3	50	>65	0.25992	12.41	24.82		0.51984	
3	Screw		16	>3	04	<4	0.002	0.84	13.44		0.032	
4	OSB sheathing board		5	>3	50	>65	27.216	12.41	62.05		136.08	
5	Nail fixings		96	>3	04	<4	0.001	0.84	80.64		0.096	
6	Lift and turn over board		1	>3	53	>65	205.77	50.07	50.07		179.56784	
7	Insulation		2	>3	50	>65	<2.5	14.41	28.82		2.5	
8	Airtightness membrane		5	>3	50	>65	0.001	50.07	250.35		0.005	kg
9	Tacks		96	>3	04	<4	0.0005	0.84	80.64		0.048	
	Total							154.3	615.65		182.12084	

Panel	Roof panel 2177*600		2177	600								
Item	Item name		Number of items	Symettry			Size	Thickness	Weight	Chamfer	Handling	Total weight of parts
				α	β	total	mm					
1	I joist (90*sw90)		2	180	180	360	2177	240	11.1027	None	No	22.21
2	C16		2	180	180	360	600	38	3.804	None	No	7.61
3	Screw		16	360	0	360	60	5	0.002	None	No	0.03
4	OSB sheathing board		2	180	180	360	2177	18	14.10696	None	No	28.21
	Nail fixings		56	360	0	360	60	<2	0.001	None	No	0.06
5	Insulation		2	180	180	360	2177	240	<2.5	None	No	
6	Airtightness membrane		1	360	90	450	2177	1	0.05	None	No	0.05
7	Tacks		56	360	0	360	60	<2	0.001	None	No	0.06
14	Cladding fixing batten(1)		2	180	180	360	2177	1	0.00293895	None	Two hand	0.01
3	Screw		8	360	0	360	60	5	0.002	None	No	0.02
15	Cladding fixing batten (2)		2	180	180	360	600	1	0.00081	None	Two hand	0.00
3	Screw		8	360	0	360	60	5	0.002	None	No	0.02
16	Cladding		4	180	180	360	2177	19	1.47748636	None	Two hand	5.91
3	Screw		16	360	0	360	60	5	0.002	None	No	0.03
												58.22
	Item name		Number of items	Manual handling code	Handling time per item	Manual Insertion code	Insertion time per item	Total operation time	Figures for min. parts	Description		
					s		s					
1	I joist		2	95	4	00	1.5	11	1	Place in to frame		
2	C16		2	95	4	00	1.5	11	0	Place along bottom and top of frame		
3	Screw		16	10	1.5	92	5	104	0	Fix c16 timbers in place		
4	OSB sheathing board		2	95	4	00	1.5	11	0	Add		
5	Nail fixings		56	10	1.5	91	7	476	0	Nail fixings are inserted from above . Easy clear ance		
6	Insulation		2	91	3	01	2.5	11	1	Turn over and insert		
7	Airtightness membrane		1	95	4	00	1.5	5.5	0	Add		
8	Tacks		56	11	1.8	91	7	492.8	0	Staple fixings are inserted from above . Easy clear ance		
14	Cladding fixing batten(1)		2	95	4	00	1.5	11	1	Fix to the OSB prior to turning over		
3	Screw		8	10	1.5	92	5	52	0	Fix c16 timbers in place		
15	Cladding fixing batten (2)		2	95	4	00	1.5	11	0	Fix to the OSB prior to turning over		
3	Screw		8	10	1.5	92	5	52	0	Fix c16 timbers in place		
16	Cladding		4	95	4	00	1.5	22	1	Fix to the OSB prior to turning over		
3	Screw		16	10	1.5	92	5	104	0	Fix c16 timbers in place		
	Total		**137**					**1122.3**	2			

Acquisition times for large size of components							Custom assembly					
Item	Item name		Number of parts	Average distance to location of parts	Code	Size of largest part	Weight	Times	Total acquisition time		Total weight	
				m								
1	I joist		2	>65in	50	>65	11.10	12.41	24.82		22.2054	
2	C16		2	>65in	50	>65	3.80	12.41	24.82		7.6080	
3	Screw		16	>65in	04	small part	0.00	0.84	13.44		0.0320	
4	OSB sheathing board		2	>65in	50	>65	14.11	12.41	24.82		28.2139	
5	Nail fixings		56	>65in	04	small part	0.00	0.84	47.04		0.0560	
6	Lift and turn over board		1	>65in	53	>65		50.07	50.07		0.0000	
7	Insulation		2	>65in	50	600	<2.5	14.41	28.82		2.0000	
8	Airtightness membrane		1	>65in	50	2400	0.05	12.41	12.41		0.0500	kg
9	Tacks		56	>65in	04	small part	0.00	0.84	47.04		0.0560	
10	Plasterboard		1	>65in	50		0.00				0.0029	
10	cladding fixing batten(1)		1	>65in	50	600mm	0.00	12.41	12.41		0.0020	
3	Screw		8	>65in	04	small part	0.00	0.84	6.72		0.0065	
11	cladding fixing batten (2)		1	>65in	50	2400	0.00	12.41	12.41		0.0020	
3	Screw		16	>65in	04	small part	1.48	0.84	13.44		23.6398	
12	cladding		36	>65in	50		0.00				0.0720	
3	Screw		0	>65in	04	small part	0.00	0.84	47.04		0.0000	
	Total							116.64	273.28		83.9465	
Panel	**Upper floor panel 4.2m*0.6m**		**4200**	**600**								

Item	Item name		Number of items	Symettry			Size	Thickness	Weight	Chamfer	One hand /two hand	Total weight of parts
				α	β	Total	mm		/kg			
1	I joist (90*sw90)		2	180	180	360	4200	240	21.42	None	two hand	42.84
2	C16		2	180	180	360	600	44	66.528	None	two hand	133.06
3	Screw		16	360	0	360	60	5	0.002			0.03
4	OSB sheathing board		5	180	180	360	4200	18	27.216	None	two person	136.08
5	Nail fixings		60	360	0	360	60	<2	0.001		one hand	0.06
6	Insulation		2	180	180	360	4200	240	<2.5	None	Two hand	
7	OSB sheathing board		5	180	180	360	4200	18	27.216	None	two person	136.08
8	Tacks		60	360	0	360	60	<2	0.001		One hand (multiples)	0.06
9	Plasterboard		2	180	180	360	4200	12.5	18.9	None	two hand	37.80
												486.01

Item	Item name		Number of items	Manual handling code	Handling time per item	Manual Insertion code	Insertion time per item	Total operation time	Figures for min. parts	Description	Total Part efficiency (Ea)
					s		s				0.01
1	I joist		2	95	4	00	1.5	11	1	Place in to frame	
2	C16		2	95	4	00	1.5	11	0	Place along bottom and top of frame	
3	Screw		16	10	1.5	92	5	104	0	Screw timber and I joist together	
4	OSB sheathing board		5	95	4	00	1.5	27.5	0	Add	
5	Nail fixings		60	10	1.5	91	7	510	0	Nail fixings are inserted from above. Easy clearance	
6	Insulation		2	91	3	01	2.5	11	1	Turn over and insert. Space is slightly constrined and enclosed but the insulation is flexible.	
7	OSB sheathing board		5	95	4	00	1.5	27.5	0	Add	
8	Tacks		60	10	1.5	92	5	390	0	Tacks are fitted from above	
9	Plasterboard		2	95	4	00	1.5	11	0	Sealed using glue	
	Total		87					674.5	2		

Acquisition times for large size of components (booth royd pg 119)							Custom assembly					
Item	***Item name***		***Number of items***	***Average distance to location of parts***	***Code***	***Size of largest part***	***Weight***	***Times***	***Total acquisition time***		***Total weight***	
				m								
1	*I joist*		2	>3	50	2400	21.42	12.41	24.82		21.42	
2	*C16*		2	>3	50	600mm	66.528	12.41	24.82		66.528	
3	*Screw*		16	1.5	04	5	0.002	0.84	13.44		0.002	
4	*OSB sheathing board*		5	>3	50	2400	27.216	40.8	204		27.216	
5	*Nail fixings*		60		04	5	0.001	0.84	50.4		0.001	
6	*Lift and turn over board*			0	53	2400	115.167	50.07	0			
7	*Insulation*		2	>3	50	2400	<2.5	14.41	28.82		<2.5	
7	*OSB sheathing board*		5	>3	50	2400	27.216	12.41	62.05		27.216	
8	*Tacks*		60		04	15	0.001	0.84	50.4		0.001	
9	*Plasterboard*		2	>3	50	2400	18.9	12.41	24.82		18.9	
	Total							157.44	483.57			

Assembly of a panel

The panel is simple a box fully filled with insulation. Two or more I joists form the height of the box, and C16 timbers form the end. I joists are repeated at 600mm centres.
Thick board, typically OSB, is fixed to the frame structure, typically nailed.
The board is turned over, if insulation is as batts then then batts are installed by placing them into the spaces. If insulation is blown then this happens after the second facing is attached.
The second facing is either airtightness membrane or internal boarding, dependant on intended use.
At present no electrical conduit, cladding connectors or other attachments are connected. to the faces of the board
In the first case the board will be attached to each other and the sole plates using nails. Alternative solution could be proprietry panel connectors.

Panel	Wall panel 2.4m*1.2m	2400	1200								
Item	Item name	Number of items	Symettry			Siize	Thickness	Weight	chamfer	One hand /two hand	total weight of parts
			α	β	total	mm		/kg			
1	I joist (90*sw90)	3	180	180	360	2400	240	12.24	None	Two hand	36.72
2	C16	2	180	180	360	1200	38	6.5664	None	Two hand	13.1328
3	Screw	16	360	0	360	60	5	0.002		one hand	0.032
4	OSB sheathing board	1	180	180	360	2400	18	15.552	None	Two person	15.552
5	Nail fixings	96	360	0	360	60	<2	0.001		One hand	0.096
10	Cladding fixing batten(1)	3	180	180	360	2400	38	2.736	None	Two hand	8.208
11	Screw	16	360	0	360	60	5	0.002		One hand	0.032
12	Cladding fixing batten (2)	2	180	180	360	1200	38	0.06156	None	Two hand	0.12312
13	Screw	16	360	0	360	60	5	0.002		One hand	0.032
14	Cladding	8	180	180	360	2400	19	1.628832	None	Two hand	13.030656
15	Screw	16	360	0	360	60	5	0.002		One hand	0.032
6	Insulation	4	180	180	360	600	240	<2.5	None	Two hand	
7	Airtightness membrane	1	360	90	450	2400	1	0.05	None	Two person	0.05
8	Tacks	96	360	0	360	60	<2	0.001		One hand (mu	0.096
9	Tape		180	180	360	2400	1	0	None	Two hand	0
	Internal battens (vertical)	2	180	180	360	2400	38	2.736		Two hand	5.472
	Internal battens (horizontal)	2	180	180	360	1100	38	1.254		Two hand	
	Plasterboard	1	180	180	360	2400	12.5	24.048		Two person	24.048
	Total	**280**					**653**	**38.844792**			

Item	Item name	Number of items	Manual handling code	Handling time per item	Manual Insertion code	Insertion time per item	Total operation time	Figures for min. parts		Total Part efficiency (Ea)
				s		s			Description	0.008141849
1	I joist (90*sw90)	3	95	4	00	1.5	16.5	1	Place in to frame	
2	C16	2	95	4	00	1.5	11	0	Place along bottom and top of frame	
3	Screw	16	10	1.5	92	5	104	0	Fix c16 timbers in place	
4	OSB sheathing board	1	95	4	00	1.5	5.5	0	Add	
5	Nail fixings	96	10	1.5	91	7	816	0	Nail fixings are inserted from above . Easy clear ance	
10	Cladding fixing batten(1)	3	95	4	00	1.5	16.5	1	ix to the OSB prior to turning ove	
11	Screw	16	10	1.5	92	5	104	0	Fix c16 timbers in place	
12	Cladding fixing batten (2)	2	95	4	00	1.5	11	0	ix to the OSB prior to turning ove	
13	Screw	16	10	1.5	92	5	104	0	Fix c16 timbers in place	
14	Cladding	8	95	4	00	1.5	44	1	ix to the OSB prior to turning ove	
15	Screw	16	10	1.5	92	5	104	0	Fix c16 timbers in place	
6	Insulation	4	91	3	01	2.5	22	1	Turn over and insert. Must be pushed into frame. If solid, this will be more difficult	
7	Airtightness membrane	1	92	2	06	5.5	7.5	1	Lay over	
8	Tacks	96	11	1.8	91	7	844.8	0	Staple fixings are inserted from above . Easy clear ance	
9	Tape	0	92	1.8	91	7	0	1	Fix membrane	
	Internal battens (vertical)	4	95	4	00	1.5	22	1	Fix to membrane and Joist	
	Plasterboard	1	95	4	00	1.5	5.5	1	Fix to battens	
	Total	**280**					**2210.8**	**6**		

Acquisition times for large size of components						Custom assembly					
Item	Item name	Number of items	average distancew to location of parts	Code	size of largest part	weight	times	total acquisition time		Weight	
			m							/kg	
1	I joist	3	>3	50	2400	12.24	12.41	37.23		12.24	
2	C16	2	>3	50	1200	6.5664	12.41	24.82		6.5664	
3	Screw	16	>3	04	5	0.002	0.84	13.44		0.002	
4	OSB sheathing board	1	>3	50	2400	15.552	40.8	40.8		15.552	
5	nail fixings	96	>3	04	5	0.001	0.84	80.64		0.001	
6	board		>3	53	2400	34.3614	50.07	0		<2.5	
7	insulation	4	>3	50	600	<2.5	14.41	57.64		0.05	
8	membrane	1	>3	50	2400	0.05	12.41	12.41		0.001	
9	tacks	96	>3	04	15	0.001	0.84	80.64		0	
10	batten(1)	0	>3	50	2400	2.736	12.41	0		2.736	
11	Screw	16	>3	04	5	0.002	0.84	13.44		0.002	
12	(2)	3	>3	50	1200	0.06156	12.41	37.23		0.06156	
13	Screw	16	>3	04	5	0.002	0.84	13.44		0.002	
14	cladding	16	>3	50	2400	1.628832	12.41	198.56		1.628832	
15	Screw	64	>3	04	5	0.002	0.84	53.76		0.002	
	Total							**664.05**	**0**		

Panel	Floor panel 2.0m*1.2m	4200	1200								
Item	Item name	Number of items	Symettry			Siize	Thickness	Weight	chamfer		weight
			α	β	total	mm					
1	I joist	3	180	180	360	4200	240	21.42			64.26
2	C16	2	180	180	360	1200	38	1.03968			2.07936
3	Screw	16	360	0	360	60	5	0.002	None	One handed	0.032
4	OSB sheathing board	2	180	180	360	2400	18	31.104			62.208
5	nail fixings	150	360	0	360	60	5	0.002	None	One handed	0.3
7	insulation	4	360	90	450	240	240	<2.5			
8	OSB sheathing board	2	180	180	360	2400	18	31.104			62.208
9	tacks	150	360	0	360	60	<2	0.001			0.15
panel	Floor panel										191.23736
Item	Item name	Number of items	Manual handling code	Handling time per item	Manual Insertion code	Insertion time per item	Total operation time	Figures for min. parts	Description		
				s		s					
1	I joist	3	95	4	00	1.5	16.5	1	Place in to frame		
2	C16	2	95	4	00	1.5	11	0	Place along bottom and top of frame		
3	Screw	16	10	1.5	92	5	104	0	Fix c16 timbers in place		
4	OSB sheathing board	1	95	4	00	1.5	5.5	0	Add		
5	Nail fixings	150	10	1.5	91	7	1275	0	Nail fixings are inserted from above . Easy clear ance		
6	Insulation	4	91	3	01	2.5	22	1	Turn over and insert		
7	OSB sheathing board	1	95	4	00	1.5	5.5	0	Add		
8	Tacks	150	11	1.8	91	7	1320	0	Staple fixings are inserted from above . Easy clear ance		
	Total	**327**					**2759.5**	**2**			
		Acquisition times for large size of components					**Custom assembly**				
Item	Item name	Number of items	average distance to location of parts	Code	size of largest part	weight	times	total time			
			m								
1	I joist	3	>3	50	>65in	21.42	12.41	37.23		64.26	
2	C16	2	>3	50	>65in	0.25992	12.41	24.82		0.51984	
	Screw	16	>3	04		0.002	0.84	13.44		0.032	
3	OSB sheathing board	1	>3	50	>65in	31.104	12.41	12.41		31.104	
	nail fixings	150	>3	04		0.002	0.84	126		0.3	
	Lift and turn over board		>3	53	>65in	213.9	50.07			0	
4	insulation	4	>3	50	600	<2.5	14.41	57.64		2.5	
5	airtightness membrane	1	>3	50	2400	31.104	50.07	50.07		31.104	
6	tacks	150	>3	04	5	0.001	0.84	126		0.15	
	Total						154.3	447.61			

Panel	Roof panel 4.2*1.2	2177	1200								
Item	Item name	Number of items	Symettry			Siize	Thickness	Weight		chamfer	total weight of parts
			α	β	total	mm					
1	I joist (90*sw90)	3	180	180	360	2177	240	11.1027			33.3081
2	C16	2	180	180	360	1200	38	1.03968			2.07936
3	Screw	16	360	0	360	60	5	0.002			0.032
4	OSB sheathing board	2	180	180	360	2400	18	31.104			62.208
5	nail fixings	67.54	360	0	360	60	<2	0.001			0.06754
6	insulation	4	180	180	360	600	240				
7	airtightness membrane	2	360	90	450	2400	1	0.05			0.1
8	tacks	67.54	360	0	360	60	<2	0.001			0.06754
9	cladding fixing batten(1)	4	180	180	360	2177	1	0.00293895	None	Two hand	0.0117558
10	Screw	16	360	0	360	60	5	0.002	None	No	0.032
11	cladding fixing batten (2)	2	180	180	360	1200	1	0.00162	None	Two hand	0.00324
12	Screw	8	360	0	360	60	5	0.002	None	No	0.016
13	cladding	8	180	180	360	2177	19	1.47748636	None	Two hand	11.81989088
14	Screw	32	360	0	360	60	5	0.002	None	No	0.064
											109.8094267
	Item name	Number of items	Manual handling code	Handling time per item	Manual Insertion code	Insertion time per item	Total operation time	Figures for min. parts	Description		
				s		s					
1	I joist	3	95	4	00	1.5	16.5	1	Place in to frame		
2	C16	2	95	4	00	1.5	11	0	Place along bottom and top of		
3	Screw	16	10	1.5	92	5	104	0	Fix c16 timbers in place		
4	OSB sheathing board	2	95	4	00	1.5	11	0	Add		
5	nail fixings	67.54	10	1.5	91	7	574.09	0	Nail fixings are inserted from above . Easy clear ance		
6	insulation	4	91	3	01	2.5	22	1	Turn over and insert		
7	airtightness membrane	2	95	4	00	1.5	11	0	Add		
8	tacks	67.54	11	1.8	91	7	594.352	0	Staple fixings are inserted from above . Easy clear ance		
13	cladding fixing batten(1)										
3	Screw	16	10	1.5	92	5	104	0	Fix c16 timbers in place		
14	cladding fixing batten (2)										
3	Screw	8	10	1.5	92	5	52	0	Fix c16 timbers in place		
15	cladding										
3	Screw	32	10	1.5	92	5	208	0	Fix c16 timbers in place		
	Total	**164.08**					**1343.942**	**2**			

Acquisition times for large size of components						Custom assembly					
Item	Item name	Number of parts	average distance to location of parts	Code	size of largest part	weight	times	total acquisiyion time		total weight	
			m								
1	I joist	3	1.5		>65in		12.41	37.23		48.96	
2	C16	2	1.5		>65in		12.41	24.82		22.824	
3	Screw	16	1.5				0.84	13.44		0.032	
4	OSB sheathing board	2	1.5		>65in		12.41	24.82		93.312	
5	nail fixings	67.54	1.5				0.84	56.7336			
6	Lift and turn over board	1			>65in		50.07	50.07		0.05	
7	insulation	4	1.5		600		14.41	28.82		0.056	
8	airtightness membrane	2	1.5		2400		14.41	28.82		0	165.234
9	tacks	67.54	1.5				0.84	56.7336			
10	cladding fixing batten(1)		>65in								
3	Screw	8	1.5				0.84	6.72		0.032	
11	cladding fixing batten (2)		>65in								
3	Screw	32	1.5				0.84	26.88		0.032	
12	cladding		>65in								
3	Screw	0	1.5				0.84	0		0.032	
	Total						118.64	321.4872			
Panel	**Wall panel 2.4m*1.2m**	**2400**	**1200**								

Item	Item name	Number of items	Symettry			Siize	Thickness	Weight	chamfer	One hand /two hand	total weight of parts
			α	β	total	mm		/kg			
1	I joist (90*sw90)	3	180	180	360	2400	240	12.24	None	two hand	36.72
2	C16	2	180	180	360	1200	38	6.5664	None	two hand	13.1328
	Screw	16	360	0	360	60	5	0.002			0.032
3	OSB sheathing board	1	180	180	360	2400	18	15.552	None	two person	15.552
	nail fixings	96	360	0	360	60	<2	0.001		one hand	0.096
4	insulation	4	180	180	360	600	240	<2.5	None	Two hand	
3	OSB sheathing board	1	180	180	360	2400	18	15.552	None	two person	15.552
6	tacks	96	360	0	360	60	<2	0.001		One hand (mu	0.096
12	Plasterboard		1200	180	180	360	1200	12.5	0	None	two hand
Item	**Item name**	**Number of items**	**Manual handling code**	**Handling time per item**	**Manual Insertion code**	**Insertion time per item**	**Total operation time**	**Figures for min. parts**			**Total Part efficiency (Ea)**
				s		s			**Description**		**0.006153846**
1	I joist	3	95	4	00	1.5	16.5	1	Place in to frame		
2	C16	2	95	4	00	1.5	11	0	Place along bottom and top of frame		
	Screw	16	10	1.5	92	5	104	0	Fix c16 timbers in place		
3	OSB sheathing board	1	95	4	00	1.5	5.5	0	Add		
	nail fixings	96	10	1.5	91	7	816	0	Nail fixings are inserted from above . Easy clear ance		
4	insulation	4	91	3	01	2.5	22	1	Turn over and insert. Must be pushed into frame. If solid, this will be more difficult		
	OSB sheathing board	1	180	95	4	00	1.5	990	0	Add	
	Tacks	96	360	10	1.5	92	5	2340	0	Tacks are fitted from above	
	Plasterboard		1200	95	4	00	1.5	6600	0	Sealed using glue	
	Total	**122**					**975**	**2**			

Acquisition times for large size of components						Custom assembly					
Item	Item name	Number of items	average distancew to location of parts	Code	size of largest part	weight	times	total acquisition time			
			m								
1	I joist	3	1.5		>65in	12.24		12.41			
2	C16	2	1.5		>65in	6.5664		12.41			
	Screw	16	1.5			0.002		1.11			
3	OSB sheathing board	1	1.5		>65in	15.552		12.41			
	nail fixings	96	1.5			0.001					
	Lift and turn over board				>65in			50.07			
4	insulation	4	1.5			<2.5					
3	airtightness membrane	1	1.5		>65in	15.552		12.41			
6	tacks	96	1.5			0.001		1.11			
9	Plasterboard	1	180	>3	50	2400	None	12.41	2233.8		
	Total							101.93			

Summary					
Lifting panels into place on site	**Summary**	**600**	**1200**	**1800**	**2400**
	mins	1386.0	2903.0	1893.0	1784.0
	hours	23.1	48.4	31.6	29.7
	days	2.9	6.0	3.9	3.7
	Persons	**4**	**2**	**2**	**2**
	total labour (s)	**332640.00**	**348360.00**	**227160.00**	**214080.00**

sealing rate	10000	mm/min		
Sealing time	Width	wall	floor /ceiling	roof
600	600	2400	4200	2177
1200	1200	2400	4200	2177
1800	1800	2400	4200	2177
2400	2400	2400	4200	2177

Sealing	Wall length		floor/ceiling length		roof length		number of panels														
							wall	floor	roof	roof gable	upper floo	ceiling	internal wa	wall	floor	roof	roof gable	upper floo	ceiling	internal wall	
	Sealing length	Sealing time/ mins	Sealing length	Sealing time/ mins	Sealing length	Sealing time/															
600	4800	0.48	8400	0.84	4354	0.4354	76	12	24	14	12	12	37	36.48	10.08	10.4496	6.72	10.08	10.08	17.76	101.6496
1200	4800	0.48	8400	0.84	4354	0.4354	40	6	12	8	6	6	20	19.2	5.04	5.2248	3.84	5.04	5.04	9.6	52.9848
1800	4800	0.48	8400	0.84	4354	0.4354	28	4	8	6	4	4	14	13.44	3.36	3.4832	2.88	3.36	3.36	6.72	36.6032
2400	4800	0.48	8400	0.84	4354	0.4354	20	3	6	4	3	3	11	9.6	2.52	2.6124	1.92	2.52	2.52	5.28	26.9724

	setup fixing etc /s	Sealing	**total /s**		hours	
600	332640.00	6098.976	**338738.98**		94.09416	3.09927
1200	348360.00	3179.088	**351539.09**		97.64974667	6.158302
1800	227160.00	2196.192	**229356.19**		63.71005333	4.020007
2400	214080.00	1618.344	**215698.34**		59.91620667	3.772859

Summary		**Person hours for assembling house on site**		
hours				
		Lifting pan	**Sealing panels**	**Total**
600		**3.33E+05**	**3.66E+05**	**6.99E+05**
1200		**3.48E+05**	**1.91E+05**	**5.39E+05**
1800		**2.27E+05**	**1.32E+05**	**3.59E+05**
2400		**2.14E+05**	**9.71E+04**	**3.11E+05**

Blown Insulation

Double power input	2			
Voltage	120	V		
Amp	14	Amp		
Power	3.36	kW		
Blowing rate	952	kg/hr	35.26	m3/hr
Hopper capacity	0.35	m3		
	Wall	Floor	Roof	ceiling
setting up time	2.5	2.5	5	3
Sealing	2.5	2.5	2.5	2.5
total	5	5	7.5	5.5

Generic house

	number of panels								
	Wall	Floor	Roof	Roof gable	Upper floor	Ceiling	Volume	mass	
600	76.00	12.00	23.00	16.00	12.00	12.00	17.57	474.52	
1200	36.00	6.00	11.00	8.00	6.00	6.00	17.26	466.06	
1800	24.00	4.00	7.00	6.00	4.00	4.00	17.34	468.08	
2400	16.00	3.00	5.00	4.00	3.00	3.00	16.63	449.13	
	2400	4200	2177	1348.526564	4200			m3	

filling hopper	Volume	number of fills	time per fill
600	17.6	50.21	0.00
1200	17.3	49.32	0.00
1800	17.3	49.53	0.00
2400	16.6	47.53	0.00

	set up time /hr				
	Wall	Floor	Roof	ceiling	total
600	0.053	0.008	0.016	0.011	0.088
1200	0.050	0.008	0.015	0.011	0.085
1800	0.050	0.008	0.015	0.013	0.085
2400	0.044	0.008	0.014	0.011	0.078

	sealing time /hr				
	Wall	Floor	Roof	ceiling	total
600	0.053	0.008	0.016	0.011	0.088
1200	0.050	0.008	0.015	0.011	0.085
1800	0.050	0.008	0.015	0.013	0.085
2400	0.044	0.008	0.014	0.011	0.078

	Pumping time /hr	fill time	set up time /hr	sealing time /hr	Total time	Total power kW/hr
600	0.50	0.21	0.088	0.088	0.884	1.67
1200	0.490	0.21	0.085	0.085	0.864	1.64
1800	0.492	0.21	0.085	0.085	0.869	1.65
2400	0.472	0.20	0.078	0.078	0.825	1.59

EM430-400V/9.5kW http://www.warmcel.co.uk/wp-content/uploads/2015/05/EM400-en.pdf

Double power input						
Voltage	0			V		
Amp	0			Amp		
Power	9.5			kW		
Blowing rate	12150			kg/hr	450	m3/hr
Hopper capacity	0.35			m3		
	Wall			Floor	Roof	ceiling
setting up time	2.5			2.5	5	3
Sealing	2.5			2.5	2.5	2.5
total	5			5	7.5	5.5

Generic house

	number of panels								
	Wall			Floor	Roof	ceiling		Volume	mass
600.00	38.00			11.00	24.00	24.00		18.84	508.60
1200.00	20.00			6.00	12.00	12.00		19.44	524.93
1800.00	15.00			5.00	9.00	9.00		22.78	615.04
2400.00	10.00			3.00	6.00	6.00		19.44	524.93
							total		m3

filling hopper	Volume			number of	time per fill
600	18.84			53.82	0.00
1200	19.44			55.55	0.00
1800	22.78			65.08	0.00
2400	19.44			55.55	0.00

	set up time /hr						
	Wall			Floor	Roof	ceiling	total
600	0.026			0.008	0.017	0.017	0.000
1200	0.028			0.008	0.017	0.017	0.067
1800	0.031			0.010	0.019	0.019	0.069
2400	0.028			0.008	0.017	0.017	0.079

	sealing time /hr						
	Wall			Floor	Roof	ceiling	total
600	0.026			0.008	0.017	0.017	0.000
1200	0.028			0.008	0.017	0.017	0.067
1800	0.031			0.010	0.019	0.019	0.069
2400	0.028			0.008	0.017	0.017	0.079

	Pumping time /hr			fill time	set up tim	sealing tim	Total time	Total power kW/hr
600	0.04			0.22	0.000	0.000	0.000	0.40
1200	0.04			0.23	0.067	0.067	0.266	0.41
1800	0.05			0.27	0.069	0.069	0.409	0.48
2400	0.04			0.23	0.079	0.079	0.461	0.41

Crane manoevering

Average panel weight (closed)	kg
600	158
1200	49
1800	69
2400	6124120

	No of panels
600	147
1200	69
1800	45
2400	30

Distance moved	
length (Average distance to middle of the building)	7000
Height (roof level)	4800
Diagonal	8487.6
Half diagonal	4243.8

Lifting force	Nm	MNm
600	9.68E+05	968.19
1200	1.40E+05	140.05
1800	1.29E+05	129.50
2400	7.64E+09	7640959.52

Assembly of fabric

Onsite constrution of the building requires the following:
1) Foundations are already inplace and initial ground works have been completed. Electricity and ground water supply are ready to be connected to.
2) Steel frame is in place on the foundations and levelled. Frame is lifted into place using crane.
3) Install DPM.
4) Floor panel lifted into position. Depending on size either using crane or hand balling.
5) Sole plate fixed to floor panels. Sole plate levelled.
6) Wall panels, lifted into position. Panel positioned using props. Wall panels surveyed and levelled, then fixed together using nails or screw. Panels fixed to floor and to each other. Ground floof completed.
7) Headbinder attached to ground floor panels
8) Install floor hangers, (done in factory?)
9) Install ceiling panels.
10) Repeat 6-9 for first floor panels and ceiling.
11) Install roof trusses at spacing of 600mm
12)Install roof panels
13)Install cladding

Assembly times based on component properties

Panel	Building fabric	2400	600								
Item	Item name	Number of items	Symettry α	β	total	Size mm	Thickness	Weight /kg	chamfer	One hand /two hand	total weight of parts
	Steel frame	16	360	360	720	4200	240	1000		Crane	16000
	DPM	1	90	180	270	4200	2	268128		2 hands	268128
	Floor panel	12.00	360	180	540	600	240	1.83E-06		2persons	2.1906E-05
	Sole plate	10	180	180	360	2400	38	13.1328			131.328
	Wall panels	75.00	360	360	720	600	240	1.17E-05		2persons	0.000878489
	Head binder	10	180	180	360	2400	38	13.1328			131.328
	Upperfloor panels	12.00	360	180	540	600	240	1.75E-06		2persons	2.09569E-05
	Roof gable	14.00	360	360	720			1.87E-06			
	Ceiling panels	12.00	360	180	540	600	240	1.75E-06		2persons	2.09569E-05
	Head binder	10	180	180	360	2400	38	13.1328			131.328
	Roof trusses	12	360	360	720	4200	90	0		Crane	0
	Roof panels	22	360	360	720	600	240	3.17E-06		Crane	6.97139E-05
	Cladding		180	180	360	4000	19	2.0216		Two hands	0
	Glulam portal	12	180	180	360	5000	240	65		Crane	780

Item	Item name	Number of items	Manual handling code	Handling time per item s	Manual Insertion code	Insertion time per item s	Total operation time	Figures for min. parts	Description	Total Part efficiency (Ea) 0.016666667
	Steel frame	16	99	9	37	7	256	16	Installed by professional contractors. Assumed to be a simple box frame with cross members at the first floor level	
	DPM	1	99	9			9	1	Installed below panels	
	Floor panel	12	99	9	38	6	180	1	Panels hand balled into position. No restriction of access for insertion	
	Sole plate	10	99	9	38	6	150	1	Placed on steel frame. No restriction in access	
	Wall panels	76	99	9	6	6.5	1178	4	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and securded	
	Head binder	10	99	9	38	6	150	1	Placed and fixed to top of wall panels . No restriction in access	
	Upperfloor panels	12	99	9	48	8.5	210	1	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Roof gable	14	99	9	38	6	210	2	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Ceiling panels	12	99	9	38	6	180	1	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Head binder	10	99	9	38	6	150	1	Placed and fixed to top of wall panels . No restriction in access	
	Roof trusses	12	99	9	38	6	180	12	Crane into place, secured using nail pates.	
	Roof panels	24	99	9	38	6	360	2	Craned into position because of working at height.	
	Cladding	12	94	20	38	15	420			
	Glulam portal	12								

600		weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
Floor panel	12.00	59.78	0	240	0	7000	25	280	280	3360	56
Wall panels	75.00	36.33	0	240	0	7000	25	280	280	21000	350
Upper floor	12.00	57.88	0	240	0	7000	25	280	280	3360	56
Ceiling panels	12.00	50.27	0	240	0	7000	25	280	280	3360	56
Roof gable	10.00	23.75	1	240	240	7000	100	70	550	5500	92
Roof trusses	12	100.00	4	240	960	7000	100	70	1990	23880	398
Roof panels	22	33.66	2	240	480	7000	100	70	1030	22660	378
										83120	1386
	155.00										

total per building	1386	mins
total per building	23.10	hours
	2.89	days

crane cost 1342 per day

kg	lbs
1	0.45

0.0625	1.5875	0.15875

Assembly of a panel

The panel is simple a box fully filled with insulation. Two or more I joists form the height of the box, and C16 timbers form the end. I joists are repeated at 600mm centres.
Thick board, typically OSB, is fixed to the frame structure, typically nailed.
The board is turned over, if insulation is as batts then then batts are installed by placing them into the spaces. If insulation is blown then this happens after the second facing is attached (could be on site or in the factory) .
The second facing is either airtightness membrane or internal boarding, dependant on intended use.

At present no electrical conduit, cladding connectors or other attachments are connected. to the faces of the board
In the first case the board will be attached to each other and the sole plates using nails. Alternative solution could be proprietry panel connectors.

Assembly times based on component properties

Panel	Wall panel 2.4m*1.2m	2400	1200								
Item	Item name	Number of items	Symettry α	β	total	Siize mm	Thickness	Weight /kg	chamfer	One hand /two hand	total weight of parts
	Steel frame	16	360	360	720	4200	240	1000		Crane	16000
	DPM	1	90	180	270	4200	2	268128		2 hands	268128
	Floor panel	6.00	360	180	540	1200	240	#REF!		Crane	#REF!
	Sole plate	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Wall panels	40.00	360	180	540	1200	240	#REF!		2persons	#REF!
	Head binder	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Upperfloor panels	12.00	360	360	720	600	240	#REF!		2persons	#REF!
	Roof gable	7.00	360	180	540	2400	240	#REF!		Crane	#REF!
	Ceiling panels	12.00	360	360	720	600	240	#REF!		2persons	#REF!
	Head binder	10	180	180	360	2400	38	13.1328		Two hands	131.328
	Roof trusses	12	360	360	720	4200	90	0		Crane	0
	Roof panels	12.00	360	360	720	600	240	#REF!		Crane	#REF!
	Cladding		180	180	360	4000	19			Two hands	0
	glulam portal										

Item	Item name	Number of items	Manual handling code	Handling time per item s	Manual Insertion code	Insertion time per item s	Total operation time	Figures for min. parts	Description	Total Part efficiency (Ea) 0.000466019
	Steel frame	16	99	9	craning	7	256	16		
	DPM	1	92	2			2	1		
	Floor panel	5	Craning	1200	Craning	87.5	6437.5	1		
	Sole plate	10	99	9	38	6	150	4		
	Wall panels	32	Craning	1200	Craning	87.5	41200	4		
	Head binder	10	99	9	38	6	150	4		
	Upperfloor panels	5	Craning	1200	Craning	87.5	6437.5	4		
	Roof gable	6	Craning	1200	Craning	87.5	7725	2		
	Ceiling panels	5	Craning	1200	Craning	87.5	6437.5	1		
	Head binder	10	99	9	38	6	150	4		
	Roof trusses	12	Craning	1200	Craning	87.5	15450	12		
	Roof panels	10	Craning	1200	Craning	87.5	12875	2		
		0					0			
	Cladding	16	94	3			48			
	glulam portal	0								

			weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
	Floor panel	6.00	1.22E+02	5	240	1200	7000	80	87.5	2487.5	14925	249
	Wall panels	40.00	6.78E+01	3	240	720	7000	80	87.5	1527.5	61100	1019
	Ceiling panels	12.00	9.20E+01	4	240	960	7000	80	87.5	2007.5	24090	402
	Upperfloor panels	12.00	9.20E+01	4	240	960	7000	80	87.5	2007.5	24090	402
	roof gable	7.00	3.66E+01	2	240	480	7000	80	87.5	1047.5	7332.5	123
	Roof trusses	12	100	4	240	960	7000	80	87.5	2007.5	24090	402
	Roof panels	12	6.29E+01	3	240	720	7000	80	87.5	1527.5	18330	306
											173957.5	2900

total per building	2903
total per building	48.38333333
	6.047916667

crane cost 1342
8116.304167

Assembly of a panel

The panel is simple a box fully filled with insulation. Two or more I joists form the height of the box, and C16 timbers form the end. I joists are repeated at 600mm centres.
Thick board, typically OSB, is fixed to the frame structure, typically nailed.
The board is turned over, if insulation is as batts then then batts are installed by placing them into the spaces. If insulation is blown then this happens after the second facing is attached (could be on site or in the factory) .
The second facing is either airtightness membrane or internal boarding, dependant on intended use.

At present no electrical conduit, cladding connectors or other attachments are connected. to the faces of the board
In the first case the board will be attached to each other and the sole plates using nails. Alternative solution could be proprietry panel connectors.

Assembly times based on component properties

Panel	Wall panel 2.4m*1.8m	2400	1800								
Item	Item name	Number of items	Symettry α	β	total	Siize mm	Thickness	Weight /kg	chamfer	One hand /two hand	total weight of parts
	Steel frame	1	360	360	720	4200	240	1000		Crane	1000
	DPM	1	90	180	270	4200	2	268128		2 hands	268128
	Floor panel	4.00	360	180	540	1200	240	#REF!		Crane	#REF!
	Sole plate	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Wall panels	28.00	360	180	540	1200	240	#REF!		2persons	#REF!
	Head binder	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Upperfloor panels	4.00	360	360	720	600	240	#REF!		2persons	#REF!
	Roof gable	5.00	360	180	540	2400	240	#REF!		Crane	#REF!
	Ceiling panels	4.00	360	360	720	600	240	#REF!		2persons	#REF!
	Head binder	10	180	180	360	2400	38	13.1328		Two hands	131.328
	Roof trusses	90	360	360	720	4200	90	#REF!		Crane	#REF!
	Roof panels	4.00	360	360	720	600	240	1.55E+02		Crane	621.2219161
	Cladding		180	180	360	4000	19			Two hands	0
	glulam portal										

Item	Item name	Number of items	Manual handling code	Handling time per item s	Manual Insertion code	Insertion time per item s	Total operation time	Figures for min. parts	Description	Total Part efficiency (Ea) 0.002005013
	Steel frame	1	99	9	craning	7	16	16	Installed by professional contractors. Assumed to be a simple box frame with cross members at the first floor level	
	DPM	1	92	2			2	1	Installed below panels	
	Floor panel	3	Craning	480	Craning	18.75	1496.25	1	Panels hand balled into position. No restriction of access for insertion	
	Sole plate	10	99	9	38	6	150	1	Placed on steel frame. No restriction in access	
	Wall panels	20	Craning	480	Craning	18.75	9975	4	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and securded	
	Head binder	10	99	9	38	6	150	1	Placed and fixed to top of wall panels . No restriction in access	
	Upperfloor panels	3	Craning	480	Craning	18.75	1496.25	1	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Roof gable	4	Craning	480	Craning	18.75	1995	2	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Ceiling panels	3	Craning	480	Craning	18.75	1496.25	1	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Head binder	10	99	9	38	6	150	1	Placed and fixed to top of wall panels . No restriction in access	
	Roof trusses	12	Craning	480	Craning	18.75	5985	12	Crane into place, secured using nail pates.	
	Roof panels	6	Craning	480	Craning	18.75	2992.5	2	Craned into position because of working at height.	
		0								
	Cladding	20	94	3						
	glulam portal	0								

				weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
		Floor panel	3	1.79E+02	8	240	1920	7000	60	116.6666667	3956.666667	11870	198
		Wall panels	20	9.93E+01	4	240	960	7000	60	116.6666667	2036.666667	40733.33333	679
		Ceiling panels	3	1.34E+02	6	240	1440	7000	60	116.6666667	2996.666667	8990	150
		Upperfloor panels	3	1.34E+02	6	240	1440	7000	60	116.6666667	2996.666667	8990	150
		roof gable	4	6.58E+01	3	240	720	7000	60	116.6666667	1556.666667	6226.666667	104
		Roof trusses	12	100	4	240	960	7000	60	116.6666667	2036.666667	24440	408
		Roof panels	6	9.22E+01	4	240	960	7000	60	116.6666667	2036.666667	12220	204
mins										total per building	1893	mins	
mins (check)										total per building	31.55	hours	
hours											3.94375	days	
per day										crane cost	1342	per day	
											5292.5125		

Assembly of a panel

The panel is simple a box fully filled with insulation. Two or more I joists form the height of the box, and C16 timbers form the end. I joists are repeated at 600mm centres.
Thick board, typically OSB, is fixed to the frame structure, typically nailed.
The board is turned over, if insulation is as batts then then batts are installed by placing them into the spaces. If insulation is blown then this happens after the second facing is attached (could be on site or in the factory) .
The second facing is either airtightness membrane or internal boarding, dependant on intended use.

At present no electrical conduit, cladding connectors or other attachments are connected. to the faces of the board
In the first case the board will be attached to each other and the sole plates using nails. Alternative solution could be proprietry panel connectors.

Assembly times based on component properties

Panel	Wall panel 2.4m*1.8m	2400	2400								
Item	Item name	Number of items	Symettry α	β	total	Siize mm	Thickness	Weight /kg	chamfer	One hand /two hand	total weight
	Steel frame	1	360	360	720	4200	240	1000		Crane	1000
	DPM	1	90	180	270	4200	2	268128		2 hands	268128
	Floor panel	3	360	180	540	1200	240	293.5143024		Crane	880.5429072
	Sole plate	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Wall panels	20	360	180	540	1200	240	1553.054899		2persons	31061.09798
	Head binder	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Upperfloor panels	3	360	360	720	600	240	148.3838038		2persons	445.1514113
	Roof gable	4	360	180	540	2400	240	1.86553E-06		Crane	7.46213E-06
	Ceiling panels	3	360	360	720	600	240	148.3838038		2persons	445.1514113
	Head binder	10	180	180	360	2400	38	13.1328		Two hands	131.328
	Roof trusses	12	360	360	720	4200	90	0		Crane	0
	Roof panels	6	360	360	720	600	240	155.305479		Crane	931.8328741
	Cladding		180	180	360	4000	19			Two hands	0
	glulam portal										

Item	Item name	Number of items	Manual handling code	Handling time per item s	Manual Insertion code	Insertion time per item s	Total operation time	Figures for min. parts	Description
	Steel frame	1	99	9	craning	7	16	16	tors. Assumed to be a simple box frame with cros
	DPM	1	92	2			2	1	Installed below panels
	Floor panel	18	Craning	480	Craning	18.75	8977.5	1	nd balled into position. No restriction of access for
	Sole plate	10	99	9	38	6	150	1	Placed on steel frame. No restriction in access
	Wall panels	18	Craning	480	Craning	18.75	8977.5	4	neral. Parts added but not secured. Then when a
	Head binder	10	99	9	38	6	150	1	and fixed to top of wall panels . No restriction in
	Upperfloor panels	12	Craning	480	Craning	18.75	5985	1	neral. Parts added but not secured. Then when a
	Roof gable	7	Craning	480	Craning	18.75	3491.25	2	neral. Parts added but not secured. Then when a
	Ceiling panels	12	Craning	480	Craning	18.75	5985	1	neral. Parts added but not secured. Then when a
	Head binder	10	99	9	38	6	150	1	and fixed to top of wall panels . No restriction in
	Roof trusses	12	Craning	480	Craning	18.75	5985	12	Crane into place, secured using nail pates.
	Roof panels	12	Craning	480	Craning	18.75	5985	2	Craned into position because of working at height.
		0							
	Cladding	20	94	3					
	glulam portal	0							

			weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move
	Floor panel	3	213.60	9	240	2160	7000	50	140
	Wall panels	10	130.74	6	240	1440	7000	50	140
	Ceiling panels	9	175.58	8	240	1920	7000	50	140
	Ceiling panels		175.58	8	240	1920	7000	50	140
	Roof gable		81.34	4	240	960	7000	50	140
	Roof trusses	6	100	4	240	960	7000	50	140
	Roof panels	6	108.20	5	240	1200	7000	50	140
									total per building
									total per building
									crane cost

Assembly of fabric

Onsite constrution of the building requires the following:
1) Foundations are already inplace and initial ground works have been completed. Electricity and ground water supply are ready to be connected to.
2) Steel frame is in place on the foundations and levelled. Frame is lifted into place using crane.
3) Install DPM.
4) Floor panel lifted into position. Depending on size either using crane or hand balling.
5) Sole plate fixed to floor panels. Sole plate levelled.
6) Wall panels, lifted into position. Panel positioned using props. Wall panels surveyed and levelled, then fixed together using nails or screw. Panels fixed to floor and to each other. Ground floof completed.
7) Headbinder attached to ground floor panels
8) Install floor hangers, (done in factory?)
9) Install ceiling panels.
10) Repeat 6-9 for first floor panels and ceiling.
11) Install roof trusses at spacing of 600mm
12)Install roof panels
13)Install cladding

Assembly times based on component properties

Panel	Building fabric	2400	600								
Item	Item name	Number of items	Symettry α	β	total	Size mm	Thickness	Weight /kg	chamfer	One hand /two hand	total weight of parts
	Steel frame	16	360	360	720	4200	240	1000		Crane	16000
	DPM	1	90	180	270	4200	2	268128		2 hands	268128
	Floor panel	12.00	360	180	540	600	240	1.83E-06		2persons	2.1906E-05
	Sole plate	10	180	180	360	2400	38	13.1328			131.328
	Wall panels	75.00	360	360	720	600	240	1.17E-05		2persons	0.000878489
	Head binder	10	180	180	360	2400	38	13.1328			131.328
	Upperfloor panels	12.00	360	180	540	600	240	1.75E-06		2persons	2.09569E-05
	Roof gable	14.00	360	360	720			1.87E-06			
	Ceiling panels	12.00	360	180	540	600	240	1.75E-06		2persons	2.09569E-05
	Head binder	10	180	180	360	2400	38	13.1328			131.328
	Roof trusses	12	360	360	720	4200	90	0		Crane	0
	Roof panels	22	360	360	720	600	240	3.17E-06		Crane	6.97139E-05
	Cladding		180	180	360	4000	19	2.0216		Two hands	0
	Glulam portal	12	180	180	360	5000	240	65		Crane	780

Item	Item name	Number of items	Manual handling code	Handling time per item s	Manual Insertion code	Insertion time per item s	Total operation time	Figures for min. parts	Description	Total Part efficiency (Ea) 0.016666667
	Steel frame	16	99	9	37	7	256	16	Installed by professional contractors. Assumed to be a simple box frame with cross members at the first floor level	
	DPM	1	99	9			9	1	Installed below panels	
	Floor panel	12	99	9	38	6	180	1	Panels hand balled into position. No restriction of access for insertion	
	Sole plate	10	99	9	38	6	150	1	Placed on steel frame. No restriction in access	
	Wall panels	76	99	9	6	6.5	1178	4	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and securded	
	Head binder	10	99	9	38	6	150	1	Placed and fixed to top of wall panels . No restriction in access	
	Upperfloor panels	12	99	9	48	8.5	210	1	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Roof gable	14	99	9	38	6	210	2	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Ceiling panels	12	99	9	38	6	180	1	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Head binder	10	99	9	38	6	150	1	Placed and fixed to top of wall panels . No restriction in access	
	Roof trusses	12	99	9	38	6	180	12	Crane into place, secured using nail pates.	
	Roof panels	24	99	9	38	6	360	2	Craned into position because of working at height.	
	Cladding	12	94	20	38	15	420			
	Glulam portal	12								

600		weight	Number of lifting point	Connecting time per lifting point	Connect / disconnect	Distance to move (average)	Speed	Time t move	Total per piece	Total (all pieces)	Time (minutes)
Floor panel	12.00	59.78	0	240	0	7000	25	280	280	3360	56
Wall panels	75.00	36.33	0	240	0	7000	25	280	280	21000	350
Upper floor	12.00	57.88	0	240	0	7000	25	280	280	3360	56
Ceiling panels	12.00	50.27	0	240	0	7000	25	280	280	3360	56
Roof gable	10.00	23.75	1	240	240	7000	100	70	550	5500	92
Roof trusses	12	100.00	4	240	960	7000	100	70	1990	23880	398
Roof panels	22	33.66	2	240	480	7000	100	70	1030	22660	378
										83120	1386
	155.00										

total per building	1386	mins
total per building	23.10	hours
	2.89	days

crane cost 1342 per day

kg	lbs
1	0.45

0.0625	1.5875	0.15875

Assembly of a panel

The panel is simple a box fully filled with insulation. Two or more I joists form the height of the box, and C16 timbers form the end. I joists are repeated at 600mm centres.
Thick board, typically OSB, is fixed to the frame structure, typically nailed.
The board is turned over, if insulation is as batts then then batts are installed by placing them into the spaces. If insulation is blown then this happens after the second facing is attached (could be on site or in the factory) .
The second facing is either airtightness membrane or internal boarding, dependant on intended use.

At present no electrical conduit, cladding connectors or other attachments are connected. to the faces of the board
In the first case the board will be attached to each other and the sole plates using nails. Alternative solution could be proprietry panel connectors.

Assembly times based on component properties

Panel	Wall panel 2.4m*1.2m	2400	1200								
Item	Item name	Number of items	Symettry α	β	total	Siize mm	Thickness	Weight /kg	chamfer	One hand /two hand	total weight of parts
	Steel frame	16	360	360	720	4200	240	1000		Crane	16000
	DPM	1	90	180	270	4200	2	268128		2 hands	268128
	Floor panel	6.00	360	180	540	1200	240	#REF!		Crane	#REF!
	Sole plate	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Wall panels	40.00	360	180	540	1200	240	#REF!		2persons	#REF!
	Head binder	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Upperfloor panels	12.00	360	360	720	600	240	#REF!		2persons	#REF!
	Roof gable	7.00	360	180	540	2400	240	#REF!		Crane	#REF!
	Ceiling panels	12.00	360	360	720	600	240	#REF!		2persons	#REF!
	Head binder	10	180	180	360	2400	38	13.1328		Two hands	131.328
	Roof trusses	12	360	360	720	4200	90	0		Crane	0
	Roof panels	12.00	360	360	720	600	240	#REF!		Crane	#REF!
	Cladding		180	180	360	4000	19			Two hands	0
	glulam portal										

Item	Item name	Number of items	Manual handling code	Handling time per item s	Manual Insertion code	Insertion time per item s	Total operation time	Figures for min. parts	Description	Total Part efficiency (Ea) 0.000466019
	Steel frame	16	99	9	craning	7	256	16		
	DPM	1	92	2			2	1		
	Floor panel	5	Craning	1200	Craning	87.5	6437.5	1		
	Sole plate	10	99	9	38	6	150	4		
	Wall panels	32	Craning	1200	Craning	87.5	41200	4		
	Head binder	10	99	9	38	6	150	4		
	Upperfloor panels	5	Craning	1200	Craning	87.5	6437.5	4		
	Roof gable	6	Craning	1200	Craning	87.5	7725	2		
	Ceiling panels	5	Craning	1200	Craning	87.5	6437.5	1		
	Head binder	10	99	9	38	6	150	4		
	Roof trusses	12	Craning	1200	Craning	87.5	15450	12		
	Roof panels	10	Craning	1200	Craning	87.5	12875	2		
		0					0			
	Cladding	16	94	3			48			
	glulam portal	0								

			weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
	Floor panel	6.00	1.22E+02	5	240	1200	7000	80	87.5	2487.5	14925	249
	Wall panels	40.00	6.78E+01	3	240	720	7000	80	87.5	1527.5	61100	1019
	Ceiling panels	12.00	9.20E+01	4	240	960	7000	80	87.5	2007.5	24090	402
	Upperfloor panels	12.00	9.20E+01	4	240	960	7000	80	87.5	2007.5	24090	402
	roof gable	7.00	3.66E+01	2	240	480	7000	80	87.5	1047.5	7332.5	123
	Roof trusses	12	100	4	240	960	7000	80	87.5	2007.5	24090	402
	Roof panels	12	6.29E+01	3	240	720	7000	80	87.5	1527.5	18330	306
											173957.5	2900

total per building	2903
total per building	48.38333333
	6.047916667

crane cost 1342
8116.304167

Assembly of a panel

The panel is simple a box fully filled with insulation. Two or more I joists form the height of the box, and C16 timbers form the end. I joists are repeated at 600mm centres.
Thick board, typically OSB, is fixed to the frame structure, typically nailed.
The board is turned over, if insulation is as batts then then batts are installed by placing them into the spaces. If insulation is blown then this happens after the second facing is attached (could be on site or in the factory) .
The second facing is either airtightness membrane or internal boarding, dependant on intended use.

At present no electrical conduit, cladding connectors or other attachments are connected. to the faces of the board
In the first case the board will be attached to each other and the sole plates using nails. Alternative solution could be proprietry panel connectors.

Assembly times based on component properties

Panel	Wall panel 2.4m*1.8m	2400	1800									
Item	Item name	Number of items	Symettry α	β	total	Siize mm	Thickness	Weight /kg	chamfer	One hand /two hand	total weight of parts
	Steel frame	1	360	360	720	4200	240	1000		Crane	1000
	DPM	1	90	180	270	4200	2	268128		2 hands	268128
	Floor panel	4.00	360	180	540	1200	240	#REF!		Crane	#REF!
	Sole plate	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Wall panels	28.00	360	180	540	1200	240	#REF!		2persons	#REF!
	Head binder	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Upperfloor panels	4.00	360	360	720	600	240	#REF!		2persons	#REF!
	Roof gable	5.00	360	180	540	2400	240	#REF!		Crane	#REF!
	Ceiling panels	4.00	360	360	720	600	240	#REF!		2persons	#REF!
	Head binder	10	180	180	360	2400	38	13.1328		Two hands	131.328
	Roof trusses	90	360	360	720	4200	90	#REF!		Crane	#REF!
	Roof panels	4.00	360	360	720	600	240	1.55E+02		Crane	621.2219161
	Cladding		180	180	360	4000	19			Two hands	0
	glulam portal										

Item	Item name	Number of items	Manual handling code	Handling time per item s	Manual Insertion code	Insertion time per item s	Total operation time	Figures for min. parts	Description	Total Part efficiency (Ea) 0.002005013
	Steel frame	1	99	9	craning	7	16	16	Installed by professional contractors. Assumed to be a simple box frame with cross members at the first floor level	
	DPM	1	92	2			2	1	Installed below panels	
	Floor panel	3	Craning	480	Craning	18.75	1496.25	1	Panels hand balled into position. No restriction of access for insertion	
	Sole plate	10	99	9	38	6	150	1	Placed on steel frame. No restriction in access	
	Wall panels	20	Craning	480	Craning	18.75	9975	4	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and securded	
	Head binder	10	99	9	38	6	150	1	Placed and fixed to top of wall panels . No restriction in access	
	Upperfloor panels	3	Craning	480	Craning	18.75	1496.25	1	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Roof gable	4	Craning	480	Craning	18.75	1995	2	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Ceiling panels	3	Craning	480	Craning	18.75	1496.25	1	Hand balled into position. No restricted access in general. Parts added but not secured. Then when all parts in position They are surveyed and secured.	
	Head binder	10	99	9	38	6	150	1	Placed and fixed to top of wall panels . No restriction in access	
	Roof trusses	12	Craning	480	Craning	18.75	5985	12	Crane into place, secured using nail pates.	
	Roof panels	6	Craning	480	Craning	18.75	2992.5	2	Craned into position because of working at height.	
		0								
	Cladding	20	94	3						
	glulam portal	0								

				weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move	total per piece	total (all pieces)	time (minutes)
		Floor panel	3	1.79E+02	8	240	1920	7000	60	116.6666667	3956.666667	11870	198
		Wall panels	20	9.93E+01	4	240	960	7000	60	116.6666667	2036.666667	40733.33333	679
		Ceiling panels	3	1.34E+02	6	240	1440	7000	60	116.6666667	2996.666667	8990	150
		Upperfloor panels	3	1.34E+02	6	240	1440	7000	60	116.6666667	2996.666667	8990	150
		roof gable	4	6.58E+01	3	240	720	7000	60	116.6666667	1556.666667	6226.666667	104
		Roof trusses	12	100	4	240	960	7000	60	116.6666667	2036.666667	24440	408
		Roof panels	6	9.22E+01	4	240	960	7000	60	116.6666667	2036.666667	12220	204
mins										total per building		1893 mins	
mins (check)										total per building		31.55 hours	
hours												3.94375 days	
per day										crane cost		1342 per day	

5292.5125

Assembly of a panel

The panel is simple a box fully filled with insulation. Two or more I joists form the height of the box, and C16 timbers form the end. I joists are repeated at 600mm centres.
Thick board, typically OSB, is fixed to the frame structure, typically nailed.
The board is turned over, if insulation is as batts then then batts are installed by placing them into the spaces. If insulation is blown then this happens after the second facing is attached (could be on site or in the factory) .
The second facing is either airtightness membrane or internal boarding, dependant on intended use.

At present no electrical conduit, cladding connectors or other attachments are connected. to the faces of the board
In the first case the board will be attached to each other and the sole plates using nails. Alternative solution could be proprietry panel connectors.

Assembly times based on component properties

Panel	Wall panel 2.4m*1.8m	2400	2400								
Item	Item name	Number of items	Symettry α	β	total	Siize mm	Thickness	Weight /kg	chamfer	One hand /two hand	total weight
	Steel frame	1	360	360	720	4200	240	1000		Crane	1000
	DPM	1	90	180	270	4200	2	268128		2 hands	268128
	Floor panel	3	360	180	540	1200	240	293.5143024		Crane	880.5429072
	Sole plate	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Wall panels	20	360	180	540	1200	240	1553.054899		2persons	31061.09798
	Head binder	10	180	180	360	2400	38	13.1328		2 hands	131.328
	Upperfloor panels	3	360	360	720	600	240	148.3838038		2persons	445.1514113
	Roof gable	4	360	180	540	2400	240	1.86553E-06		Crane	7.46213E-06
	Ceiling panels	3	360	360	720	600	240	148.3838038		2persons	445.1514113
	Head binder	10	180	180	360	2400	38	13.1328		Two hands	131.328
	Roof trusses	12	360	360	720	4200	90	0		Crane	0
	Roof panels	6	360	360	720	600	240	155.305479		Crane	931.8328741
	Cladding		180	180	360	4000	19			Two hands	0
	glulam portal										

Item	Item name	Number of items	Manual handling code	Handling time per item s	Manual Insertion code	Insertion time per item s	Total operation time	Figures for min. parts	Description
	Steel frame	1	99	9	craning	7	16	16	tors. Assumed to be a simple box frame with cros
	DPM	1	92	2			2	1	Installed below panels
	Floor panel	18	Craning	480	Craning	18.75	8977.5	1	d balled into position. No restriction of access for
	Sole plate	10	99	9	38	6	150	1	Placed on steel frame. No restriction in access
	Wall panels	18	Craning	480	Craning	18.75	8977.5	4	neral. Parts added but not secured. Then when a
	Head binder	10	99	9	38	6	150	1	and fixed to top of wall panels . No restriction in
	Upperfloor panels	12	Craning	480	Craning	18.75	5985	1	neral. Parts added but not secured. Then when a
	Roof gable	7	Craning	480	Craning	18.75	3491.25	2	neral. Parts added but not secured. Then when a
	Ceiling panels	12	Craning	480	Craning	18.75	5985	1	neral. Parts added but not secured. Then when a
	Head binder	10	99	9	38	6	150	1	and fixed to top of wall panels . No restriction in
	Roof trusses	12	Craning	480	Craning	18.75	5985	12	Crane into place, secured using nail pates.
	Roof panels	12	Craning	480	Craning	18.75	5985	2	Craned into position because of working at height.
		0							
	Cladding	20	94	3					
	glulam portal	0							

				weight	Number of lifting point	connecting time per lifting point	connect/ disconnect	distance to move (average)	speed	time t move
		Floor panel	3	213.60	9	240	2160	7000	50	140
		Wall panels	10	130.74	6	240	1440	7000	50	140
		Ceiling panels	9	175.58	8	240	1920	7000	50	140
		Ceiling panels		175.58	8	240	1920	7000	50	140
		Roof gable		81.34	4	240	960	7000	50	140
		Roof trusses	6	100	4	240	960	7000	50	140
		Roof panels	6	108.20	5	240	1200	7000	50	140
										total per building
										total per building
										crane cost

H SOCIAL

H1 RISK ASSESSMENT

The construction is split into four key phases based on when a risk assessment would be completed and actions taken. A External wall B Ground floor C Upper ceiling D Roof E Internal walls F Internal finishes G: Maintenance; H End of life	Hazard events are considered and the product of the severity of accident and the likelihood of an incident is recorded. • Exposure to the elements • Exposure to toxic materials • Risk of injury (equipment) • Multiple activities in a small area • Handling • Risk of falling
The severity of the identified accidents are scored according to the level of notification to the HSE required. 1) Recordable incident (>3days incapacitated); 2) Reportable incident (7 days of work) 3) Death of a person	Likelihood is determined 1) Remote/ unlikely 2) Possible: could occur some time , 3) Probably: will occur several times 4) Likely: occur repeatedly/event only to be expected

Risk assessment for traditional construction r

A External Wall

The brick and block work is built by a team of brick layers. The materials are assembled in situ at the building. Materials are transported to where the assembly occurs. This could be by vehicles or by manual handling. The assembly requires repeated movement lifting bricks to the wall. Materials may need to be prepared by cutting and this can done using an axel grinder, us by brick cutter.

The work is outside and workers are always exposed to the elements.

Preparation of bricks is often completed using an angle grinder. This represents a vibration hazard. Equipment has been designed to minimise the associated which could replace use of the angle grinder.

Mortar and concrete are hazardous materials to human health. Contact with the materials should be minimised. Inhalation of dust should be minimised also. This can achieved by use of PPE.

Where materials are heavy, they move in small batches or moved using vehicles. Bricklaying requires repeated bending and lifting movements. To minimise risk the distance materials are moved should be minimised. This can achieved by raising materials to the level of the builder. When construction work occurs at height, the work station needs to move so that the workers position is safe, this can be achieved using scaffolding, working platforms or similar.

C Ground floor

The ground floor is at ground level. Concrete is poured and levelled using machinery.

The work is outside and workers are always exposed to the elements.

Mortar and concrete are hazardous materials to human health. Contact with the materials should be minimised. Inhalation of dust should be minimised also. This can achieved by use of PPE.

Construction of the floor slab occurs early in the process. As such, there are few other obstructions.

Materials are delivered to assembly area by vehicles.

Trip hazards are those associated with a general contraction site. No increase risk associated with the activity.

D&E Upper ceiling

The ceiling structure is built of timber joist and struts, chipboard floor covering and plasterboard ceiling. Insulation is inserted to minimise sound transference. The upper ceiling does not have the floor covering of the insulation. To construct, joist hangers are attached to the inner leaf of the building wall external walls, and timber beams are inserted. Plasterboard in attached to the bottom of the joists. Insulation is inserted between the joists. Floor boards are screwed to the top of the joists.

The work is outside and workers are always exposed to the elements. However there is some shelter from the walls. The roof has not be constructed.

Materials have low toxicity. However, care must be taken when preparing and handling the materials. Cutting timber can produce hazardous dust and insulation can be a skin irritant.

Preparation of materials require cutting equipment. Installation is above head height, so lifting equipment and a raised platform is required.

The space in which the construction occurs is confined; however, other construction processes are limited.

Materials are large and may require two persons to handle. Installation is over head so work should occur using a raised platform and materials should be available at the height of the platform.

Work occurs at height and as such there is a risk of falling.

F Roof.

The roof trusses are prefabricated offsite and brought to site from the factory. A crane will lift the trusses into place . Workers are needed at roof height to secure the trusses. A working platform at roof height is required (scaffolding). Once secured roof felt covers the trusses. Battens are fixed and the roof is tiled.

The work is very exposed, occurring both outside and at height.

Materials are non toxic. Mortar is used to fix tiles, which can be an irritant.

Trusses are positioned using a crane and their positions secured by the workers. The trusses are large and heavy and their movement, controlled by the crane but affected by wind must be carefully managed.

Positioning the trusses requires the workers to use two hands. They are working at height. The risk of falling is high.

G Internal walls

Structural walls are built in a similar manner to the external walls and the workers are exposed to the same hazards.

H Internal finishes

Internal finishes are created using wet plaster or plaster board. These are applied by hand. They represent low risk, although the compound is alkaline and a potential irritant so PPE should be used.

H.1.1 Responsible Soucing

Material	Score
Steel	3.0
Glulam	3.0
I joist	3.0
Red cedar	2.0
Zinc	3.0
Stone	2
Warmcell	2
Rockwool	2.5
EPS	0.0
Plaster board	2.0
Sheep wool	3.0
Timber (general)	3.0
Membrane	1.0
OSB	3.0
Brick	3.0
Block	3.0
Concrete	3.0
Wet plaster	3.0
Roof tiles	3.0

H.1.2 Responsible sourcing

Data was collected from supplier websites, or direct contact with the supplier.

Element	Component	Material	Responsible sourcing	ems14001: 2004	PEFC	Internal document environmental/other	BES6001 accreditation	BS 8902	ETI	OHSAS18001	Other/ internal statement social	BBA	iso9001/EPD	Internal document quality	GRI (all)	Score
Structural portal	Glulam	90x240mm glulam	1	1	1	0.5	0	0	0	0	0	0	1	0	0	2.5
Structural portal	Steel	Steel rsj beam 203*133	0	0	0	0	0	0	0	0	0	0	0	0.5	0	2.0
TF panel	I-joists	240x45mm timber I-Joist	1	1	1	0.5	0	0	0	0	0	0	1	0	0	2.5
SIP Panel	Structural board SIP	18mm 2440x1220 OSB3	1	1	1	0.5	0	0	0	0	0.5	0	1	0	0	2.5
TF panel	Sheathing board	11mm 2440x1220 OSB3	1	1	1	0.5	0	0	0	0	0.5	0	1	0	0	2.5
TF panel	Panel structure C16	240*44mm SW battens	1	1	1	0.5	0	0	0	0	0.5	0	1	0	0	2.5
Fabric assembly	Top plates; (sole)plates …	44x240mm SW	1	1	1	0.5	0	0	0	0	0.5	0	1	0	0	2.5
TF panel	Structural stud	89x38mm SW battens	1	1	1	0.5	0	0	0	0	0.5	0	1	0	0	2.5
External panel faces (excluding floor)	External battens	38x50mm treated SW battens	1	1	1	0.5	0	0	0	0	0.5	0	1	0	0	2.5
Internal panel faces	Internal battens (plaster board)	44x69mm SW battens	1	1	1	0.5	0	0	0	0	0.5	0	1	0	0	2.5
Inner lining	OSB	18mm OSB panel	1	1	1	0.5	0	0	0	0	0.5	0	1	0	0	2.5
Insulation	Warmcel	Blown material	0	1	0	0.5	0	0	0	0	0.0	1	1	0	0	1.5
Insulation	Insulation batts	Rockwool	1	1	0	0	1	0	0	0	0	0	1	0	0	3
Insulation	Insulation batts	Sheep wool	0	1	0	0	1	0	0	0	0	0	01	0	0	3
Insulation	SIP panel sandwich	EPS density 20kg/m3	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0
Cladding	Red Cedar	94x19mm Western Red Cedar	1	1	1	0.5	0	0	0	0	0.5	0	0	0	0	2.0
Cladding	Zinc	4mm thick cladding 600mm spacing	1	1	0	0	0	0	0	0	0.5	1	1		0	3.0
Cladding	Stone cladding	Taylor Maxwell z shaped stone cladding	1	1	0	0	0	0	0	0	0.5	1	1		0	3.0

Lining	Plasterboar d	Board: 12.5x1200 x2400mm	0	0	0	0	1.00	0	0	0	0.0	0	1	0	0	2
Membrane	Internal membrane	Pro Clima Intello Plus	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0
Membrane	Breather membrane	Pro Clima Solitex WA	0	0	0	0	0	0	0	0	0. 0	0	0	0	0	0
Membrane	Damp proof membrane	DPM	0	0	0	0	0	0	0	0	0. 0	0	0	0	0	0

	A&B	C&D	E	F
Structural Frame	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood
Handling	0	3*2	0	3*3
Risk of falling	0	3*3	0	0
Exposure to toxic materials	0	1*1	0	1*1
Exposure to the elements	0	2*3	0	2*3
Risk of Injury (by equipment)	0	2*3	0	3*3
Load bearing panels				
Handling	2*3	3*2	0	3*3
Risk of falling	2*3	3*3	0	0
Exposure to toxic materials	1*1	1*1	0	1*1
Exposure to the elements	0	2*3	0	2*3
Risk of Injury (by equipment)	2*3	2*3	0	3*3
Panel size 600/1200				
Handling	1*3	1*3	0	1*3
Risk of falling	0	2*2	0	0
Exposure to toxic materials	3*2	0	0	0
Exposure to the elements	0	2*2	0	2*2
Risk of Injury (by equipment)	2*3	3*2	0	3*1
Panel size 1800/2400				
Handling	2*3	2*3	0	2*3
Risk of falling	0	2*2	0	0
Exposure to toxic materials	3*2	0	0	0
Exposure to the elements	0	2*2	0	2*2
Risk of Injury (by equipment)	2*3	3*2	0	3*1
Insulation batts				
Handling	0	0	0	0
Risk of falling	0	0	0	0
Exposure to toxic materials	0	0	0	0
Exposure to the elements	0	0	0	0
Risk of Injury (by equipment)	1*2	1*2	0	0
Blown Insulation				
Handling	0	0	0	0
Risk of falling	0	0	0	0
Exposure to toxic materials	0	0	0	0
Exposure to the elements	0	0	0	0
Risk of Injury (by equipment)	0	0	0	0
EPS				
Handling	0	0	0	0
Risk of falling	0	0	0	0
Exposure to toxic materials	0	0	0	0

Exposure to the elements	0	0	0	0
Risk of Injury (by equipment)	0	0	0	0
Timber Frame				
Handling	1*3	1*3	0	1*3
Risk of falling	0	2*2	0	0
Exposure to toxic materials	3*2	0	0	0
Exposure to the elements	0	2*2	0	2*2
Risk of Injury (by equipment)	2*3	3*2	0	3*1
SIP				
Handling	1*3	1*3	0	1*3
Risk of falling	0	2*2	0	0
Exposure to toxic materials	3*2	0	0	0
Exposure to the elements	0	2*2	0	2*2
Risk of Injury (by equipment)	2*3	3*2	0	3*1
Red cedar				
Handling	1*3	1*3	1*3	1*3
Risk of falling	0	3*2	3*2	3*2
Exposure to toxic materials	2*2	2*1	2*1	0
Exposure to the elements	0	2*2	2*2	2*1
Risk of Injury (by equipment)	2*2	2*2	2*2	0
Stone				
Handling	1*3	1*3	1*3	1*3
Risk of falling	0	3*2	3*2	3*2
Exposure to toxic materials	2*2	2*1	2*1	0
Exposure to the elements	0	2*2	2*2	2*1
Risk of Injury (by equipment)	2*2	2*2	2*2	0
Zinc				
Handling	0	1*3	1*3	1*3
Risk of falling	0	3*2	3*2	3*2
Exposure to toxic materials	0	0	0	0
Exposure to the elements	0	2*2	2*2	2*1
Risk of Injury (by equipment)	0	1*2	1*2	0
Open panel				
Handling	1*3	1*3	0	1*3
Risk of falling	0	2*2	0	0
Exposure to toxic materials	3*2	0	0	0
Exposure to the elements	0	2*2	0	2*2
Risk of Injury (by equipment)	2*3	3*2	0	3*1
Closed Panel				
Handling	2*3	2*3	0	2*3
Risk of falling	0	2*2	0	0
Exposure to toxic materials	3*2	0	0	0
Exposure to the elements	0	2*2	0	2*2

Risk of Injury (by equipment)	2*3	3*2	0	3*1
Volumetric				
Handling	2*3	2*3	0	1*3
Risk of falling	0	2*1	0	0
Exposure to toxic materials	0	0	0	0
Exposure to the elements	0	2*1	0	2*2
Risk of Injury (by equipment)	2*3	3*2	0	3*1

Adaptability

	External wall Internal wall	Ground floor	First floor/upper ceiling	Roof	Internal finishes	Maintenance	End of life
Traditional construction	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood
Handling	1*4	1*1	2*3	3*2	1*4	3*2	1*2
Risk of falling	3*2	1*2	3*2	3*3	1*1	3*2	2*2
Exposure to toxic materials	1*4	1*4	1*2	1*4	1*4	1*1	1*1
Exposure to the elements	1*4	1*4	1*4	1*4	1*4	1*4	1*4
Risk of Injury (by equipment)	1*2	1*1	1*1	3*4	1*1	2*2	2*2

	External wall Internal wall	Ground floor	First floor/upper ceiling	Roof	Internal finishes	Maintenance	End of life
Traditional construction	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood	Con. * L-Hood
Handling	4	1	6	6	4	6	2
Risk of falling	6	2	6	9	1	6	4
Exposure to toxic materials	4	4	2	4	4	1	1
Exposure to the elements	4	4	4	4	4	4	4
Risk of Injury (by equipment)	2	1	1	12	1	4	4
	20	12	19	35	14	21	15

H.1.3 Adaptability

Marking sheet Design………………		Indicator	Max. Score	
1a	Design flexibility	Capacity to have a range of buildings using similar components (product platform)	20	0-5 Bespoke design for the building . 5-10 Some common design elements used within the design but not between different designs 10-15 Some design details Components/ Panels/volumes expected to be usable within a range of design. Design principles shared across options. 15-20 Active identification of components/panels to be used in product range
2a	In-use Maintenance,	Layering Where materials have shorter lifetimes, they can be replaced without damaging the longer lasting components (which are still serviceable).	30	0-5 Low proportion of materials with lifetime less than 25 years can be removed without significant additional damage or cost 6-10 Some materials with lifetime less than 25 years can be removed without significant additional damage or cost 11-15 Most materials with lifetime less than 25years can be removed without significant additional damage or cost
2b	In-use Change of use	Structure allows for changes in fabric arrangement without significant reengineering. Are any internal walls load bearing structures?	20	0-5 Internal walls required for fabric stability and to support load of upper floors. 5-9- Internal wall support internal floors only 10-14 Some internal walls structurally necessary but only a central core, (large spaces remain) A number of different configurations are available) 15-20 Internal space is completely flexible.
3	Disassembly and reuse at end of life	Change of location of the building (dismantle and rebuild) Can the building be disassembled and reassembled in its current form? Can building modules be recovered and used in different form?	30	0 -4 Elements are not designed to be taken apart. Components materials can be recycled 5-10 Individual components can be recovered and reused 11-15 Some assembled components can be recovered and reused, but with significant fixing required. (screwed rather than nailed) 16-20 Most components can be recovered and reused. 20-25 Building is designed to be dissembled and reassembled 25-30 Building is designed to be disassembled and reconfigured as desired
			score / 100	

Traditional construction: Adaptability

		Traditional build	Score
	Indicator		
1a	Design flexibility	Bricks and tiles are versatile and are able to produce a variety of forms. Joist and trusses are bespoke; they are engineered to be suitable for the building design.	
1b		Brick and tiles are available in a range of finishes. The structural strength of the brick and block form enable them to used created a variety of forms. There are no constraints to the suitability heating systems. The building has thermal mass so will have a lagged response to heating and cooling.	
2a	Long life	As layout The concrete floor and upperfloor would require specific consideration if lifetime homes was required.	
2b		Service runs would be embedded into the internal plaster serfaces. Changes to any services would require the surface finish to be disturbed and, later repaired.	

3	Maintenance flexibility	There is little consideration of layering in the design. Access for maintenace and repair require breaking and repair of materials.	
4	Change of location of the building (dismantle and rebuild)	Not economically feasible.	
5a	Change of use	The building has been designed such that internal wall contribute to the structural stability of the building. Any alterations to the internal layout would require consideration of the structural impact of the changes.	
5c		Any additional structure would need to be independently structurally stable.	

I TOTAL SCORES

Stage	Location	Parameter	Panel			Component	Proccess			cost	labour	power	time
Material	Factory	Cost	SIP Panel	OPCL	Component	Original	Material	SIP	600	£ 5,381.90	0.00	£ -	0.00
Material	Factory	Cost	SIP Panel	OPCL	Component	Original	Material	SIP	1200	£ 5,921.33	0.00	£ -	0.00
Manufacture	Factory	Cost	SIP Panel	OPCL	Component	Original	Manufacture	SIP	600	£ 1,186.34	£ 238.83	£ 2,971.76	29466.17
Manufacture	Factory	Cost	SIP Panel	OPCL	Component	Original	Manufacture	SIP	1200	£ 1,064.41	£ 124.50	£ 1,564.09	14733.09
Assembly	Factory	Cost	SIP Panel	OPCL	Component	Original	Setup	SIP	600	£ 27.27	£ 1.97	£ -	540.00
Assembly	Factory	Cost	SIP Panel	OPCL	Component	Original	Setup	SIP	1200	£ 21.21	£ 1.53	£ -	420.00
Material	Factory	Cost	TFpanel	OPCL	Component	Original	Material	TFpanel	600	£ 9,811.93	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Component	Original	Material	TFpanel	1200	£ 8,974.61	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Component	Original	Material	TFpanel	1800	£ 7,286.74	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Component	Original	Material	TFpanel	2400	£ 6,543.25	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Component	Maintenance	Material	TFpanel	600	£ 641.47	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Component	Maintenance	Material	TFpanel	1200	£ 1,068.99	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Component	Maintenance	Material	TFpanel	1800	£ 942.01	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Component	Maintenance	Material	TFpanel	2400	£ 868.63	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Lining	Original	Material	TFpanel	600	£ 158.14	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Lining	Original	Material	TFpanel	1200	£ 190.66	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Lining	Original	Material	TFpanel	1800	£ 136.94	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Lining	Original	Material	TFpanel	2400	£ 126.31	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Lining	Maintenance	Material	TFpanel	600	£ 661.31	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Lining	Maintenance	Material	TFpanel	1200	£ 797.31	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Lining	Maintenance	Material	TFpanel	1800	£ 572.65	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	OPCL	Lining	Maintenance	Material	TFpanel	2400	£ 528.21	0.00	£ -	0.00
Manufacture	Factory	Cost	TFpanel	OPCL	Lining	Original	Manufacture	TFpanel	600	£ 43.74	£ 11.17	£ 278.72	2533.78
Manufacture	Factory	Cost	TFpanel	OPCL	Lining	Original	Manufacture	TFpanel	1200	£ 36.52	£ 9.38	£ 232.26	2111.48
Manufacture	Factory	Cost	TFpanel	OPCL	Lining	Original	Manufacture	TFpanel	1800	£ 24.39	£ 6.30	£ 154.85	1407.69
Manufacture	Factory	Cost	TFpanel	OPCL	Lining	Original	Manufacture	TFpanel	2400	£ 18.28	£ 4.71	£ 116.13	1055.74
Manufacture	Factory	Cost	TFpanel	OPCL	Lining	Maintenance	Manufacture	TFpanel	600	£ 43.74	£ 32.57	£ 800.55	7277.72
Manufacture	Factory	Cost	TFpanel	OPCL	Lining	Maintenance	Manufacture	TFpanel	1200	£ 36.52	£ 27.14	£ 667.12	6064.77
Manufacture	Factory	Cost	TFpanel	OPCL	Lining	Maintenance	Manufacture	TFpanel	1800	£ 24.39	£ 18.09	£ 444.76	4043.23
Manufacture	Factory	Cost	TFpanel	OPCL	Lining	Maintenance	Manufacture	TFpanel	2400	£ 18.28	£ 13.57	£ 333.56	3032.38

Stage	Location	Parameter	Panel			Component	Proccess			cost	labour	power	time
Material	Factory	Cost	TFpanel	**OPCL**	Warmcell	Original	Material	TFpanel	600	£ 3,000.00	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Warmcell	Original	Material	TFpanel	1200	£ 3,000.00	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Warmcell	Original	Material	TFpanel	1800	£ 3,000.00	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Warmcell	Original	Material	TFpanel	2400	£ 3,000.00	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Rockwool	Original	Material	TFpanel	600	£ 3,810.37	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Rockwool	Original	Material	TFpanel	1200	£ 3,810.37	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Rockwool	Original	Material	TFpanel	1800	£ 3,810.37	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Rockwool	Original	Material	TFpanel	2400	£ 3,810.37	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Sheep wool	Original	Material	TFpanel	600	£ 6,428.04	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Sheep wool	Original	Material	TFpanel	1200	£ 6,428.04	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Sheep wool	Original	Material	TFpanel	1800	£ 6,428.04	0.00	£ -	**0.00**
Material	Factory	Cost	TFpanel	**OPCL**	Sheep wool	Original	Material	TFpanel	2400	£ 6,428.04	0.00	£ -	**0.00**
Manufacture	Factory	Cost	TFpanel	**OPCL**	**Component**	Original	Manufacture	TFpanel	600	**£ 1,170.88**	£ 1,234.43	£ 55.14	**283624.98**
Manufacture	Factory	Cost	TFpanel	**OPCL**	**Component**	Original	Manufacture	TFpanel	1200	**£ 1,071.15**	£ 1,036.20	£ 50.55	**227083.13**
Manufacture	Factory	Cost	TFpanel	**OPCL**	**Component**	Original	Manufacture	TFpanel	1800	**£ 744.12**	£ 691.58	£ 35.12	**147454.92**
Manufacture	Factory	Cost	TFpanel	**OPCL**	**Component**	Original	Manufacture	TFpanel	2400	**£ 352.08**	£ 378.96	£ 16.58	**83327.78**
Manufacture	Site	Cost	TFpanel	**OPCL**	Warmcell	Original	Manufacture	TFpanel	600	£ -	£ 11.58		3182.61
Manufacture	Site	Cost	TFpanel	**OPCL**	Warmcell	Original	Manufacture	TFpanel	1200	£ -	£ 11.32		3112.17
Manufacture	Site	Cost	TFpanel	**OPCL**	Warmcell	Original	Manufacture	TFpanel	1800	£ -	£ 11.38		3128.02
Manufacture	Site	Cost	TFpanel	**OPCL**	Warmcell	Original	Manufacture	TFpanel	2400	£ -	£ 10.81		2971.28
Manufacture	Factory	Cost	TFpanel	**OPCL**	Rockwool	Original	Manufacture	TFpanel	600	£ 102.49	£ 97.14	£ 2,486.58	22605.31
Manufacture	Factory	Cost	TFpanel	**OPCL**	Rockwool	Original	Manufacture	TFpanel	1200	£ 55.35	£ 52.68	£ 1,348.40	12258.16
Manufacture	Factory	Cost	TFpanel	**OPCL**	Rockwool	Original	Manufacture	TFpanel	1800	£ 39.64	£ 37.86	£ 969.05	8809.59
Manufacture	Factory	Cost	TFpanel	**OPCL**	Rockwool	Original	Manufacture	TFpanel	2400	£ 31.78	£ 30.44	£ 779.30	7084.58
Manufacture	Factory	Cost	TFpanel	**OPCL**	Sheep wool	Original	Manufacture	TFpanel	600	£ 98.78	£ 93.70	£ 1,893.87	17217.00
Manufacture	Factory	Cost	TFpanel	**OPCL**	Sheep wool	Original	Manufacture	TFpanel	1200	£ 53.50	£ 50.96	£ 1,031.83	9380.25
Manufacture	Factory	Cost	TFpanel	**OPCL**	Sheep wool	Original	Manufacture	TFpanel	1800	£ 38.40	£ 36.71	£ 744.48	6768.00
Manufacture	Factory	Cost	TFpanel	**OPCL**	Sheep wool	Original	Manufacture	TFpanel	2400	£ 30.85	£ 29.58	£ 600.81	5461.88

Stage	Location	Parameter	Panel			Component	Proccess			cost		labour		power		time
Manufacture	Factory	cost	TFpanel	**OPCL**	**Component**	Original	Setup	TFpanel	600	£	33.33	£	2.40	£	-	660.00
Manufacture	Factory	cost	TFpanel	**OPCL**	**Component**	Original	Setup	TFpanel	1200	£	24.24	£	1.75	£	-	480.00
Manufacture	Factory	cost	TFpanel	**OPCL**	**Component**	Original	Setup	TFpanel	1800	£	45.45	£	3.28	£	-	900.00
Manufacture	Factory	cost	TFpanel	**OPCL**	**Component**	Original	Setup	TFpanel	2400	£	24.24	£	1.75	£	-	480.00
Assembly	Factory	Cost	TFpanel	**OPCL**	**Component**	Original	Assembly	TFpanel	600	**£**	**2,006.79**	£	4,282.08	£	-	**3.86E+05**
Assembly	Factory	Cost	TFpanel	**OPCL**	**Component**	Original	Assembly	TFpanel	1200	**£**	**1,133.01**	£	733.55	£	399.46	**2.18E+05**
Assembly	Factory	Cost	TFpanel	**OPCL**	**Component**	Original	Assembly	TFpanel	1800	**£**	**1,200.61**	£	777.32	£	423.29	**2.31E+05**
Assembly	Factory	Cost	TFpanel	**OPCL**	**Component**	Original	Assembly	TFpanel	2400	**£**	**967.11**	£	626.14	£	340.97	**2.57E+05**
Transport	Transport	Cost	Open	**OPCL**	**Building**	Original	Transport	SIP	600	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Open	**OPCL**	**Building**	Original	Transport	SIP	1200	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Closed	**OPCL**	**Building**	Original	Transport	SIP	600	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Closed	**OPCL**	**Building**	Original	Transport	SIP	1200	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Open	**OPCL**	**Building**	Original	Transport	TFpanel	600	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Open	**OPCL**	**Building**	Original	Transport	TFpanel	1200	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Open	**OPCL**	**Building**	Original	Transport	TFpanel	1800	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Open	**OPCL**	**Building**	Original	Transport	TFpanel	2400	£	132.00	£	-	£	-	0.00
Transport	Transport	Cost	Closed	**OPCL**	**Building**	Original	Transport	TFpanel	600	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Closed	**OPCL**	**Building**	Original	Transport	TFpanel	1200	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Closed	**OPCL**	**Building**	Original	Transport	TFpanel	1800	£	66.00	£	-	£	-	0.00
Transport	Transport	Cost	Closed	**OPCL**	**Building**	Original	Transport	TFpanel	2400	£	132.00	£	-	£	-	0.00
Transport	Transport	Cost	Volumetric	Volume	**Building**	Original	Transport	Volume	600	£	264.00	£	-	£	-	0.00
Transport	Transport	Cost	Volumetric	Volume	**Building**	Original	Transport	Volume	1200	£	264.00	£	-	£	-	0.00
Transport	Transport	Cost	Volumetric	Volume	**Building**	Original	Transport	Volume	1800	£	264.00	£	-	£	-	0.00
Transport	Transport	Cost	Volumetric	Volume	**Building**	Original	Transport	Volume	2400	£	264.00	£	-	£	-	0.00

Stage	Location	Parameter	Panel			Component	Proccess			cost	labour	power	time
Material	Factory	Cost	Cladding	**OPCL**	Z-shaped stone (	Original	Material	Any	600	£ 5,421.12	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Z-shaped stone (	Original	Material	Any	1200	£ 5,421.12	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Z-shaped stone (	Original	Material	Any	1800	£ 5,421.12	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Z-shaped stone (	Original	Material	Any	2400	£ 5,421.12	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Original	Material	Any	600	£ 8,016.01	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Original	Material	Any	1200	£ 8,016.01	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Original	Material	Any	1800	£ 8,016.01	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Original	Material	Any	2400	£ 8,016.01	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Zinc cladding	Original	Material	Any	600	£ 15,690.07	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Zinc cladding	Original	Material	Any	1200	£ 15,690.07	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Zinc cladding	Original	Material	Any	1800	£ 15,690.07	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Zinc cladding	Original	Material	Any	2400	£ 15,690.07	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Z-shaped stone (	Maintenance	Maintenance	Any	600	£ -	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Z-shaped stone (	Maintenance	Maintenance	Any	1200	£ -	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Z-shaped stone (	Maintenance	Maintenance	Any	1800	£ -	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Z-shaped stone (	Maintenance	Maintenance	Any	2400	£ -	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Maintenance	Maintenance	Any	600	£ 12,942.32	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Maintenance	Maintenance	Any	1200	£ 12,942.32	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Maintenance	Maintenance	Any	1800	£ 12,942.32	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Maintenance	Maintenance	Any	2400	£ 12,942.32	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Zinc cladding	Maintenance	Maintenance	Any	600	£ -	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Zinc cladding	Maintenance	Maintenance	Any	1200	£ -	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Zinc cladding	Maintenance	Maintenance	Any	1800	£ -	0	£ -	0.00
Material	Factory	Cost	Cladding	**OPCL**	Zinc cladding	Maintenance	Maintenance	Any	2400	£ -	0	£ -	0.00

Stage	Location	Parameter	Panel			Component	Proccess			cost	labour	power	time
Manufacture	Site	Cost	Cladding	**OPCL**	Z-shaped stone	Original	Manufacture	Any	600	£ -	£ -		
Manufacture	Site	Cost	Cladding	**OPCL**	Z-shaped stone	Original	Manufacture	Any	1200	£ -	£ -		
Manufacture	Site	Cost	Cladding	**OPCL**	Z-shaped stone	Original	Manufacture	Any	1800	£ -	£ -		
Manufacture	Site	Cost	Cladding	**OPCL**	Z-shaped stone	Original	Manufacture	Any	2400	£ -	£ -		
Manufacture	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Original	Manufacture	Any	600	£ 400.17	£ 1.46	£ 44.02	400.17
Manufacture	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Original	Manufacture	Any	1200	£ 421.57	£ 1.53	£ 46.37	421.57
Manufacture	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Original	Manufacture	Any	1800	£ 443.01	£ 1.61	£ 48.73	443.01
Manufacture	Factory	Cost	Cladding	**OPCL**	Western Red Ce	Original	Manufacture	Any	2400	£ 422.23	£ 1.54	£ 46.44	422.23
Manufacture	Site	Cost	Cladding	**OPCL**	Zinc cladding	Original	Manufacture	Any	600	£ -	£ -		
Manufacture	Site	Cost	Cladding	**OPCL**	Zinc cladding	Original	Manufacture	Any	1200	£ -	£ -		
Manufacture	Site	Cost	Cladding	**OPCL**	Zinc cladding	Original	Manufacture	Any	1800	£ -	£ -		
Manufacture	Site	Cost	Cladding	**OPCL**	Zinc cladding	Original	Manufacture	Any	2400	£ -	£ -		
Assembly	Site	Cost	Cladding	**OPCL**	Z-shaped stone	Original	Assembly	Any	600	£ 7,370.80	£ 81.51		2.24E+04
Assembly	Site	Cost	Cladding	**OPCL**	Z-shaped stone	Original	Assembly	Any	1200	£ 7,370.80	£ 81.51		2.24E+04
Assembly	Site	Cost	Cladding	**OPCL**	Z-shaped stone	Original	Assembly	Any	1800	£ 7,370.80	£ 81.51		2.24E+04
Assembly	Site	Cost	Cladding	**OPCL**	Z-shaped stone	Original	Assembly	Any	2400	£ 7,370.80	£ 81.51		2.24E+04
Assembly	Site	Cost	Cladding	**OPCL**	Western Red Ce	Original	Assembly	Any	600	£ 165.90	£ 175.99		4.84E+04
Assembly	Site	Cost	Cladding	**OPCL**	Western Red Ce	Original	Assembly	Any	1200	£ 173.80	£ 175.99		4.84E+04
Assembly	Site	Cost	Cladding	**OPCL**	Western Red Ce	Original	Assembly	Any	1800	£ 181.70	£ 175.99		4.84E+04
Assembly	Site	Cost	Cladding	**OPCL**	Western Red Ce	Original	Assembly	Any	2400	£ 173.80	£ 175.99		4.84E+04
Assembly	Site	Cost	Cladding	**OPCL**	Zinc cladding	Original	Assembly	Any	600	£ 4,282.08	£ 40.50		1.11E+04
Assembly	Site	Cost	Cladding	**OPCL**	Zinc cladding	Original	Assembly	Any	1200	£ 4,282.08	£ 40.50		1.11E+04
Assembly	Site	Cost	Cladding	**OPCL**	Zinc cladding	Original	Assembly	Any	1800	£ 4,282.08	£ 40.50		1.11E+04
Assembly	Site	Cost	Cladding	**OPCL**	Zinc cladding	Original	Assembly	Any	2400	£ 4,282.08	£ 40.50		1.11E+04

Stage	Location	Parameter	Panel			Component	Proccess			cost	labour	power	time
Manufacture	Factory	Cost	SIP Panel	**OPCL**	Lining	Original	Manufacture	SIP Panel	600	£ 43.74	£ 11.17	£ 278.72	2533.78
Manufacture	Factory	Cost	SIP Panel	**OPCL**	Lining	Original	Manufacture	SIP Panel	1200	£ 36.52	£ 9.38	£ 232.26	2111.48
Manufacture	Factory	Cost	SIP Panel	**OPCL**	Lining	Maintenance	Manufacture	SIP Panel	600	£ 43.74	£ 32.57	£ 800.55	7277.72
Manufacture	Factory	Cost	SIP Panel	**OPCL**	Lining	Maintenance	Manufacture	SIP Panel	1200	£ 43.74	£ 27.14	£ 667.12	6064.77
Assembly	**Site**	Cost	TFpanel	**OPCL**	**Building**	Original	Setup	TFpanel	600	£ -	£ -		
Assembly	**Site**	Cost	TFpanel	**OPCL**	**Building**	Original	Setup	TFpanel	1200	£ -	£ -		
Assembly	**Site**	Cost	TFpanel	**OPCL**	**Building**	Original	Setup	TFpanel	1800	£ -	£ -		
Assembly	**Site**	Cost	TFpanel	**OPCL**	**Building**	Original	Setup	TFpanel	2400	£ -	£ -		
Manufacture	**Site**	Cost	SIP Panel	**OPCL**	**Building**	Original	Setup	SIP	600	£ -	£ -		
Manufacture	**Site**	Cost	SIP Panel	**OPCL**	**Building**	Original	Setup	SIP	1200	£ -	£ -		
Assembly	Site	Cost	Open	**OPCL**	**Building**	Original	Assembly	SIP	600	£ 2,542.05	£ 2,542.05	0.00E+00	6.99E+05
Assembly	Site	Cost	Open	**OPCL**	**Building**	Original	Assembly	SIP	1200	£ 1,961.74	£ 1,961.74	0.00E+00	5.39E+05
Assembly	Site	Cost	Open	**OPCL**	**Building**	Original	Assembly	TFpanel	600	£ 2,542.05	£ 2,542.05		6.99E+05
Assembly	Site	Cost	Open	**OPCL**	**Building**	Original	Assembly	TFpanel	1200	£ 1,961.74	£ 1,961.74		5.39E+05
Assembly	Site	Cost	Open	**OPCL**	**Building**	Original	Assembly	TFpanel	1800	£ 1,306.11	£ 1,306.11		3.59E+05
Assembly	Site	Cost	Open	**OPCL**	**Building**	Original	Assembly	TFpanel	2400	£ 1,132.35	£ 1,132.35		3.11E+05
Assembly	Site	Cost	Closed	**OPCL**	**Building**	Original	Assembly	TFpanel	600	£ 4,866.92	**4867**		1.08E+06
Assembly	Site	Cost	Closed	**OPCL**	**Building**	Original	Assembly	TFpanel	1200	£ 3,908.23	**3908**		8.65E+05
Assembly	Site	Cost	Closed	**OPCL**	**Building**	Original	Assembly	TFpanel	1800	£ 3,978.56	**3979**		8.80E+05
Assembly	Site	Cost	Closed	**OPCL**	**Building**	Original	Assembly	TFpanel	2400	£ 3,742.30	**3742**		8.28E+05

Stage	Location	Parameter	Panel			Component	Proccess			cost	labour	power	time
Assembly	Site	Cost	Volumetric	Volume	**Building**	Original	Assembly	Volumetric	600	£ 8,921.10	£ 8,921.10		2.45E+06
Assembly	Site	Cost	Volumetric	Volume	**Building**	Original	Assembly	Volumetric	1200	£ 3,851.40	£ 3,851.40		1.06E+06
Assembly	Site	Cost	Volumetric	Volume	**Building**	Original	Assembly	Volumetric	1800	£ 3,026.10	£ 3,026.10		8.32E+05
Assembly	Site	Cost	Volumetric	Volume	**Building**	Original	Assembly	Volumetric	2400	£ 3,026.10	£ 3,026.10		8.32E+05
Manufacture	**Site**	Cost	TFpanel	**OPCL**	**Building**	Original	Setup	TFpanel	600	£ -	£ -		
Manufacture	**Site**	Cost	TFpanel	**OPCL**	**Building**	Original	Setup	TFpanel	1200	£ -	£ -		
Manufacture	**Site**	Cost	TFpanel	**OPCL**	**Building**	Original	Setup	TFpanel	1800	£ -	£ -		
Manufacture	**Site**	Cost	TFpanel	**OPCL**	**Building**	Original	Setup	TFpanel	2400	£ -	£ -		
Disposal	**Site**	Cost	TFpanel	**OPCL**	**Building**	End of life	Waste	TFpanel	600	£ 1,056.92	0		0
Disposal	**Site**	Cost	TFpanel	**OPCL**	**Building**	End of life	Waste	TFpanel	1200	£ 966.34	0		0
Disposal	**Site**	Cost	TFpanel	**OPCL**	**Building**	End of life	Waste	TFpanel	1800	£ 919.23	0		0
Disposal	**Site**	Cost	TFpanel	**OPCL**	**Building**	End of life	Waste	TFpanel	2400	£ 843.21	0		0
Disposal	**Site**	Cost	SIP Panel	**OPCL**	**Building**	End of life	Waste	SIP Panel	600	£ 945.94	0		0
Disposal	**Site**	Cost	SIP Panel	**OPCL**	**Building**	End of life	Waste	SIP Panel	1200	£ 851.83	0		0
Disposal	**Site**	Cost	Cladding	**OPCL**	**Z-shaped stone**	End of life	Waste	Cladding	-	£ 434.49	0		0
Disposal	**Site**	Cost	Cladding	**OPCL**	**Zinc cladding**	End of life	Waste	Cladding	--	£ 73.07	0		0
Disposal	**Site**	Cost	Cladding	**OPCL**	**Western Red Ce**	End of life	Waste	Cladding	-	202.6940259	0		0
Disposal	Factory	Cost	SIP Panel	**OPCL**	Lining	End of life	Waste	SIP Panel	600	£ 223.05	0	0	0
Disposal	Factory	Cost	SIP Panel	**OPCL**	Lining	End of life	Waste	SIP Panel	1200	£ 268.92	0	0	0
Disposal	Factory	Cost	TFpanel	**OPCL**	Lining	End of life	Waste	TFpanel	600	£ 223.05	0	0	0
Disposal	Factory	Cost	TFpanel	**OPCL**	Lining	End of life	Waste	TFpanel	1200	£ 268.92	0	0	0
Disposal	Factory	Cost	TFpanel	**OPCL**	Lining	End of life	Waste	TFpanel	1800	£ 193.14	0	0	0
Disposal	Factory	Cost	TFpanel	**OPCL**	Lining	End of life	Waste	TFpanel	2400	£ 178.16	0	0	0

Stage	Location	Parameter	Panel			Component	Proccess			cost	labour	power	time
Material	Factory	Cost	TFpanel	Volume	Component	volume	Material	TFpanel	1200	£ 16,749.19	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	Volume	Component	volume	Material	TFpanel	1800	£ 9,361.19	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	Volume	Component	volume	Material	TFpanel	2400	£ 6,653.67	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	Volume	Component	volume	Material	TFpanel	600	£ 6,900.01	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	Volume	Component	Maintenance	Material	TFpanel	1200	£ -	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	Volume	Component	Maintenance	Material	TFpanel	1800	£ -	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	Volume	Component	Maintenance	Material	TFpanel	2400	£ -	0.00	£ -	0.00
Material	Factory	Cost	TFpanel	Volume	Component	Maintenance	Material	TFpanel	600	£ -	0.00	£ -	0.00
Material	Factory	Cost	Volumetric	Volume	Lining	Original	Material	Volumetric	600	£ 192.62	0.00	£ -	0.00
Material	Factory	Cost	Volumetric	Volume	Lining	Original	Material	Volumetric	1200	£ 179.21	0.00	£ -	0.00
Material	Factory	Cost	Volumetric	Volume	Lining	Original	Material	Volumetric	1800	£ 126.42	0.00	£ -	0.00
Material	Factory	Cost	Volumetric	Volume	Lining	Original	Material	Volumetric	2400	£ 126.36	0.00	£ -	0.00
Material	Factory	Cost	SIP Panel	volume	Component	Original	Material	SIP	600				
Material	Factory	Cost	SIP Panel	volume	Component	Original	Material	SIP	1200				
Manufacture	Factory	Cost	SIP Panel	volume	Component	Original	Manufacture	SIP	600				
Manufacture	Factory	Cost	SIP Panel	volume	Component	Original	Manufacture	SIP	1200				
Assembly	Factory	Cost	SIP Panel	volume	Component	Original	Setup	SIP	600				
Assembly	Factory	Cost	SIP Panel	volume	Component	Original	Setup	SIP	1200				

Stage	Location	Parameter	Panel			Component	Proccess			cost	labour	power	time
Material	Factory	Cost	TFpanel	**volume**	**Lining**	Original	Material	TFpanel	600	£ 263.15			
Material	Factory	Cost	TFpanel	**volume**	**Lining**	Original	Material	TFpanel	1200	£ 179.21			
Material	Factory	Cost	TFpanel	**volume**	**Lining**	Original	Material	TFpanel	1800	£ 126.42			
Material	Factory	Cost	TFpanel	**volume**	**Lining**	Original	Material	TFpanel	2400	£ 126.36			
Manufacture	Factory	Cost	TFpanel	**volume**	Lining	Original	Manufacture	TFpanel	600	£ 314.09			
Manufacture	Factory	Cost	TFpanel	**volume**	Lining	Original	Manufacture	TFpanel	1200	£ 185.68			
Manufacture	Factory	Cost	TFpanel	**volume**	Lining	Original	Manufacture	TFpanel	1800	£ 80.38			
Manufacture	Factory	Cost	TFpanel	**volume**	Lining	Original	Manufacture	TFpanel	2400	£ 2.12			
Manufacture	Factory	Cost	TFpanel	**volume**	Lining	Maintenance	Manufacture	TFpanel	600	£ 203.19			
Manufacture	Factory	Cost	TFpanel	**volume**	Lining	Maintenance	Manufacture	TFpanel	1200	£ 557.03			
Manufacture	Factory	Cost	TFpanel	**volume**	Lining	Maintenance	Manufacture	TFpanel	1800	£ 241.14			
Manufacture	Factory	Cost	TFpanel	**volume**	Lining	Maintenance	Manufacture	TFpanel	2400	£ 6.36			
Manufacture	Factory	cost	TFpanel	**volume**	**Component**	Original	Setup	TFpanel	600	£ 106.05			
Manufacture	Factory	cost	TFpanel	**volume**	**Component**	Original	Setup	TFpanel	1200	£ 72.72			
Manufacture	Factory	cost	TFpanel	**volume**	**Component**	Original	Setup	TFpanel	1800	£ 75.75			
Manufacture	Factory	cost	TFpanel	**volume**	**Component**	Original	Setup	TFpanel	2400	£ 57.57			
Manufacture	Factory	Cost	SIP Panel	**volume**	Lining	Original	Manufacture	SIP Panel	600				
Manufacture	Factory	Cost	SIP Panel	**volume**	Lining	Original	Manufacture	SIP Panel	1200				
Manufacture	Factory	Cost	SIP Panel	**volume**	Lining	Maintenance	Manufacture	SIP Panel	600				
Manufacture	Factory	Cost	SIP Panel	**volume**	Lining	Maintenance	Manufacture	SIP Panel	1200				
Manufacture	**Site**	Cost	SIP Panel	**volume**	**Building**	Original	Setup	SIP	600				
Manufacture	**Site**	Cost	SIP Panel	**volume**	**Building**	Original	Setup	SIP	1200				
Disposal	**Site**	Cost	TFpanel	**volume**	**Building**	End of life	Waste	TFpanel	600	£ 2,214.84			0.00E+00
Disposal	**Site**	Cost	TFpanel	**volume**	**Building**	End of life	Waste	TFpanel	1200	£ 1,441.57			0.00E+00
Disposal	**Site**	Cost	TFpanel	**volume**	**Building**	End of life	Waste	TFpanel	1800	£ 1,170.68			0.00E+00
Disposal	**Site**	Cost	TFpanel	**volume**	**Building**	End of life	Waste	TFpanel	2400	£ 1,233.26			0.00E+00
Disposal	**Site**	Cost	SIP Panel	**volume**	**Building**	End of life	Waste	SIP Panel	600				
Disposal	**Site**	Cost	SIP Panel	**volume**	**Building**	End of life	Waste	SIP Panel	1200				
Disposal	Factory	Cost	SIP Panel	**volume**	Lining	End of life	Waste	SIP Panel	600				
Disposal	Factory	Cost	SIP Panel	**volume**	Lining	End of life	Waste	SIP Panel	1200				
Disposal	Factory	Cost	TFpanel	**volume**	Lining	End of life	Waste	TFpanel	600	£ 461.91			0.00E+00
Disposal	Factory	Cost	TFpanel	**volume**	Lining	End of life	Waste	TFpanel	1200	£ 278.04			0.00E+00
Disposal	Factory	Cost	TFpanel	**volume**	Lining	End of life	Waste	TFpanel	1800	£ 196.14			0.00E+00
Disposal	Factory	Cost	TFpanel	**volume**	Lining	End of life	Waste	TFpanel	2400	£ 196.04			0.00E+00

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Cost				Transport	Assembly	Structural assembly	Disposal	Total cost
										factory; TF/SIP components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance materials manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	**Structural Frame Materials and** Assembly	Disposal	
1	**traditional**									£ 18,794.92								**£ 18,794.92**
2	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 8,416	£ 3,000	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,279.97	**£ 33,641.05**
3	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 8,416	£ 3,913	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,279.97	**£ 34,553.92**
4	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 8,416	£ 6,527	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,279.97	**£ 37,167.88**
5	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 5,421	£ 3,000	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,279.97	**£ 30,645.99**
6	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 5,421	£ 3,913	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,279.97	**£ 31,558.85**
7	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 5,421	£ 6,527	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,279.97	**£ 34,172.82**
8	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 15,690	£ 3,000	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,279.97	**£ 40,914.94**
9	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 15,690	£ 3,913	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,279.97	**£ 41,827.80**
10	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 15,690	£ 6,527	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,279.97	**£ 44,441.77**
11	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 8,416	£ 3,000	£ 132.00	£ 4,866.92	£ -	£ 1,279.97	**£ 31,073.91**
12	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 8,416	£ 3,913	£ 132.00	£ 4,866.92	£ -	£ 1,279.97	**£ 31,986.77**
13	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 8,416	£ 6,527	£ 132.00	£ 4,866.92	£ -	£ 1,279.97	**£ 34,600.73**
14	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 5,421	£ 3,000	£ 132.00	£ 4,866.92	£ -	£ 1,279.97	**£ 28,078.84**
15	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 5,421	£ 3,913	£ 132.00	£ 4,866.92	£ -	£ 1,279.97	**£ 28,991.71**
16	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 5,421	£ 6,527	£ 132.00	£ 4,866.92	£ -	£ 1,279.97	**£ 31,605.67**
17	TFpanel	TF/SIP	**600**	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 15,690	£ 3,000	£ 132.00	£ 4,866.92	£ -	£ 1,279.97	**£ 38,347.80**
18	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 15,690	£ 3,913	£ 132.00	£ 4,866.92	£ -	£ 1,279.97	**£ 39,260.66**
19	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 15,690	£ 6,527	£ 132.00	£ 4,866.92	£ -	£ 1,279.97	**£ 41,874.62**
20	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 8,416	£ 3,000	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,279.97	**£ 34,054.14**
21	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 8,416	£ 3,913	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,279.97	**£ 34,967.00**
22	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 8,416	£ 6,527	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,279.97	**£ 37,580.97**
23	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 5,421	£ 3,000	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,279.97	**£ 31,059.08**
24	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 5,421	£ 3,913	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,279.97	**£ 31,971.94**
25	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 5,421	£ 6,527	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,279.97	**£ 34,585.90**
26	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 15,690	£ 3,000	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,279.97	**£ 41,328.03**
27	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 15,690	£ 3,913	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,279.97	**£ 42,240.89**
28	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 15,690	£ 6,527	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,279.97	**£ 44,854.86**
29	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 8,416	£ 3,000	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,279.97	**£ 33,858.23**
30	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 8,416	£ 3,913	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,279.97	**£ 34,771.09**
31	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 8,416	£ 6,527	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,279.97	**£ 37,385.06**
32	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 5,421	£ 3,000	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,279.97	**£ 30,863.16**
33	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 5,421	£ 3,913	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,279.97	**£ 31,776.03**
34	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 5,421	£ 6,527	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,279.97	**£ 34,389.99**
35	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 15,690	£ 3,000	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,279.97	**£ 41,132.12**
36	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 15,690	£ 3,913	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,279.97	**£ 42,044.98**
37	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 15,690	£ 6,527	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,279.97	**£ 44,658.94**
38	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 8,416	£ 3,000	£ 132.00	£ 5,084.10	£ -	£ 1,279.97	**£ 31,291.08**
39	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 8,416	£ 3,913	£ 132.00	£ 5,084.10	£ -	£ 1,279.97	**£ 32,203.95**
40	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 8,416	£ 6,527	£ 132.00	£ 5,084.10	£ -	£ 1,279.97	**£ 34,817.91**
41	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 5,421	£ 3,000	£ 132.00	£ 5,084.10	£ -	£ 1,279.97	**£ 28,296.02**
42	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 5,421	£ 3,913	£ 132.00	£ 5,084.10	£ -	£ 1,279.97	**£ 29,208.88**
43	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 5,421	£ 6,527	£ 132.00	£ 5,084.10	£ -	£ 1,279.97	**£ 31,822.85**
44	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 15,690	£ 3,000	£ 132.00	£ 5,084.10	£ -	£ 1,279.97	**£ 38,564.97**
45	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 15,690	£ 3,913	£ 132.00	£ 5,084.10	£ -	£ 1,279.97	**£ 39,477.83**
46	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 15,690	£ 6,527	£ 132.00	£ 5,084.10	£ -	£ 1,279.97	**£ 42,091.80**
47	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 8,416	£ 3,000	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,279.97	**£ 34,271.32**
48	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 8,416	£ 3,913	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,279.97	**£ 35,184.18**
49	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 8,416	£ 6,527	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,279.97	**£ 37,798.14**
50	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 5,421	£ 3,000	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,279.97	**£ 31,276.25**
51	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 5,421	£ 3,913	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,279.97	**£ 32,189.11**
52	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 5,421	£ 6,527	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,279.97	**£ 34,803.08**
53	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 13,664.41	£ 994	£ 15,690	£ 3,000	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,279.97	**£ 41,545.21**
54	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 13,664.41	£ 994	£ 15,690	£ 3,913	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,279.97	**£ 42,458.07**
55	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 13,664.41	£ 994	£ 15,690	£ 6,527	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,279.97	**£ 45,072.03**
56	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 7,006.06	£ 973	£ 8,416	£ 3,000	£ 264.00	£ 8,921.10	£ 2,567.15	£ 2,676.75	**£ 31,147.55**
57	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 7,006.06	£ 973	£ 8,416	£ 3,913	£ 264.00	£ 8,921.10	£ 2,567.15	£ 2,676.75	**£ 32,060.41**
58	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 7,006.06	£ 973	£ 8,416	£ 6,527	£ 264.00	£ 8,921.10	£ 2,567.15	£ 2,676.75	**£ 34,674.38**
59	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 7,006.06	£ 973	£ 5,421	£ 3,000	£ 264.00	£ 8,921.10	£ 2,567.15	£ 2,676.75	**£ 28,152.49**
60	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 7,006.06	£ 973	£ 5,421	£ 3,913	£ 264.00	£ 8,921.10	£ 2,567.15	£ 2,676.75	**£ 29,065.35**
61	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 7,006.06	£ 973	£ 5,421	£ 6,527	£ 264.00	£ 8,921.10	£ 2,567.15	£ 2,676.75	**£ 31,679.31**
62	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 7,006.06	£ 973	£ 15,690	£ 3,000	£ 264.00	£ 8,921.10	£ 2,567.15	£ 2,676.75	**£ 38,421.44**
63	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 7,006.06	£ 973	£ 15,690	£ 3,913	£ 264.00	£ 8,921.10	£ 2,567.15	£ 2,676.75	**£ 39,334.30**
64	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 7,006.06	£ 973	£ 15,690	£ 6,527	£ 264.00	£ 8,921.10	£ 2,567.15	£ 2,676.75	**£ 41,948.27**
65	TFpanel	TF/SIP	**600**	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 7,006.06	£ 973	£ 8,416	£ 3,000	£ 264.00	£ 8,921.10	£ -	£ 2,676.75	**£ 28,580.41**
66	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 7,006.06	£ 973	£ 8,416	£ 3,913	£ 264.00	£ 8,921.10	£ -	£ 2,676.75	**£ 29,493.27**
67	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 7,006.06	£ 973	£ 8,416	£ 6,527	£ 264.00	£ 8,921.10	£ -	£ 2,676.75	**£ 32,107.23**
68	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 7,006.06	£ 973	£ 5,421	£ 3,000	£ 264.00	£ 8,921.10	£ -	£ 2,676.75	**£ 25,585.34**
69	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 7,006.06	£ 973	£ 5,421	£ 3,913	£ 264.00	£ 8,921.10	£ -	£ 2,676.75	**£ 26,498.20**
70	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 7,006.06	£ 973	£ 5,421	£ 6,527	£ 264.00	£ 8,921.10	£ -	£ 2,676.75	**£ 29,112.17**
71	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 7,006.06	£ 973	£ 15,690	£ 3,000	£ 264.00	£ 8,921.10	£ -	£ 2,676.75	**£ 35,854.29**
72	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 7,006.06	£ 973	£ 15,690	£ 3,913	£ 264.00	£ 8,921.10	£ -	£ 2,676.75	**£ 36,767.16**
73	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 7,006.06	£ 973	£ 15,690	£ 6,527	£ 264.00	£ 8,921.10	£ -	£ 2,676.75	**£ 39,381.12**
74	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 7,006.06	£ 973	£ 8,416	£ 3,000	£ 264.00	£ 8,921.10	£ 2,980.23	£ 2,676.75	**£ 31,560.64**
75	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 7,006.06	£ 973	£ 8,416	£ 3,913	£ 264.00	£ 8,921.10	£ 2,980.23	£ 2,676.75	**£ 32,473.50**
76	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 7,006.06	£ 973	£ 8,416	£ 6,527	£ 264.00	£ 8,921.10	£ 2,980.23	£ 2,676.75	**£ 35,087.47**
77	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 7,006.06	£ 973	£ 5,421	£ 3,000	£ 264.00	£ 8,921.10	£ 2,980.23	£ 2,676.75	**£ 28,565.58**
78	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 7,006.06	£ 973	£ 5,421	£ 3,913	£ 264.00	£ 8,921.10	£ 2,980.23	£ 2,676.75	**£ 29,478.44**
79	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 7,006.06	£ 973	£ 5,421	£ 6,527	£ 264.00	£ 8,921.10	£ 2,980.23	£ 2,676.75	**£ 32,092.40**
80	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 7,006.06	£ 973	£ 15,690	£ 3,000	£ 264.00	£ 8,921.10	£ 2,980.23	£ 2,676.75	**£ 38,834.53**
81	TFpanel	TF/SIP	**600**	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 7,006.06	£ 973	£ 15,690	£ 3,913	£ 264.00	£ 8,921.10	£ 2,980.23	£ 2,676.75	**£ 39,747.39**
82	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 7,006.06	£ 973	£ 15,690	£ 6,527	£ 264.00	£ 8,921.10	£ 2,980.23	£ 2,676.75	**£ 42,361.35**
83	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 8,438	£ 3,000	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,235.26	**£ 31,458.25**
84	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 8,438	£ 3,866	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,235.26	**£ 32,323.97**
85	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 8,438	£ 6,482	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,235.26	**£ 34,939.79**

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Cost				Transport	Assembly	Structural assembly	Disposal	Total cost
										factory; TF/SIP components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance materials manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	**Structural Frame Materials and** Assembly	Disposal	
86	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 5,421	£ 3,000	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,235.26	**£ 28,441.78**
87	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 5,421	£ 3,866	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,235.26	**£ 29,307.51**
88	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 5,421	£ 6,482	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,235.26	**£ 31,923.33**
89	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 15,690	£ 3,000	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,235.26	**£ 38,710.74**
90	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 15,690	£ 3,866	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,235.26	**£ 39,576.46**
91	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 15,690	£ 6,482	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,235.26	**£ 42,192.28**
92	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 8,438	£ 3,000	£ 132.00	£ 3,908.23	£ -	£ 1,235.26	**£ 28,891.10**
93	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 8,438	£ 3,866	£ 132.00	£ 3,908.23	£ -	£ 1,235.26	**£ 29,756.83**
94	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 8,438	£ 6,482	£ 132.00	£ 3,908.23	£ -	£ 1,235.26	**£ 32,372.65**
95	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 5,421	£ 3,000	£ 132.00	£ 3,908.23	£ -	£ 1,235.26	**£ 25,874.64**
96	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 5,421	£ 3,866	£ 132.00	£ 3,908.23	£ -	£ 1,235.26	**£ 26,740.36**
97	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 5,421	£ 6,482	£ 132.00	£ 3,908.23	£ -	£ 1,235.26	**£ 29,356.18**
98	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 15,690	£ 3,000	£ 132.00	£ 3,908.23	£ -	£ 1,235.26	**£ 36,143.59**
99	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 15,690	£ 3,866	£ 132.00	£ 3,908.23	£ -	£ 1,235.26	**£ 37,009.31**
100	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 15,690	£ 6,482	£ 132.00	£ 3,908.23	£ -	£ 1,235.26	**£ 39,625.13**
101	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 8,438	£ 3,000	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,235.26	**£ 31,871.34**
102	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 8,438	£ 3,866	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,235.26	**£ 32,737.06**
103	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 8,438	£ 6,482	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,235.26	**£ 35,352.88**
104	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 5,421	£ 3,000	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,235.26	**£ 28,854.87**
105	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 5,421	£ 3,866	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,235.26	**£ 29,720.59**
106	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 5,421	£ 6,482	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,235.26	**£ 32,336.41**
107	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 15,690	£ 3,000	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,235.26	**£ 39,123.82**
108	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 15,690	£ 3,866	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,235.26	**£ 39,989.55**
109	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 15,690	£ 6,482	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,235.26	**£ 42,605.37**
110	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 8,438	£ 3,000	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,235.26	**£ 31,473.51**
111	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 8,438	£ 3,866	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,235.26	**£ 32,339.23**
112	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 8,438	£ 6,482	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,235.26	**£ 34,955.05**
113	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 5,421	£ 3,000	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,235.26	**£ 28,457.05**
114	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 5,421	£ 3,866	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,235.26	**£ 29,322.77**
115	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 5,421	£ 6,482	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,235.26	**£ 31,938.59**
116	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 15,690	£ 3,000	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,235.26	**£ 38,726.00**
117	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 15,690	£ 3,866	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,235.26	**£ 39,591.72**
118	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 15,690	£ 6,482	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,235.26	**£ 42,207.54**
119	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 8,438	£ 3,000	£ 132.00	£ 3,923.49	£ -	£ 1,235.26	**£ 28,906.37**
120	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 8,438	£ 3,866	£ 132.00	£ 3,923.49	£ -	£ 1,235.26	**£ 29,772.09**
121	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 8,438	£ 6,482	£ 132.00	£ 3,923.49	£ -	£ 1,235.26	**£ 32,387.91**
122	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 5,421	£ 3,000	£ 132.00	£ 3,923.49	£ -	£ 1,235.26	**£ 25,889.90**
123	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 5,421	£ 3,866	£ 132.00	£ 3,923.49	£ -	£ 1,235.26	**£ 26,755.62**
124	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 5,421	£ 6,482	£ 132.00	£ 3,923.49	£ -	£ 1,235.26	**£ 29,371.44**
125	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 15,690	£ 3,000	£ 132.00	£ 3,923.49	£ -	£ 1,235.26	**£ 36,158.85**
126	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 15,690	£ 3,866	£ 132.00	£ 3,923.49	£ -	£ 1,235.26	**£ 37,024.58**
127	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 15,690	£ 6,482	£ 132.00	£ 3,923.49	£ -	£ 1,235.26	**£ 39,640.40**
128	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 8,438	£ 3,000	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,235.26	**£ 31,886.60**
129	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 8,438	£ 3,866	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,235.26	**£ 32,752.32**
130	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 8,438	£ 6,482	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,235.26	**£ 35,368.14**
131	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 5,421	£ 3,000	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,235.26	**£ 28,870.13**
132	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 5,421	£ 3,866	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,235.26	**£ 29,735.86**
133	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 5,421	£ 6,482	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,235.26	**£ 32,351.68**
134	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 12,272.01	£ 1,141	£ 15,690	£ 3,000	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,235.26	**£ 39,139.09**
135	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 12,272.01	£ 1,141	£ 15,690	£ 3,866	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,235.26	**£ 40,004.81**
136	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 12,272.01	£ 1,141	£ 15,690	£ 6,482	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,235.26	**£ 42,620.63**
137	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 16,821.91	£ 1,101	£ 8,438	£ 3,000	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,719.62	**£ 36,043.18**
138	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 16,821.91	£ 1,101	£ 8,438	£ 3,866	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,719.62	**£ 36,908.90**
139	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 16,821.91	£ 1,101	£ 8,438	£ 6,482	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,719.62	**£ 39,524.72**
140	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 16,821.91	£ 1,101	£ 5,421	£ 3,000	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,719.62	**£ 33,026.71**
141	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 16,821.91	£ 1,101	£ 5,421	£ 3,866	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,719.62	**£ 33,892.43**
142	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 16,821.91	£ 1,101	£ 5,421	£ 6,482	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,719.62	**£ 36,508.25**
143	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 16,821.91	£ 1,101	£ 15,690	£ 3,000	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,719.62	**£ 43,295.66**
144	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 16,821.91	£ 1,101	£ 15,690	£ 3,866	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,719.62	**£ 44,161.39**
145	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 16,821.91	£ 1,101	£ 15,690	£ 6,482	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,719.62	**£ 46,777.21**
146	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 16,821.91	£ 1,101	£ 8,438	£ 3,000	£ 264.00	£ 3,851.40	£ -	£ 1,719.62	**£ 33,476.03**
147	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 16,821.91	£ 1,101	£ 8,438	£ 3,866	£ 264.00	£ 3,851.40	£ -	£ 1,719.62	**£ 34,341.75**
148	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 16,821.91	£ 1,101	£ 8,438	£ 6,482	£ 264.00	£ 3,851.40	£ -	£ 1,719.62	**£ 36,957.57**
149	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 16,821.91	£ 1,101	£ 5,421	£ 3,000	£ 264.00	£ 3,851.40	£ -	£ 1,719.62	**£ 30,459.57**
150	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 16,821.91	£ 1,101	£ 5,421	£ 3,866	£ 264.00	£ 3,851.40	£ -	£ 1,719.62	**£ 31,325.29**
151	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 16,821.91	£ 1,101	£ 5,421	£ 6,482	£ 264.00	£ 3,851.40	£ -	£ 1,719.62	**£ 33,941.11**
152	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 16,821.91	£ 1,101	£ 15,690	£ 3,000	£ 264.00	£ 3,851.40	£ -	£ 1,719.62	**£ 40,728.52**
153	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 16,821.91	£ 1,101	£ 15,690	£ 3,866	£ 264.00	£ 3,851.40	£ -	£ 1,719.62	**£ 41,594.24**
154	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 16,821.91	£ 1,101	£ 15,690	£ 6,482	£ 264.00	£ 3,851.40	£ -	£ 1,719.62	**£ 44,210.06**
155	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 16,821.91	£ 1,101	£ 8,438	£ 3,000	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,719.62	**£ 36,456.27**
156	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 16,821.91	£ 1,101	£ 8,438	£ 3,866	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,719.62	**£ 37,321.99**
157	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 16,821.91	£ 1,101	£ 8,438	£ 6,482	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,719.62	**£ 39,937.81**
158	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 16,821.91	£ 1,101	£ 5,421	£ 3,000	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,719.62	**£ 33,439.80**
159	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 16,821.91	£ 1,101	£ 5,421	£ 3,866	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,719.62	**£ 34,305.52**
160	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 16,821.91	£ 1,101	£ 5,421	£ 6,482	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,719.62	**£ 36,921.34**
161	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 16,821.91	£ 1,101	£ 15,690	£ 3,000	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,719.62	**£ 43,708.75**
162	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 16,821.91	£ 1,101	£ 15,690	£ 3,866	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,719.62	**£ 44,574.47**
163	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 16,821.91	£ 1,101	£ 15,690	£ 6,482	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,719.62	**£ 47,190.29**
164	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 8,459	£ 3,000	£ 66.00	£ 3,978.56	£ 2,567.15	£ 1,112.37	**£ 29,048.03**
165	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 8,459	£ 3,850	£ 66.00	£ 3,978.56	£ 2,567.15	£ 1,112.37	**£ 29,898.04**
166	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 8,459	£ 6,466	£ 66.00	£ 3,978.56	£ 2,567.15	£ 1,112.37	**£ 32,514.48**
167	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 5,421	£ 3,000	£ 66.00	£ 3,978.56	£ 2,567.15	£ 1,112.37	**£ 26,010.13**
168	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 5,421	£ 3,850	£ 66.00	£ 3,978.56	£ 2,567.15	£ 1,112.37	**£ 26,860.14**
169	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 5,421	£ 6,466	£ 66.00	£ 3,978.56	£ 2,567.15	£ 1,112.37	**£ 29,476.58**
170	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 15,690	£ 3,000	£ 66.00	£ 3,978.56	£ 2,567.15	£ 1,112.37	**£ 36,279.08**

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Cost				Transport	Assembly	Structural assembly	Disposal	Total cost
										factory; TF/SIP components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance materials, manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	Structural Frame Materials and Assembly	Disposal	
171	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 15,690	£ 3,850	£ 66.00	£ 3,978.56	£ 2,567.15	£ 1,112.37	£ 37,129.09
172	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 15,690	£ 6,466	£ 66.00	£ 3,978.56	£ 2,567.15	£ 1,112.37	£ 39,745.53
173	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 8,459	£ 3,000	£ 66.00	£ 3,978.56	£ -	£ 1,112.37	£ 26,480.88
174	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 8,459	£ 3,850	£ 66.00	£ 3,978.56	£ -	£ 1,112.37	£ 27,330.89
175	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 8,459	£ 6,466	£ 66.00	£ 3,978.56	£ -	£ 1,112.37	£ 29,947.33
176	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 5,421	£ 3,000	£ 66.00	£ 3,978.56	£ -	£ 1,112.37	£ 23,442.98
177	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 5,421	£ 3,850	£ 66.00	£ 3,978.56	£ -	£ 1,112.37	£ 24,292.99
178	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 5,421	£ 6,466	£ 66.00	£ 3,978.56	£ -	£ 1,112.37	£ 26,909.43
179	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 15,690	£ 3,000	£ 66.00	£ 3,978.56	£ -	£ 1,112.37	£ 33,711.94
180	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 15,690	£ 3,850	£ 66.00	£ 3,978.56	£ -	£ 1,112.37	£ 34,561.95
181	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 15,690	£ 6,466	£ 66.00	£ 3,978.56	£ -	£ 1,112.37	£ 37,178.38
182	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 8,459	£ 3,000	£ 66.00	£ 3,978.56	£ 2,980.23	£ 1,112.37	£ 29,461.12
183	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 8,459	£ 3,850	£ 66.00	£ 3,978.56	£ 2,980.23	£ 1,112.37	£ 30,311.13
184	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 8,459	£ 6,466	£ 66.00	£ 3,978.56	£ 2,980.23	£ 1,112.37	£ 32,927.56
185	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 5,421	£ 3,000	£ 66.00	£ 3,978.56	£ 2,980.23	£ 1,112.37	£ 26,423.22
186	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 5,421	£ 3,850	£ 66.00	£ 3,978.56	£ 2,980.23	£ 1,112.37	£ 27,273.23
187	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 5,421	£ 6,466	£ 66.00	£ 3,978.56	£ 2,980.23	£ 1,112.37	£ 29,889.66
188	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 15,690	£ 3,000	£ 66.00	£ 3,978.56	£ 2,980.23	£ 1,112.37	£ 36,692.17
189	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 15,690	£ 3,850	£ 66.00	£ 3,978.56	£ 2,980.23	£ 1,112.37	£ 37,542.18
190	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 15,690	£ 6,466	£ 66.00	£ 3,978.56	£ 2,980.23	£ 1,112.37	£ 40,158.62
191	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 8,459	£ 3,000	£ 66.00	£ 1,306.11	£ 2,567.15	£ 1,112.37	£ 26,375.58
192	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 8,459	£ 3,850	£ 66.00	£ 1,306.11	£ 2,567.15	£ 1,112.37	£ 27,225.59
193	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 8,459	£ 6,466	£ 66.00	£ 1,306.11	£ 2,567.15	£ 1,112.37	£ 29,842.03
194	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 5,421	£ 3,000	£ 66.00	£ 1,306.11	£ 2,567.15	£ 1,112.37	£ 23,337.68
195	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 5,421	£ 3,850	£ 66.00	£ 1,306.11	£ 2,567.15	£ 1,112.37	£ 24,187.69
196	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 5,421	£ 6,466	£ 66.00	£ 1,306.11	£ 2,567.15	£ 1,112.37	£ 26,804.13
197	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 15,690	£ 3,000	£ 66.00	£ 1,306.11	£ 2,567.15	£ 1,112.37	£ 33,606.64
198	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 15,690	£ 3,850	£ 66.00	£ 1,306.11	£ 2,567.15	£ 1,112.37	£ 34,456.65
199	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 15,690	£ 6,466	£ 66.00	£ 1,306.11	£ 2,567.15	£ 1,112.37	£ 37,073.08
200	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 8,459	£ 3,000	£ 66.00	£ 1,306.11	£ -	£ 1,112.37	£ 23,808.44
201	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 8,459	£ 3,850	£ 66.00	£ 1,306.11	£ -	£ 1,112.37	£ 24,658.45
202	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 8,459	£ 6,466	£ 66.00	£ 1,306.11	£ -	£ 1,112.37	£ 27,274.89
203	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 5,421	£ 3,000	£ 66.00	£ 1,306.11	£ -	£ 1,112.37	£ 20,770.54
204	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 5,421	£ 3,850	£ 66.00	£ 1,306.11	£ -	£ 1,112.37	£ 21,620.55
205	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 5,421	£ 6,466	£ 66.00	£ 1,306.11	£ -	£ 1,112.37	£ 24,236.99
206	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 15,690	£ 3,000	£ 66.00	£ 1,306.11	£ -	£ 1,112.37	£ 31,039.49
207	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 15,690	£ 3,850	£ 66.00	£ 1,306.11	£ -	£ 1,112.37	£ 31,889.50
208	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 15,690	£ 6,466	£ 66.00	£ 1,306.11	£ -	£ 1,112.37	£ 34,505.94
209	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 8,459	£ 3,000	£ 66.00	£ 1,306.11	£ 2,980.23	£ 1,112.37	£ 26,788.67
210	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 8,459	£ 3,850	£ 66.00	£ 1,306.11	£ 2,980.23	£ 1,112.37	£ 27,638.68
211	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 8,459	£ 6,466	£ 66.00	£ 1,306.11	£ 2,980.23	£ 1,112.37	£ 30,255.12
212	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 5,421	£ 3,000	£ 66.00	£ 1,306.11	£ 2,980.23	£ 1,112.37	£ 23,750.77
213	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 5,421	£ 3,850	£ 66.00	£ 1,306.11	£ 2,980.23	£ 1,112.37	£ 24,600.78
214	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 5,421	£ 6,466	£ 66.00	£ 1,306.11	£ 2,980.23	£ 1,112.37	£ 27,217.22
215	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 10,218.93	£ 758	£ 15,690	£ 3,000	£ 66.00	£ 1,306.11	£ 2,980.23	£ 1,112.37	£ 34,019.72
216	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 10,218.93	£ 758	£ 15,690	£ 3,850	£ 66.00	£ 1,306.11	£ 2,980.23	£ 1,112.37	£ 34,869.73
217	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 10,218.93	£ 758	£ 15,690	£ 6,466	£ 66.00	£ 1,306.11	£ 2,980.23	£ 1,112.37	£ 37,486.17
218	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 9,436.94	£ 574	£ 8,459	£ 3,000	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,366.82	£ 27,327.56
219	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 9,436.94	£ 574	£ 8,459	£ 3,850	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,366.82	£ 28,177.57
220	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 9,436.94	£ 574	£ 8,459	£ 6,466	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,366.82	£ 30,794.01
221	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 9,436.94	£ 574	£ 5,421	£ 3,000	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,366.82	£ 24,289.66
222	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 9,436.94	£ 574	£ 5,421	£ 3,850	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,366.82	£ 25,139.67
223	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 9,436.94	£ 574	£ 5,421	£ 6,466	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,366.82	£ 27,756.11
224	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 9,436.94	£ 574	£ 15,690	£ 3,000	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,366.82	£ 34,558.61
225	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 9,436.94	£ 574	£ 15,690	£ 3,850	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,366.82	£ 35,408.63
226	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 9,436.94	£ 574	£ 15,690	£ 6,466	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,366.82	£ 38,025.06
227	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 9,436.94	£ 574	£ 8,459	£ 3,000	£ 264.00	£ 3,026.10	£ -	£ 1,366.82	£ 24,760.42
228	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 9,436.94	£ 574	£ 8,459	£ 3,850	£ 264.00	£ 3,026.10	£ -	£ 1,366.82	£ 25,610.43
229	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 9,436.94	£ 574	£ 8,459	£ 6,466	£ 264.00	£ 3,026.10	£ -	£ 1,366.82	£ 28,226.86
230	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 9,436.94	£ 574	£ 5,421	£ 3,000	£ 264.00	£ 3,026.10	£ -	£ 1,366.82	£ 21,722.52
231	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 9,436.94	£ 574	£ 5,421	£ 3,850	£ 264.00	£ 3,026.10	£ -	£ 1,366.82	£ 22,572.53
232	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 9,436.94	£ 574	£ 5,421	£ 6,466	£ 264.00	£ 3,026.10	£ -	£ 1,366.82	£ 25,188.96
233	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 9,436.94	£ 574	£ 15,690	£ 3,000	£ 264.00	£ 3,026.10	£ -	£ 1,366.82	£ 31,991.47
234	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 9,436.94	£ 574	£ 15,690	£ 3,850	£ 264.00	£ 3,026.10	£ -	£ 1,366.82	£ 32,841.48
235	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 9,436.94	£ 574	£ 15,690	£ 6,466	£ 264.00	£ 3,026.10	£ -	£ 1,366.82	£ 35,457.92
236	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 9,436.94	£ 574	£ 8,459	£ 3,000	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,366.82	£ 27,740.65
237	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 9,436.94	£ 574	£ 8,459	£ 3,850	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,366.82	£ 28,590.66
238	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 9,436.94	£ 574	£ 8,459	£ 6,466	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,366.82	£ 31,207.10
239	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 9,436.94	£ 574	£ 5,421	£ 3,000	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,366.82	£ 24,702.75
240	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 9,436.94	£ 574	£ 5,421	£ 3,850	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,366.82	£ 25,552.76
241	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 9,436.94	£ 574	£ 5,421	£ 6,466	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,366.82	£ 28,169.20
242	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 9,436.94	£ 574	£ 15,690	£ 3,000	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,366.82	£ 34,971.70
243	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 9,436.94	£ 574	£ 15,690	£ 3,850	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,366.82	£ 35,821.71
244	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 9,436.94	£ 574	£ 15,690	£ 6,466	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,366.82	£ 38,438.15
245	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 8,438	£ 3,000	£ 132.00	£ 3,742.30	£ 2,567.15	£ 1,021.36	£ 27,326.09
246	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 8,438	£ 3,842	£ 132.00	£ 3,742.30	£ 2,567.15	£ 1,021.36	£ 28,168.24
247	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 8,438	£ 6,459	£ 132.00	£ 3,742.30	£ 2,567.15	£ 1,021.36	£ 30,784.99
248	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 5,421	£ 3,000	£ 132.00	£ 3,742.30	£ 2,567.15	£ 1,021.36	£ 24,308.97
249	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 5,421	£ 3,842	£ 132.00	£ 3,742.30	£ 2,567.15	£ 1,021.36	£ 25,151.12
250	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 5,421	£ 6,459	£ 132.00	£ 3,742.30	£ 2,567.15	£ 1,021.36	£ 27,767.87
251	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 15,690	£ 3,000	£ 132.00	£ 3,742.30	£ 2,567.15	£ 1,021.36	£ 34,577.92
252	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 15,690	£ 3,842	£ 132.00	£ 3,742.30	£ 2,567.15	£ 1,021.36	£ 35,420.08
253	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 15,690	£ 6,459	£ 132.00	£ 3,742.30	£ 2,567.15	£ 1,021.36	£ 38,036.82
254	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 8,438	£ 3,000	£ 132.00	£ 3,742.30	£ -	£ 1,021.36	£ 24,758.94
255	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 8,438	£ 3,842	£ 132.00	£ 3,742.30	£ -	£ 1,021.36	£ 25,601.10

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Cost				Transport	Assembly	Structural assembly	Disposal	Total cost
										factory; TF/SIP components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	Structural Frame Materials and Assembly	Disposal	
256	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 8,438	£ 6,459	£ 132.00	£ 3,742.30	£ -	£ 1,021.36	£ 28,217.84
257	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 5,421	£ 3,000	£ 132.00	£ 3,742.30	£ -	£ 1,021.36	£ 21,741.83
258	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 5,421	£ 3,842	£ 132.00	£ 3,742.30	£ -	£ 1,021.36	£ 22,583.98
259	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 5,421	£ 6,459	£ 132.00	£ 3,742.30	£ -	£ 1,021.36	£ 25,200.73
260	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 15,690	£ 3,000	£ 132.00	£ 3,742.30	£ -	£ 1,021.36	£ 32,010.78
261	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 15,690	£ 3,842	£ 132.00	£ 3,742.30	£ -	£ 1,021.36	£ 32,852.93
262	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 15,690	£ 6,459	£ 132.00	£ 3,742.30	£ -	£ 1,021.36	£ 35,469.68
263	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 8,438	£ 3,000	£ 132.00	£ 3,742.30	£ 2,980.23	£ 1,021.36	£ 27,739.18
264	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 8,438	£ 3,842	£ 132.00	£ 3,742.30	£ 2,980.23	£ 1,021.36	£ 28,581.33
265	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 8,438	£ 6,459	£ 132.00	£ 3,742.30	£ 2,980.23	£ 1,021.36	£ 31,198.08
266	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 5,421	£ 3,000	£ 132.00	£ 3,742.30	£ 2,980.23	£ 1,021.36	£ 24,722.06
267	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 5,421	£ 3,842	£ 132.00	£ 3,742.30	£ 2,980.23	£ 1,021.36	£ 25,564.21
268	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 5,421	£ 6,459	£ 132.00	£ 3,742.30	£ 2,980.23	£ 1,021.36	£ 28,180.96
269	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 15,690	£ 3,000	£ 132.00	£ 3,742.30	£ 2,980.23	£ 1,021.36	£ 34,991.01
270	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 15,690	£ 3,842	£ 132.00	£ 3,742.30	£ 2,980.23	£ 1,021.36	£ 35,833.16
271	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 15,690	£ 6,459	£ 132.00	£ 3,742.30	£ 2,980.23	£ 1,021.36	£ 38,449.91
272	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 8,438	£ 3,000	£ 132.00	£ 1,132.35	£ 2,567.15	£ 1,021.36	£ 24,716.14
273	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 8,438	£ 3,842	£ 132.00	£ 1,132.35	£ 2,567.15	£ 1,021.36	£ 25,558.29
274	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 8,438	£ 6,459	£ 132.00	£ 1,132.35	£ 2,567.15	£ 1,021.36	£ 28,175.04
275	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 5,421	£ 3,000	£ 132.00	£ 1,132.35	£ 2,567.15	£ 1,021.36	£ 21,699.02
276	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 5,421	£ 3,842	£ 132.00	£ 1,132.35	£ 2,567.15	£ 1,021.36	£ 22,541.17
277	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 5,421	£ 6,459	£ 132.00	£ 1,132.35	£ 2,567.15	£ 1,021.36	£ 25,157.92
278	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 15,690	£ 3,000	£ 132.00	£ 1,132.35	£ 2,567.15	£ 1,021.36	£ 31,967.97
279	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 15,690	£ 3,842	£ 132.00	£ 1,132.35	£ 2,567.15	£ 1,021.36	£ 32,810.12
280	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 15,690	£ 6,459	£ 132.00	£ 1,132.35	£ 2,567.15	£ 1,021.36	£ 35,426.87
281	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 8,438	£ 3,000	£ 132.00	£ 1,132.35	£ -	£ 1,021.36	£ 22,148.99
282	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 8,438	£ 3,842	£ 132.00	£ 1,132.35	£ -	£ 1,021.36	£ 22,991.14
283	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 8,438	£ 6,459	£ 132.00	£ 1,132.35	£ -	£ 1,021.36	£ 25,607.89
284	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 5,421	£ 3,000	£ 132.00	£ 1,132.35	£ -	£ 1,021.36	£ 19,131.87
285	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 5,421	£ 3,842	£ 132.00	£ 1,132.35	£ -	£ 1,021.36	£ 19,974.03
286	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 5,421	£ 6,459	£ 132.00	£ 1,132.35	£ -	£ 1,021.36	£ 22,590.77
287	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 15,690	£ 3,000	£ 132.00	£ 1,132.35	£ -	£ 1,021.36	£ 29,400.83
288	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 15,690	£ 3,842	£ 132.00	£ 1,132.35	£ -	£ 1,021.36	£ 30,242.98
289	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 15,690	£ 6,459	£ 132.00	£ 1,132.35	£ -	£ 1,021.36	£ 32,859.73
290	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 8,438	£ 3,000	£ 132.00	£ 1,132.35	£ 2,980.23	£ 1,021.36	£ 25,129.22
291	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 8,438	£ 3,842	£ 132.00	£ 1,132.35	£ 2,980.23	£ 1,021.36	£ 25,971.38
292	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 8,438	£ 6,459	£ 132.00	£ 1,132.35	£ 2,980.23	£ 1,021.36	£ 28,588.12
293	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 5,421	£ 3,000	£ 132.00	£ 1,132.35	£ 2,980.23	£ 1,021.36	£ 22,112.11
294	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 5,421	£ 3,842	£ 132.00	£ 1,132.35	£ 2,980.23	£ 1,021.36	£ 22,954.26
295	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 5,421	£ 6,459	£ 132.00	£ 1,132.35	£ 2,980.23	£ 1,021.36	£ 25,571.01
296	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 8,755.31	£ 691	£ 15,690	£ 3,000	£ 132.00	£ 1,132.35	£ 2,980.23	£ 1,021.36	£ 32,381.06
297	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 8,755.31	£ 691	£ 15,690	£ 3,842	£ 132.00	£ 1,132.35	£ 2,980.23	£ 1,021.36	£ 33,223.21
298	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 8,755.31	£ 691	£ 15,690	£ 6,459	£ 132.00	£ 1,132.35	£ 2,980.23	£ 1,021.36	£ 35,839.96
299	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	£ 6,711.24	£ 261	£ 8,438	£ 3,000	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,429.30	£ 24,267.91
300	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 6,711.24	£ 261	£ 8,438	£ 3,842	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,429.30	£ 25,110.06
301	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 6,711.24	£ 261	£ 8,438	£ 6,459	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,429.30	£ 27,726.81
302	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	£ 6,711.24	£ 261	£ 5,421	£ 3,000	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,429.30	£ 21,250.79
303	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 6,711.24	£ 261	£ 5,421	£ 3,842	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,429.30	£ 22,092.95
304	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 6,711.24	£ 261	£ 5,421	£ 6,459	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,429.30	£ 24,709.69
305	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	£ 6,711.24	£ 261	£ 15,690	£ 3,000	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,429.30	£ 31,519.75
306	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 6,711.24	£ 261	£ 15,690	£ 3,842	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,429.30	£ 32,361.90
307	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 6,711.24	£ 261	£ 15,690	£ 6,459	£ 264.00	£ 3,026.10	£ 2,567.15	£ 1,429.30	£ 34,978.65
308	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell	£ 6,711.24	£ 261	£ 8,438	£ 3,000	£ 264.00	£ 3,026.10	£ -	£ 1,429.30	£ 21,700.77
309	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 6,711.24	£ 261	£ 8,438	£ 3,842	£ 264.00	£ 3,026.10	£ -	£ 1,429.30	£ 22,542.92
310	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 6,711.24	£ 261	£ 8,438	£ 6,459	£ 264.00	£ 3,026.10	£ -	£ 1,429.30	£ 25,159.66
311	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	£ 6,711.24	£ 261	£ 5,421	£ 3,000	£ 264.00	£ 3,026.10	£ -	£ 1,429.30	£ 18,683.65
312	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 6,711.24	£ 261	£ 5,421	£ 3,842	£ 264.00	£ 3,026.10	£ -	£ 1,429.30	£ 19,525.80
313	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 6,711.24	£ 261	£ 5,421	£ 6,459	£ 264.00	£ 3,026.10	£ -	£ 1,429.30	£ 22,142.55
314	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell	£ 6,711.24	£ 261	£ 15,690	£ 3,000	£ 264.00	£ 3,026.10	£ -	£ 1,429.30	£ 28,952.60
315	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 6,711.24	£ 261	£ 15,690	£ 3,842	£ 264.00	£ 3,026.10	£ -	£ 1,429.30	£ 29,794.75
316	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 6,711.24	£ 261	£ 15,690	£ 6,459	£ 264.00	£ 3,026.10	£ -	£ 1,429.30	£ 32,411.50
317	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	£ 6,711.24	£ 261	£ 8,438	£ 3,000	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,429.30	£ 24,681.00
318	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	£ 6,711.24	£ 261	£ 8,438	£ 3,842	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,429.30	£ 25,523.15
319	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	£ 6,711.24	£ 261	£ 8,438	£ 6,459	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,429.30	£ 28,139.90
320	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	£ 6,711.24	£ 261	£ 5,421	£ 3,000	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,429.30	£ 21,663.88
321	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 6,711.24	£ 261	£ 5,421	£ 3,842	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,429.30	£ 22,506.03
322	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 6,711.24	£ 261	£ 5,421	£ 6,459	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,429.30	£ 25,122.78
323	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	£ 6,711.24	£ 261	£ 15,690	£ 3,000	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,429.30	£ 31,932.83
324	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	£ 6,711.24	£ 261	£ 15,690	£ 3,842	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,429.30	£ 32,774.99
325	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	£ 6,711.24	£ 261	£ 15,690	£ 6,459	£ 264.00	£ 3,026.10	£ 2,980.23	£ 1,429.30	£ 35,391.73
326	**SIP Panel**	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	£ 8,602.30	£ 1,967	£ 8,416	£ -	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,168.98	£ 26,552.01
327	**SIP Panel**	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 5,421	£ -	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,168.98	£ 22,583.89
328	**SIP Panel**	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 15,690	£ -	£ 132.00	£ 4,866.92	£ 2,567.15	£ 1,168.98	£ 32,852.84
329	**SIP Panel**	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 8,416	£ -	£ 132.00	£ 4,866.92	£ -	£ 1,168.98	£ 23,011.81
330	**SIP Panel**	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 5,421	£ -	£ 132.00	£ 4,866.92	£ -	£ 1,168.98	£ 20,016.74
331	**SIP Panel**	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 15,690	£ -	£ 132.00	£ 4,866.92	£ -	£ 1,168.98	£ 30,285.69
332	**SIP Panel**	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 8,416	£ -	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,168.98	£ 25,992.04
333	**SIP Panel**	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 5,421	£ -	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,168.98	£ 22,996.98
334	**SIP Panel**	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 15,690	£ -	£ 132.00	£ 4,866.92	£ 2,980.23	£ 1,168.98	£ 33,265.93
335	**SIP Panel**	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 8,416	£ -	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,168.98	£ 25,796.13
336	**SIP Panel**	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 5,421	£ -	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,168.98	£ 22,801.06
337	**SIP Panel**	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 15,690	£ -	£ 132.00	£ 5,084.10	£ 2,567.15	£ 1,168.98	£ 33,070.02
338	**SIP Panel**	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 8,416	£ -	£ 132.00	£ 5,084.10	£ -	£ 1,168.98	£ 23,228.98
339	**SIP Panel**	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 5,421	£ -	£ 132.00	£ 5,084.10	£ -	£ 1,168.98	£ 20,233.92
340	**SIP Panel**	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 15,690	£ -	£ 132.00	£ 5,084.10	£ -	£ 1,168.98	£ 30,502.87

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Cost				Transport	Assembly	Structural assembly	Disposal	Total cost
										factory; TF/SIP components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance materials manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	**Structural Frame Materials and** Assembly	Disposal	
341	**SIP Panel**	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 8,416	£ -	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,168.98	**£ 26,209.22**
342	**SIP Panel**	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 5,421	£ -	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,168.98	**£ 23,214.15**
343	**SIP Panel**	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	£ 8,602.30	£ 994	£ 15,690	£ -	£ 132.00	£ 5,084.10	£ 2,980.23	£ 1,168.98	**£ 33,483.10**
344	**SIP Panel**	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	£ 6,568.24	£ 973	£ 8,416	£ -	£ 264.00	£ 8,921.10	£ 2,567.15	£ 1,168.98	**£ 27,709.73**
345	**SIP Panel**	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 6,568.24	£ 973	£ 5,421	£ -	£ 264.00	£ 8,921.10	£ 2,567.15	£ 1,168.98	**£ 24,714.67**
346	**SIP Panel**	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	£ 6,568.24	£ 973	£ 15,690	£ -	£ 264.00	£ 8,921.10	£ 2,567.15	£ 1,168.98	**£ 34,983.62**
347	**SIP Panel**	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	£ 6,568.24	£ 973	£ 8,416	£ -	£ 264.00	£ 8,921.10	£ -	£ 1,168.98	**£ 25,142.59**
348	**SIP Panel**	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 6,568.24	£ 973	£ 5,421	£ -	£ 264.00	£ 8,921.10	£ -	£ 1,168.98	**£ 22,147.52**
349	**SIP Panel**	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	EPS	EPS density 20kg/	£ 6,568.24	£ 973	£ 15,690	£ -	£ 264.00	£ 8,921.10	£ -	£ 1,168.98	**£ 32,416.47**
350	**SIP Panel**	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	£ 6,568.24	£ 973	£ 8,416	£ -	£ 264.00	£ 8,921.10	£ 2,980.23	£ 1,168.98	**£ 28,122.82**
351	**SIP Panel**	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 6,568.24	£ 973	£ 5,421	£ -	£ 264.00	£ 8,921.10	£ 2,980.23	£ 1,168.98	**£ 25,127.76**
352	**SIP Panel**	TF/SIP	**600**	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	£ 6,568.24	£ 973	£ 15,690	£ -	£ 264.00	£ 8,921.10	£ 2,980.23	£ 1,168.98	**£ 35,396.71**
353	**SIP Panel**	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 8,438	£ -	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,120.75	**£ 24,326.20**
354	**SIP Panel**	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 5,421	£ -	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,120.75	**£ 21,309.74**
355	**SIP Panel**	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 15,690	£ -	£ 132.00	£ 3,908.23	£ 2,567.15	£ 1,120.75	**£ 31,578.69**
356	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 8,438	£ -	£ 132.00	£ 3,908.23	£ -	£ 1,120.75	**£ 21,759.06**
357	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 5,421	£ -	£ 132.00	£ 3,908.23	£ -	£ 1,120.75	**£ 18,742.59**
358	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 15,690	£ -	£ 132.00	£ 3,908.23	£ -	£ 1,120.75	**£ 29,011.55**
359	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 8,438	£ -	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,120.75	**£ 24,739.29**
360	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 5,421	£ -	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,120.75	**£ 21,722.83**
361	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 15,690	£ -	£ 132.00	£ 3,908.23	£ 2,980.23	£ 1,120.75	**£ 31,991.78**
362	**SIP Panel**	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 8,438	£ -	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,120.75	**£ 24,341.47**
363	**SIP Panel**	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 5,421	£ -	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,120.75	**£ 21,325.00**
364	**SIP Panel**	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 15,690	£ -	£ 132.00	£ 3,923.49	£ 2,567.15	£ 1,120.75	**£ 31,593.95**
365	**SIP Panel**	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 8,438	£ -	£ 132.00	£ 3,923.49	£ -	£ 1,120.75	**£ 21,774.32**
366	**SIP Panel**	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 5,421	£ -	£ 132.00	£ 3,923.49	£ -	£ 1,120.75	**£ 18,757.86**
367	**SIP Panel**	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 15,690	£ -	£ 132.00	£ 3,923.49	£ -	£ 1,120.75	**£ 29,026.81**
368	**SIP Panel**	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 8,438	£ -	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,120.75	**£ 24,754.56**
369	**SIP Panel**	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 5,421	£ -	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,120.75	**£ 21,738.09**
370	**SIP Panel**	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	£ 8,139.96	£ 1,141	£ 15,690	£ -	£ 132.00	£ 3,923.49	£ 2,980.23	£ 1,120.75	**£ 32,007.04**
371	**SIP Panel**	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	£ 6,985.74	£ 1,101	£ 8,438	£ -	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,120.75	**£ 23,207.01**
372	**SIP Panel**	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 6,985.74	£ 1,101	£ 5,421	£ -	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,120.75	**£ 20,190.54**
373	**SIP Panel**	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	£ 6,985.74	£ 1,101	£ 15,690	£ -	£ 264.00	£ 3,851.40	£ 2,567.15	£ 1,120.75	**£ 30,459.49**
374	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	£ 6,985.74	£ 1,101	£ 8,438	£ -	£ 264.00	£ 3,851.40	£ -	£ 1,120.75	**£ 20,639.86**
375	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 6,985.74	£ 1,101	£ 5,421	£ -	£ 264.00	£ 3,851.40	£ -	£ 1,120.75	**£ 17,623.39**
376	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	EPS	EPS density 20kg/	£ 6,985.74	£ 1,101	£ 15,690	£ -	£ 264.00	£ 3,851.40	£ -	£ 1,120.75	**£ 27,892.35**
377	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	£ 6,985.74	£ 1,101	£ 8,438	£ -	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,120.75	**£ 23,620.09**
378	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	£ 6,985.74	£ 1,101	£ 5,421	£ -	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,120.75	**£ 20,603.63**
379	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	£ 6,985.74	£ 1,101	£ 15,690	£ -	£ 264.00	£ 3,851.40	£ 2,980.23	£ 1,120.75	**£ 30,872.58**

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation		Time factory; TF components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance materials manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	Structural frame	Total time	Total	total time hours	total time/ days
1	**traditional**																		781596	217.11	
2	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		670206.70	19622.99	400.17	0.00	0.00	1076885.47	374.00	1767489.33	1767115.329	490.97	61.37115727
3	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	400.17	22605.31	0.00	1076885.47	374.00	1790094.64	1789720.639	497.25	62.15606386
4	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	400.17	17217.00	0.00	1076885.47	374.00	1784706.33	1784332.331	495.75	61.96896982
5	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1076885.47	374.00	1767089.16	1766715.156	490.86	61.35726235
6	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1076885.47	374.00	1789694.47	1789320.466	497.14	62.14216895
7	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1076885.47	374.00	1784306.16	1783932.157	495.64	61.95507491
8	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1076885.47	374.00	1767089.16	1766715.156	490.86	61.35726235
9	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1076885.47	374.00	1789694.47	1789320.466	497.14	62.14216895
10	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1076885.47	374.00	1784306.16	1783932.157	495.64	61.95507491
11	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell		670206.70	19622.99	400.17	0.00	0.00	1076885.47	0.00	1767115.33	1767115.329	490.87	61.35817116
12	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	400.17	22605.31	0.00	1076885.47	0.00	1789720.64	1789720.639	497.14	62.14307775
13	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	400.17	17217.00	0.00	1076885.47	0.00	1784332.33	1784332.331	495.65	61.95598371
14	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1076885.47	0.00	1766715.16	1766715.156	490.75	61.34427624
15	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1076885.47	0.00	1789320.47	1789320.466	497.03	62.12918284
16	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1076885.47	0.00	1783932.16	1783932.157	495.54	61.9420888
17	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1076885.47	0.00	1766715.16	1766715.156	490.75	61.34427624
18	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1076885.47	0.00	1789320.47	1789320.466	497.03	62.12918284
19	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1076885.47	0.00	1783932.16	1783932.157	495.54	61.9420888
20	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		670206.70	19622.99	400.17	0.00	0.00	1076885.47	136.00	1767251.33	1767115.329	490.90	61.36289338
21	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	400.17	22605.31	0.00	1076885.47	136.00	1789856.64	1789720.639	497.18	62.14779998
22	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	400.17	17217.00	0.00	1076885.47	136.00	1784468.33	1784332.331	495.69	61.96070594
23	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1076885.47	136.00	1766851.16	1766715.156	490.79	61.34899846
24	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1076885.47	136.00	1789456.47	1789320.466	497.07	62.13390506
25	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1076885.47	136.00	1784068.16	1783932.157	495.57	61.94681102
26	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1076885.47	136.00	1766851.16	1766715.156	490.79	61.34899846
27	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1076885.47	136.00	1789456.47	1789320.466	497.07	62.13390506
28	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1076885.47	136.00	1784068.16	1783932.157	495.57	61.94681102
29	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		670206.70	19622.99	400.17	0.00	0.00	1397157.12	374.00	2087760.98	2087386.977	579.93	72.4917006
30	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	400.17	22605.31	0.00	1397157.12	374.00	2110366.29	2109992.287	586.21	73.2766072
31	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	400.17	17217.00	0.00	1397157.12	374.00	2104977.98	2104603.979	584.72	73.08951316
32	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1397157.12	374.00	2087360.80	2086986.804	579.82	72.47780569
33	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1397157.12	374.00	2109966.11	2109592.114	586.10	73.26271228
34	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1397157.12	374.00	2104577.81	2104203.805	584.60	73.07561824
35	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1397157.12	374.00	2087360.80	2086986.804	579.82	72.47780569
36	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1397157.12	374.00	2109966.11	2109592.114	586.10	73.26271228
37	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1397157.12	374.00	2104577.81	2104203.805	584.60	73.07561824
38	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell		670206.70	19622.99	400.17	0.00	0.00	1397157.12	0.00	2087386.98	2087386.977	579.83	72.47871449
39	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	400.17	22605.31	0.00	1397157.12	0.00	2109992.29	2109992.287	586.11	73.26362109
40	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	400.17	17217.00	0.00	1397157.12	0.00	2104603.98	2104603.979	584.61	73.07652705
41	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1397157.12	0.00	2086986.80	2086986.804	579.72	72.46481957
42	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1397157.12	0.00	2109592.11	2109592.114	586.00	73.24972617
43	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1397157.12	0.00	2104203.81	2104203.805	584.50	73.06263213
44	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1397157.12	0.00	2086986.80	2086986.804	579.72	72.46481957
45	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1397157.12	0.00	2109592.11	2109592.114	586.00	73.24972617
46	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1397157.12	0.00	2104203.81	2104203.805	584.50	73.06263213
47	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		670206.70	19622.99	400.17	0.00	0.00	1397157.12	136.00	2087522.98	2087386.977	579.87	72.48343671
48	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	400.17	22605.31	0.00	1397157.12	136.00	2110128.29	2109992.287	586.15	73.26834331
49	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	400.17	17217.00	0.00	1397157.12	136.00	2104739.98	2104603.979	584.65	73.08124927
50	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1397157.12	136.00	2087122.80	2086986.804	579.76	72.4695418
51	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1397157.12	136.00	2109728.11	2109592.114	586.04	73.25444839
52	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1397157.12	136.00	2104339.81	2104203.805	584.54	73.06735436
53	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	1397157.12	136.00	2087122.80	2086986.804	579.76	72.4695418
54	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	1397157.12	136.00	2109728.11	2109592.114	586.04	73.25444839
55	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	1397157.12	136.00	2104339.81	2104203.805	584.54	73.06735436
56	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		670206.70	19622.99	400.17	0.00	0.00	2451600.00	374.00	3142203.86	3141829.857	872.83	109.1043006
57	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	400.17	22605.31	0.00	2451600.00	374.00	3164809.17	3164435.167	879.11	109.8892072
58	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	400.17	17217.00	0.00	2451600.00	374.00	3159420.86	3159046.859	877.62	109.7021132
59	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	2451600.00	374.00	3141803.68	3141429.684	872.72	109.0904057
60	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	2451600.00	374.00	3164408.99	3164034.994	879.00	109.8753123
61	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	2451600.00	374.00	3159020.69	3158646.685	877.51	109.6882182
62	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	2451600.00	374.00	3141803.68	3141429.684	872.72	109.0904057
63	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	2451600.00	374.00	3164408.99	3164034.994	879.00	109.8753123
64	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	2451600.00	374.00	3159020.69	3158646.685	877.51	109.6882182
65	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell		670206.70	19622.99	400.17	0.00	0.00	2451600.00	0.00	3141829.86	3141829.857	872.73	109.0913145
66	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	400.17	22605.31	0.00	2451600.00	0.00	3164435.17	3164435.167	879.01	109.8762211
67	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	400.17	17217.00	0.00	2451600.00	0.00	3159046.86	3159046.859	877.51	109.689127
68	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	2451600.00	0.00	3141429.68	3141429.684	872.62	109.0774196
69	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	2451600.00	0.00	3164034.99	3164034.994	878.90	109.8623262
70	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	2451600.00	0.00	3158646.69	3158646.685	877.40	109.6752321
71	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	2451600.00	0.00	3141429.68	3141429.684	872.62	109.0774196
72	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	2451600.00	0.00	3164034.99	3164034.994	878.90	109.8623262
73	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	2451600.00	0.00	3158646.69	3158646.685	877.40	109.6752321
74	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		670206.70	19622.99	400.17	0.00	0.00	2451600.00	136.00	3141965.86	3141829.857	872.77	109.0960367
75	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	400.17	22605.31	0.00	2451600.00	136.00	3164571.17	3164435.167	879.05	109.8809433
76	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	400.17	17217.00	0.00	2451600.00	136.00	3159182.86	3159046.859	877.55	109.6938493
77	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	2451600.00	136.00	3141565.68	3141429.684	872.66	109.0821418
78	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	2451600.00	136.00	3164170.99	3164034.994	878.94	109.8670484
79	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	2451600.00	136.00	3158782.69	3158646.685	877.44	109.6799544
80	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		670206.70	19622.99	0.00	0.00	0.00	2451600.00	136.00	3141565.68	3141429.684	872.66	109.0821418
81	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		670206.70	19622.99	0.00	22605.31	0.00	2451600.00	136.00	3164170.99	3164034.994	878.94	109.8670484
82	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		670206.70	19622.99	0.00	17217.00	0.00	2451600.00	136.00	3158782.69	3158646.685	877.44	109.6799544
83	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		445450.16	16352.49	421.57	0.00	0.00	864757.87	374.00	1327356.09	1326982.094	368.71	46.08875326
84	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	421.57	12258.16	0.00	864757.87	374.00	1339614.25	1339240.249	372.12	46.51438365
85	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	421.57	9380.25	0.00	864757.87	374.00	1336736.34	1336362.345	371.32	46.41445642

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation		Time factory; TF components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance materials manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	Structural frame	Total time	Total	total time hours	total time/ days
86	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	864757.87	374.00	1326934.52	1326560.519	368.59	46.07411525
87	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	864757.87	374.00	1339192.67	1338818.674	372.00	46.49974564
88	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	864757.87	374.00	1336314.77	1335940.77	371.20	46.39981841
89	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	864757.87	374.00	1326934.52	1326560.519	368.59	46.07411525
90	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	864757.87	374.00	1339192.67	1338818.674	372.00	46.49974564
91	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	864757.87	374.00	1336314.77	1335940.77	371.20	46.39981841
92	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell		445450.16	16352.49	421.57	0.00	0.00	864757.87	0.00	1326982.09	1326982.094	368.61	46.07576715
93	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	421.57	12258.16	0.00	864757.87	0.00	1339240.25	1339240.249	372.01	46.50139754
94	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	421.57	9380.25	0.00	864757.87	0.00	1336362.34	1336362.345	371.21	46.40147031
95	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	864757.87	0.00	1326560.52	1326560.519	368.49	46.06112914
96	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	864757.87	0.00	1338818.67	1338818.674	371.89	46.48675953
97	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	864757.87	0.00	1335940.77	1335940.77	371.09	46.3868323
98	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	864757.87	0.00	1326560.52	1326560.519	368.49	46.06112914
99	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	864757.87	0.00	1338818.67	1338818.674	371.89	46.48675953
100	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	864757.87	0.00	1335940.77	1335940.77	371.09	46.3868323
101	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		445450.16	16352.49	421.57	0.00	0.00	864757.87	136.00	1327118.09	1326982.094	368.64	46.08048938
102	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	421.57	12258.16	0.00	864757.87	136.00	1339376.25	1339240.249	372.05	46.50611976
103	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	421.57	9380.25	0.00	864757.87	136.00	1336498.34	1336362.345	371.25	46.40619253
104	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	864757.87	136.00	1326696.52	1326560.519	368.53	46.06585137
105	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	864757.87	136.00	1338954.67	1338818.674	371.93	46.49148175
106	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	864757.87	136.00	1336076.77	1335940.77	371.13	46.39155452
107	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	864757.87	136.00	1326696.52	1326560.519	368.53	46.06585137
108	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	864757.87	136.00	1338954.67	1338818.674	371.93	46.49148175
109	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	864757.87	136.00	1336076.77	1335940.77	371.13	46.39155452
110	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		445450.16	16352.49	421.57	0.00	0.00	1078210.56	374.00	1540808.78	1540434.782	428.00	53.50030493
111	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	421.57	12258.16	0.00	1078210.56	374.00	1553066.94	1552692.937	431.41	53.92593531
112	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	421.57	9380.25	0.00	1078210.56	374.00	1550189.03	1549815.033	430.61	53.82600809
113	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1078210.56	374.00	1540387.21	1540013.207	427.89	53.48566692
114	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1078210.56	374.00	1552645.36	1552271.362	431.29	53.9112973
115	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1078210.56	374.00	1549767.46	1549393.458	430.49	53.81137008
116	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1078210.56	374.00	1540387.21	1540013.207	427.89	53.48566692
117	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1078210.56	374.00	1552645.36	1552271.362	431.29	53.9112973
118	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1078210.56	374.00	1549767.46	1549393.458	430.49	53.81137008
119	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell		445450.16	16352.49	421.57	0.00	0.00	1078210.56	0.00	1540434.78	1540434.782	427.90	53.48731882
120	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	421.57	12258.16	0.00	1078210.56	0.00	1552692.94	1552692.937	431.30	53.9129492
121	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	421.57	9380.25	0.00	1078210.56	0.00	1549815.03	1549815.033	430.50	53.81302197
122	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1078210.56	0.00	1540013.21	1540013.207	427.78	53.47268081
123	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1078210.56	0.00	1552271.36	1552271.362	431.19	53.89831119
124	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1078210.56	0.00	1549393.46	1549393.458	430.39	53.79838396
125	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1078210.56	0.00	1540013.21	1540013.207	427.78	53.47268081
126	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1078210.56	0.00	1552271.36	1552271.362	431.19	53.89831119
127	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1078210.56	0.00	1549393.46	1549393.458	430.39	53.79838396
128	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		445450.16	16352.49	421.57	0.00	0.00	1078210.56	136.00	1540570.78	1540434.782	427.94	53.49204104
129	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	421.57	12258.16	0.00	1078210.56	136.00	1552828.94	1552692.937	431.34	53.91767142
130	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	421.57	9380.25	0.00	1078210.56	136.00	1549951.03	1549815.033	430.54	53.8177442
131	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1078210.56	136.00	1540149.21	1540013.207	427.82	53.47740303
132	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1078210.56	136.00	1552407.36	1552271.362	431.22	53.90303341
133	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1078210.56	136.00	1549529.46	1549393.458	430.42	53.80310619
134	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1078210.56	136.00	1540149.21	1540013.207	427.82	53.47740303
135	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1078210.56	136.00	1552407.36	1552271.362	431.22	53.90303341
136	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1078210.56	136.00	1549529.46	1549393.458	430.42	53.80310619
137	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		445450.16	16352.49	421.57	0.00	0.00	1058400.00	374.00	1520998.22	1520624.222	422.50	52.81243826
138	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	421.57	12258.16	0.00	1058400.00	374.00	1533256.38	1532882.377	425.90	53.23806865
139	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	421.57	9380.25	0.00	1058400.00	374.00	1530378.47	1530004.473	425.11	53.13814142
140	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1058400.00	374.00	1520576.65	1520202.647	422.38	52.79780025
141	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1058400.00	374.00	1532834.80	1532460.802	425.79	53.22343064
142	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1058400.00	374.00	1529956.90	1529582.898	424.99	53.12350341
143	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1058400.00	374.00	1520576.65	1520202.647	422.38	52.79780025
144	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1058400.00	374.00	1532834.80	1532460.802	425.79	53.22343064
145	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1058400.00	374.00	1529956.90	1529582.898	424.99	53.12350341
146	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell		445450.16	16352.49	421.57	0.00	0.00	1058400.00	0.00	1520624.22	1520624.222	422.40	52.79945215
147	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	421.57	12258.16	0.00	1058400.00	0.00	1532882.38	1532882.377	425.80	53.22508254
148	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	421.57	9380.25	0.00	1058400.00	0.00	1530004.47	1530004.473	425.00	53.12515531
149	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1058400.00	0.00	1520202.65	1520202.647	422.28	52.78481414
150	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1058400.00	0.00	1532460.80	1532460.802	425.68	53.21044453
151	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1058400.00	0.00	1529582.90	1529582.898	424.88	53.1105173
152	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1058400.00	0.00	1520202.65	1520202.647	422.28	52.78481414
153	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1058400.00	0.00	1532460.80	1532460.802	425.68	53.21044453
154	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1058400.00	0.00	1529582.90	1529582.898	424.88	53.1105173
155	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		445450.16	16352.49	421.57	0.00	0.00	1058400.00	136.00	1520760.22	1520624.222	422.43	52.80417438
156	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	421.57	12258.16	0.00	1058400.00	136.00	1533018.38	1532882.377	425.84	53.22980476
157	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	421.57	9380.25	0.00	1058400.00	136.00	1530140.47	1530004.473	425.04	53.12987753
158	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1058400.00	136.00	1520338.65	1520202.647	422.32	52.78953637
159	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1058400.00	136.00	1532596.80	1532460.802	425.72	53.21516675
160	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1058400.00	136.00	1529718.90	1529582.898	424.92	53.11523952
161	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		445450.16	16352.49	0.00	0.00	0.00	1058400.00	136.00	1520338.65	1520202.647	422.32	52.78953637
162	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		445450.16	16352.49	0.00	12258.16	0.00	1058400.00	136.00	1532596.80	1532460.802	425.72	53.21516675
163	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		445450.16	16352.49	0.00	9380.25	0.00	1058400.00	136.00	1529718.90	1529582.898	424.92	53.11523952
164	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		379240.60	5450.92	443.01	0.00	0.00	880319.92	374.00	1265828.44	1265454.435	351.62	43.95237623
165	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	443.01	8809.59	0.00	880319.92	374.00	1274638.02	1274264.023	354.07	44.25826467
166	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	443.01	6768.00	0.00	880319.92	374.00	1272596.44	1272222.436	353.50	44.18737624
167	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	880319.92	374.00	1265385.43	1265011.427	351.50	43.93699399
168	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	880319.92	374.00	1274195.01	1273821.014	353.94	44.24288244
169	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	880319.92	374.00	1272153.43	1271779.427	353.38	44.17199401
170	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	880319.92	374.00	1265385.43	1265011.427	351.50	43.93699399

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation		Time factory; TF components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance materials manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	Structural frame	Total time	Total	total time hours	total time/ days
171	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	880319.92	374.00	1274195.01	1273821.014	353.94	44.24288244
172	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	880319.92	374.00	1272153.43	1271779.427	353.38	44.17199401
173	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell		379240.60	5450.92	443.01	0.00	0.00	880319.92	0.00	1265454.44	1265454.435	351.52	43.93939011
174	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	443.01	8809.59	0.00	880319.92	0.00	1274264.02	1274264.023	353.96	44.24527856
175	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	443.01	6768.00	0.00	880319.92	0.00	1272222.44	1272222.436	353.40	44.17439013
176	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	880319.92	0.00	1265011.43	1265011.427	351.39	43.92400788
177	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	880319.92	0.00	1273821.01	1273821.014	353.84	44.22989633
178	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	880319.92	0.00	1271779.43	1271779.427	353.27	44.1590079
179	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	880319.92	0.00	1265011.43	1265011.427	351.39	43.92400788
180	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	880319.92	0.00	1273821.01	1273821.014	353.84	44.22989633
181	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	880319.92	0.00	1271779.43	1271779.427	353.27	44.1590079
182	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		379240.60	5450.92	443.01	0.00	0.00	880319.92	136.00	1265590.44	1265454.435	351.55	43.94411234
183	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	443.01	8809.59	0.00	880319.92	136.00	1274400.02	1274264.023	354.00	44.25000079
184	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	443.01	6768.00	0.00	880319.92	136.00	1272358.44	1272222.436	353.43	44.17911236
185	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	880319.92	136.00	1265147.43	1265011.427	351.43	43.9287301
186	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	880319.92	136.00	1273957.01	1273821.014	353.88	44.23461855
187	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	880319.92	136.00	1271915.43	1271779.427	353.31	44.16373012
188	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	880319.92	136.00	1265147.43	1265011.427	351.43	43.9287301
189	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	880319.92	136.00	1273957.01	1273821.014	353.88	44.23461855
190	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	880319.92	136.00	1271915.43	1271779.427	353.31	44.16373012
191	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		379240.60	5450.92	443.01	0.00	0.00	358931.52	374.00	744440.04	744066.0393	206.79	25.84861248
192	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	443.01	8809.59	0.00	358931.52	374.00	753249.63	752875.6266	209.24	26.15450092
193	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	443.01	6768.00	0.00	358931.52	374.00	751208.04	750834.0398	208.67	26.08361249
194	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	358931.52	374.00	743997.03	743623.0309	206.67	25.83323024
195	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	358931.52	374.00	752806.62	752432.6182	209.11	26.13911869
196	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	358931.52	374.00	750765.03	750391.0314	208.55	26.06823026
197	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	358931.52	374.00	743997.03	743623.0309	206.67	25.83323024
198	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	358931.52	374.00	752806.62	752432.6182	209.11	26.13911869
199	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	358931.52	374.00	750765.03	750391.0314	208.55	26.06823026
200	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell		379240.60	5450.92	443.01	0.00	0.00	358931.52	0.00	744066.04	744066.0393	206.69	25.83562636
201	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	443.01	8809.59	0.00	358931.52	0.00	752875.63	752875.6266	209.13	26.14151481
202	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	443.01	6768.00	0.00	358931.52	0.00	750834.04	750834.0398	208.57	26.07062638
203	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	358931.52	0.00	743623.03	743623.0309	206.56	25.82024413
204	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	358931.52	0.00	752432.62	752432.6182	209.01	26.12613258
205	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	358931.52	0.00	750391.03	750391.0314	208.44	26.05524415
206	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	358931.52	0.00	743623.03	743623.0309	206.56	25.82024413
207	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	358931.52	0.00	752432.62	752432.6182	209.01	26.12613258
208	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	358931.52	0.00	750391.03	750391.0314	208.44	26.05524415
209	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		379240.60	5450.92	443.01	0.00	0.00	358931.52	136.00	744202.04	744066.0393	206.72	25.84034859
210	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	443.01	8809.59	0.00	358931.52	136.00	753011.63	752875.6266	209.17	26.14623704
211	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	443.01	6768.00	0.00	358931.52	136.00	750970.04	750834.0398	208.60	26.07534861
212	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	358931.52	136.00	743759.03	743623.0309	206.60	25.82496635
213	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	358931.52	136.00	752568.62	752432.6182	209.05	26.1308548
214	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	358931.52	136.00	750527.03	750391.0314	208.48	26.05996637
215	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	358931.52	136.00	743759.03	743623.0309	206.60	25.82496635
216	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	358931.52	136.00	752568.62	752432.6182	209.05	26.1308548
217	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	358931.52	136.00	750527.03	750391.0314	208.48	26.05996637
218	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		379240.60	5450.92	443.01	0.00	0.00	831600.00	374.00	1217108.52	1216734.519	338.09	42.26071248
219	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	443.01	8809.59	0.00	831600.00	374.00	1225918.11	1225544.107	340.53	42.56660092
220	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	443.01	6768.00	0.00	831600.00	374.00	1223876.52	1223502.52	339.97	42.49571249
221	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	831600.00	374.00	1216665.51	1216291.511	337.96	42.24533024
222	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	831600.00	374.00	1225475.10	1225101.098	340.41	42.55121869
223	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	831600.00	374.00	1223433.51	1223059.511	339.84	42.48033026
224	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	831600.00	374.00	1216665.51	1216291.511	337.96	42.24533024
225	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	831600.00	374.00	1225475.10	1225101.098	340.41	42.55121869
226	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	831600.00	374.00	1223433.51	1223059.511	339.84	42.48033026
227	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell		379240.60	5450.92	443.01	0.00	0.00	831600.00	0.00	1216734.52	1216734.519	337.98	42.24772636
228	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	443.01	8809.59	0.00	831600.00	0.00	1225544.11	1225544.107	340.43	42.55361481
229	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	443.01	6768.00	0.00	831600.00	0.00	1223502.52	1223502.52	339.86	42.48272638
230	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	831600.00	0.00	1216291.51	1216291.511	337.86	42.23234413
231	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	831600.00	0.00	1225101.10	1225101.098	340.31	42.53823258
232	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	831600.00	0.00	1223059.51	1223059.511	339.74	42.46734415
233	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	831600.00	0.00	1216291.51	1216291.511	337.86	42.23234413
234	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	831600.00	0.00	1225101.10	1225101.098	340.31	42.53823258
235	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	831600.00	0.00	1223059.51	1223059.511	339.74	42.46734415
236	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		379240.60	5450.92	443.01	0.00	0.00	831600.00	136.00	1216870.52	1216734.519	338.02	42.25244859
237	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	443.01	8809.59	0.00	831600.00	136.00	1225680.11	1225544.107	340.47	42.55833704
238	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	443.01	6768.00	0.00	831600.00	136.00	1223638.52	1223502.52	339.90	42.48744861
239	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	831600.00	136.00	1216427.51	1216291.511	337.90	42.23706635
240	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	831600.00	136.00	1225237.10	1225101.098	340.34	42.5429548
241	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	831600.00	136.00	1223195.51	1223059.511	339.78	42.47206637
242	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		379240.60	5450.92	0.00	0.00	0.00	831600.00	136.00	1216427.51	1216291.511	337.90	42.23706635
243	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		379240.60	5450.92	0.00	8809.59	0.00	831600.00	136.00	1225237.10	1225101.098	340.34	42.5429548
244	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		379240.60	5450.92	0.00	6768.00	0.00	831600.00	136.00	1223195.51	1223059.511	339.78	42.47206637
245	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		340325.50	4088.12	422.23	0.00	0.00	828045.29	374.00	1173255.14	1172881.137	325.90	40.73802558
246	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	422.23	7084.58	0.00	828045.29	374.00	1180339.71	1179965.714	327.87	40.98401786
247	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	422.23	5461.88	0.00	828045.29	374.00	1178717.01	1178343.012	327.42	40.92767404
248	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	828045.29	374.00	1172832.91	1172458.911	325.79	40.72336496
249	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	828045.29	374.00	1179917.49	1179543.488	327.75	40.96935723
250	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	828045.29	374.00	1178294.79	1177920.786	327.30	40.91301341
251	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	828045.29	374.00	1172832.91	1172458.911	325.79	40.72336496
252	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	828045.29	374.00	1179917.49	1179543.488	327.75	40.96935723
253	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	828045.29	374.00	1178294.79	1177920.786	327.30	40.91301341
254	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell		340325.50	4088.12	422.23	0.00	0.00	828045.29	0.00	1172881.14	1172881.137	325.80	40.72503947
255	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	422.23	7084.58	0.00	828045.29	0.00	1179965.71	1179965.714	327.77	40.97103175

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation		Time factory; TF components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance materials manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	Structural frame	Total time	Total	total time hours	total time/ days
256	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	422.23	5461.88	0.00	828045.29	0.00	1178343.01	1178343.012	327.32	40.91468792
257	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	828045.29	0.00	1172458.91	1172458.911	325.68	40.71037885
258	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	828045.29	0.00	1179543.49	1179543.488	327.65	40.95637112
259	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	828045.29	0.00	1177920.79	1177920.786	327.20	40.9000273
260	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	828045.29	0.00	1172458.91	1172458.911	325.68	40.71037885
261	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	828045.29	0.00	1179543.49	1179543.488	327.65	40.95637112
262	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	828045.29	0.00	1177920.79	1177920.786	327.20	40.9000273
263	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		340325.50	4088.12	422.23	0.00	0.00	828045.29	136.00	1173017.14	1172881.137	325.84	40.72976169
264	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	422.23	7084.58	0.00	828045.29	136.00	1180101.71	1179965.714	327.81	40.97575397
265	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	422.23	5461.88	0.00	828045.29	136.00	1178479.01	1178343.012	327.36	40.91941015
266	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	828045.29	136.00	1172594.91	1172458.911	325.72	40.71510107
267	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	828045.29	136.00	1179679.49	1179543.488	327.69	40.96109334
268	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	828045.29	136.00	1178056.79	1177920.786	327.24	40.90474952
269	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	828045.29	136.00	1172594.91	1172458.911	325.72	40.71510107
270	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	828045.29	136.00	1179679.49	1179543.488	327.69	40.96109334
271	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	828045.29	136.00	1178056.79	1177920.786	327.24	40.90474952
272	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		340325.50	4088.12	422.23	0.00	0.00	311180.64	374.00	656390.49	656016.4888	182.33	22.79133642
273	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	422.23	7084.58	0.00	311180.64	374.00	663475.07	663101.0663	184.30	23.03732869
274	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	422.23	5461.88	0.00	311180.64	374.00	661852.36	661478.3642	183.85	22.98098487
275	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	311180.64	374.00	655968.26	655594.2628	182.21	22.77667579
276	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	311180.64	374.00	663052.84	662678.8403	184.18	23.02266806
277	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	311180.64	374.00	661430.14	661056.1382	183.73	22.96632424
278	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	311180.64	374.00	655968.26	655594.2628	182.21	22.77667579
279	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	311180.64	374.00	663052.84	662678.8403	184.18	23.02266806
280	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	311180.64	374.00	661430.14	661056.1382	183.73	22.96632424
281	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell		340325.50	4088.12	422.23	0.00	0.00	311180.64	0.00	656016.49	656016.4888	182.23	22.77835031
282	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	422.23	7084.58	0.00	311180.64	0.00	663101.07	663101.0663	184.19	23.02434258
283	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	422.23	5461.88	0.00	311180.64	0.00	661478.36	661478.3642	183.74	22.96799876
284	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	311180.64	0.00	655594.26	655594.2628	182.11	22.76368968
285	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	311180.64	0.00	662678.84	662678.8403	184.08	23.00968195
286	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	311180.64	0.00	661056.14	661056.1382	183.63	22.95333813
287	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	311180.64	0.00	655594.26	655594.2628	182.11	22.76368968
288	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	311180.64	0.00	662678.84	662678.8403	184.08	23.00968195
289	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	311180.64	0.00	661056.14	661056.1382	183.63	22.95333813
290	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		340325.50	4088.12	422.23	0.00	0.00	311180.64	136.00	656152.49	656016.4888	182.26	22.78307253
291	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	422.23	7084.58	0.00	311180.64	136.00	663237.07	663101.0663	184.23	23.0290648
292	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	422.23	5461.88	0.00	311180.64	136.00	661614.36	661478.3642	183.78	22.97272098
293	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	311180.64	136.00	655730.26	655594.2628	182.15	22.7684119
294	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	311180.64	136.00	662814.84	662678.8403	184.12	23.01440418
295	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	311180.64	136.00	661192.14	661056.1382	183.66	22.95806035
296	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	311180.64	136.00	655730.26	655594.2628	182.15	22.7684119
297	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	311180.64	136.00	662814.84	662678.8403	184.12	23.01440418
298	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	311180.64	136.00	661192.14	661056.1382	183.66	22.95806035
299	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell		340325.50	4088.12	422.23	0.00	0.00	831600.00	374.00	1176809.85	1176435.849	326.89	40.86145308
300	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	422.23	7084.58	0.00	831600.00	374.00	1183894.43	1183520.426	328.86	41.10744536
301	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	422.23	5461.88	0.00	831600.00	374.00	1182271.72	1181897.724	328.41	41.05110154
302	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	831600.00	374.00	1176387.62	1176013.623	326.77	40.84679246
303	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	831600.00	374.00	1183472.20	1183098.2	328.74	41.09278473
304	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	831600.00	374.00	1181849.50	1181475.498	328.29	41.03644091
305	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	831600.00	374.00	1176387.62	1176013.623	326.77	40.84679246
306	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	831600.00	374.00	1183472.20	1183098.2	328.74	41.09278473
307	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	831600.00	374.00	1181849.50	1181475.498	328.29	41.03644091
308	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell		340325.50	4088.12	422.23	0.00	0.00	831600.00	0.00	1176435.85	1176435.849	326.79	40.84846697
309	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	422.23	7084.58	0.00	831600.00	0.00	1183520.43	1183520.426	328.76	41.09445925
310	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	422.23	5461.88	0.00	831600.00	0.00	1181897.72	1181897.724	328.30	41.03811542
311	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	831600.00	0.00	1176013.62	1176013.623	326.67	40.83380635
312	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	831600.00	0.00	1183098.20	1183098.2	328.64	41.07979862
313	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	831600.00	0.00	1181475.50	1181475.498	328.19	41.0234548
314	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	831600.00	0.00	1176013.62	1176013.623	326.67	40.83380635
315	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	831600.00	0.00	1183098.20	1183098.2	328.64	41.07979862
316	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	831600.00	0.00	1181475.50	1181475.498	328.19	41.0234548
317	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell		340325.50	4088.12	422.23	0.00	0.00	831600.00	136.00	1176571.85	1176435.849	326.83	40.85318919
318	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	422.23	7084.58	0.00	831600.00	136.00	1183656.43	1183520.426	328.79	41.09918147
319	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	422.23	5461.88	0.00	831600.00	136.00	1182033.72	1181897.724	328.34	41.04283765
320	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	831600.00	136.00	1176149.62	1176013.623	326.71	40.83852857
321	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	831600.00	136.00	1183234.20	1183098.2	328.68	41.08452084
322	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	831600.00	136.00	1181611.50	1181475.498	328.23	41.02817702
323	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell		340325.50	4088.12	0.00	0.00	0.00	831600.00	136.00	1176149.62	1176013.623	326.71	40.83852857
324	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool		340325.50	4088.12	0.00	7084.58	0.00	831600.00	136.00	1183234.20	1183098.2	328.68	41.08452084
325	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool		340325.50	4088.12	0.00	5461.88	0.00	831600.00	136.00	1181611.50	1181475.498	328.23	41.02817702
326	SIP Panel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/		415927.89	19622.99	400.17	0.00	0.00	1076885.47	374.00	1513210.53	1512836.527	420.34	52.54203218
327	SIP Panel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1076885.47	374.00	1512810.35	1512436.353	420.23	52.52813727
328	SIP Panel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1076885.47	374.00	1512810.35	1512436.353	420.23	52.52813727
329	SIP Panel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/		415927.89	19622.99	400.17	0.00	0.00	1076885.47	0.00	1512836.53	1512836.527	420.23	52.52904607
330	SIP Panel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1076885.47	0.00	1512436.35	1512436.353	420.12	52.51515116
331	SIP Panel	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1076885.47	0.00	1512436.35	1512436.353	420.12	52.51515116
332	SIP Panel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/		415927.89	19622.99	400.17	0.00	0.00	1076885.47	136.00	1512972.53	1512836.527	420.27	52.53376829
333	SIP Panel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1076885.47	136.00	1512572.35	1512436.353	420.16	52.51987338
334	SIP Panel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1076885.47	136.00	1512572.35	1512436.353	420.16	52.51987338
335	SIP Panel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/		415927.89	19622.99	400.17	0.00	0.00	1397157.12	374.00	1833482.17	1833108.175	509.30	63.66257552
336	SIP Panel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1397157.12	374.00	1833082.00	1832708.001	509.19	63.6486806
337	SIP Panel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1397157.12	374.00	1833082.00	1832708.001	509.19	63.6486806
338	SIP Panel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/		415927.89	19622.99	400.17	0.00	0.00	1397157.12	0.00	1833108.17	1833108.175	509.20	63.6495894
339	SIP Panel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1397157.12	0.00	1832708.00	1832708.001	509.09	63.63569449
340	SIP Panel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1397157.12	0.00	1832708.00	1832708.001	509.09	63.63569449

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation		Time factory; TF components, original and maintenance materials, manufacture and assembly panel size	factory; TF lining original and maintenance materials manufacture and assembly	factory; TF cladding original and maintenance materials, manufacture and assembly	factory; TF insul original and maintenance materials, manufacture and assembly	transport	site panels assembly maintenance assembly	Structural frame	Total time	Total	total time hours	total time/ days
341	SIP Panel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/		415927.89	19622.99	400.17	0.00	0.00	1397157.12	136.00	1833244.17	1833108.175	509.23	63.65431163
342	SIP Panel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1397157.12	136.00	1832844.00	1832708.001	509.12	63.64041671
343	SIP Panel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	1397157.12	136.00	1832844.00	1832708.001	509.12	63.64041671
344	SIP Panel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/		415927.89	19622.99	400.17	0.00	0.00	2451600.00	374.00	2887925.05	2887551.055	802.20	100.2751755
345	SIP Panel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	2451600.00	374.00	2887524.88	2887150.881	802.09	100.2612806
346	SIP Panel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	2451600.00	374.00	2887524.88	2887150.881	802.09	100.2612806
347	SIP Panel	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	EPS	EPS density 20kg/		415927.89	19622.99	400.17	0.00	0.00	2451600.00	0.00	2887551.05	2887551.055	802.10	100.2621894
348	SIP Panel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	2451600.00	0.00	2887150.88	2887150.881	801.99	100.2482945
349	SIP Panel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	2451600.00	0.00	2887150.88	2887150.881	801.99	100.2482945
350	SIP Panel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/		415927.89	19622.99	400.17	0.00	0.00	2451600.00	136.00	2887687.05	2887551.055	802.14	100.2669116
351	SIP Panel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	2451600.00	136.00	2887286.88	2887150.881	802.02	100.2530167
352	SIP Panel	TF/SIP	**600**	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/		415927.89	19622.99	0.00	0.00	0.00	2451600.00	136.00	2887286.88	2887150.881	802.02	100.2530167
353	SIP Panel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/		233040.12	16352.49	421.57	0.00	0.00	864757.87	374.00	1114946.05	1114572.054	309.71	38.71340464
354	SIP Panel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	864757.87	374.00	1114524.48	1114150.479	309.59	38.69876663
355	SIP Panel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	864757.87	374.00	1114524.48	1114150.479	309.59	38.69876663
356	SIP Panel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/		233040.12	16352.49	421.57	0.00	0.00	864757.87	0.00	1114572.05	1114572.054	309.60	38.70041853
357	SIP Panel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	864757.87	0.00	1114150.48	1114150.479	309.49	38.68578052
358	SIP Panel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	864757.87	0.00	1114150.48	1114150.479	309.49	38.68578052
359	SIP Panel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/		233040.12	16352.49	421.57	0.00	0.00	864757.87	136.00	1114708.05	1114572.054	309.64	38.70514076
360	SIP Panel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	864757.87	136.00	1114286.48	1114150.479	309.52	38.69050275
361	SIP Panel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	864757.87	136.00	1114286.48	1114150.479	309.52	38.69050275
362	SIP Panel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/		233040.12	16352.49	421.57	0.00	0.00	1078210.56	374.00	1328398.74	1328024.742	369.00	46.12495631
363	SIP Panel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1078210.56	374.00	1327977.17	1327603.167	368.88	46.1103183
364	SIP Panel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1078210.56	374.00	1327977.17	1327603.167	368.88	46.1103183
365	SIP Panel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/		233040.12	16352.49	421.57	0.00	0.00	1078210.56	0.00	1328024.74	1328024.742	368.90	46.1119702
366	SIP Panel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1078210.56	0.00	1327603.17	1327603.167	368.78	46.09733219
367	SIP Panel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1078210.56	0.00	1327603.17	1327603.167	368.78	46.09733219
368	SIP Panel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/		233040.12	16352.49	421.57	0.00	0.00	1078210.56	136.00	1328160.74	1328024.742	368.93	46.11669242
369	SIP Panel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1078210.56	136.00	1327739.17	1327603.167	368.82	46.10205441
370	SIP Panel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1078210.56	136.00	1327739.17	1327603.167	368.82	46.10205441
371	SIP Panel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/		233040.12	16352.49	421.57	0.00	0.00	1058400.00	374.00	1308588.18	1308214.182	363.50	45.43708964
372	SIP Panel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1058400.00	374.00	1308166.61	1307792.607	363.38	45.42245163
373	SIP Panel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1058400.00	374.00	1308166.61	1307792.607	363.38	45.42245163
374	SIP Panel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	EPS	EPS density 20kg/		233040.12	16352.49	421.57	0.00	0.00	1058400.00	0.00	1308214.18	1308214.182	363.39	45.42410353
375	SIP Panel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1058400.00	0.00	1307792.61	1307792.607	363.28	45.40946552
376	SIP Panel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1058400.00	0.00	1307792.61	1307792.607	363.28	45.40946552
377	SIP Panel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/		233040.12	16352.49	421.57	0.00	0.00	1058400.00	136.00	1308350.18	1308214.182	363.43	45.42882576
378	SIP Panel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1058400.00	136.00	1307928.61	1307792.607	363.31	45.41418775
379	SIP Panel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/		233040.12	16352.49	0.00	0.00	0.00	1058400.00	136.00	1307928.61	1307792.607	363.31	45.41418775

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Element responsible soucing						Element environment							Cost score				
										Panels	Cladding	Insulation	Lining	Structure	Total Panel Cladding Insulation Lining Structure	Wall panel and cladding	upper floor	Insulation	Internal wall		Time score	Environmental	Cost score	Adaptability	H&S	responsible sourcin	Sustainibility score
1	**traditional**									3	3	2.50	2.00	3	5.55						9	10	**10**	**3.1**	**8.13**	**5.55**	46
2	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		3	9.2	4	5.6	7.70	**5.3**	35
3	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		2	9.2	3	5.6	7.67	**5.35**	33
4	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		3	9.2	2	5.6	7.67	**5.4**	33
5	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		3	9.2	6	5.6	7.70	**5.3**	37
6	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		2	9.2	5	5.6	7.67	**5.35**	35
7	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		3	9.2	4	5.6	7.67	**5.4**	35
8	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		3	9.2	1	5.6	7.88	**5.5**	32
9	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		2	9.2	1	5.6	7.84	**5.55**	31
10	TFpanel	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		3	9.2	1	5.6	7.84	**5.6**	32
11	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		3	10	6	6.2	7.53	**5.3**	38
12	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		2	10	5	6.2	7.49	**5.35**	36
13	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		3	10	3	6.2	7.49	**5.4**	35
14	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		3	10	7	6.2	7.53	**5.3**	39
15	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		2	10	7	6.2	7.49	**5.35**	38
16	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		3	10	5	6.2	7.49	**5.4**	37
17	TFpanel	TF/SIP	**600**	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		3	10	2	6.2	7.70	**5.5**	34
18	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		2	10	2	6.2	7.67	**5.55**	33
19	TFpanel	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		3	10	1	6.2	7.67	**5.6**	33
20	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		3	9.2	4	5.6	7.70	**5.05**	35
21	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		2	9.2	3	5.6	7.67	**5.1**	33
22	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		3	9.2	2	5.6	7.67	**5.15**	33
23	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		3	9.2	6	5.6	7.70	**5.05**	37
24	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		2	9.2	5	5.6	7.67	**5.1**	35
25	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		3	9.2	3	5.6	7.67	**5.15**	34
26	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		3	9.2	1	5.6	7.88	**5.25**	32
27	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		2	9.2	1	5.6	7.84	**5.3**	31
28	TFpanel	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		3	9.2	1	5.6	7.84	**5.35**	32
29	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		2	9.2	4	6.1	7.79	**5.3**	34
30	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		1	9.2	3	6.1	7.75	**5.35**	32
31	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		2	9.2	2	6.1	7.75	**5.4**	32
32	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		2	9.2	6	6.1	7.79	**5.3**	36
33	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		2	9.2	5	6.1	7.75	**5.35**	35
34	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		2	9.2	4	6.1	7.75	**5.4**	34
35	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		2	9.2	1	6.1	7.96	**5.5**	32
36	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		2	9.2	1	6.1	7.93	**5.55**	32
37	TFpanel	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		2	9.2	1	6.1	7.93	**5.6**	32
38	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		2	10	5	6.7	7.61	**5.3**	37
39	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		1	10	5	6.7	7.57	**5.35**	36
40	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		2	10	3	6.7	7.57	**5.4**	35
41	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		2	10	7	6.7	7.61	**5.3**	39
42	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		2	10	6	6.7	7.57	**5.35**	38
43	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		2	10	5	6.7	7.57	**5.4**	37
44	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		2	10	2	6.7	7.79	**5.5**	34
45	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		2	10	2	6.7	7.75	**5.55**	34
46	TFpanel	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		2	10	1	6.7	7.75	**5.6**	33
47	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		2	9.2	4	6.1	7.79	**5.05**	34
48	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		1	9.2	3	6.1	7.75	**5.1**	32
49	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		2	9.2	2	6.1	7.75	**5.15**	32
50	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		2	9.2	5	6.1	7.79	**5.05**	35
51	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		2	9.2	5	6.1	7.75	**5.1**	35
52	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		2	9.2	3	6.1	7.75	**5.15**	33
53	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		2	9.2	1	6.1	7.96	**5.25**	32
54	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		2	9.2	1	6.1	7.93	**5.3**	32
55	TFpanel	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		2	9.2	1	6.1	7.93	**5.35**	32
56	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		1	9.2	5	5.9	7.82	**5.3**	34
57	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		0	9.2	5	5.9	7.79	**5.35**	33
58	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		1	9.2	3	5.9	7.79	**5.4**	32
59	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		1	9.2	7	5.9	7.82	**5.3**	36
60	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		1	9.2	6	5.9	7.79	**5.35**	35
61	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		1	9.2	5	5.9	7.79	**5.4**	34
62	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		1	9.2	2	5.9	8.00	**5.5**	32
63	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		1	9.2	2	5.9	7.96	**5.55**	32
64	TFpanel	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		1	9.2	1	5.9	7.96	**5.6**	31
65	TFpanel	TF/SIP	**600**	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		1	10	7	5.9	7.65	**5.3**	37
66	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		0	10	6	5.9	7.61	**5.35**	35
67	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		1	10	5	5.9	7.61	**5.4**	35
68	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		1	10	8	5.9	7.65	**5.3**	38
69	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		1	10	8	5.9	7.61	**5.35**	38
70	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		1	10	6	5.9	7.61	**5.4**	36
71	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		1	10	3	5.9	7.82	**5.5**	33
72	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		1	10	2	5.9	7.79	**5.55**	32
73	TFpanel	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		1	10	2	5.9	7.79	**5.6**	32
74	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		1	9.2	5	5.9	7.82	**5.05**	34
75	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		0	9.2	4	5.9	7.79	**5.1**	32
76	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		1	9.2	3	5.9	7.79	**5.15**	32
77	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		1	9.2	7	5.9	7.82	**5.05**	36
78	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		1	9.2	6	5.9	7.79	**5.1**	35
79	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		1	9.2	5	5.9	7.79	**5.15**	34
80	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		1	9.2	2	5.9	8.00	**5.25**	31
81	TFpanel	TF/SIP	**600**	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		1	9.2	1	5.9	7.96	**5.3**	30
82	TFpanel	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		1	9.2	1	5.9	7.96	**5.35**	30
83	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		5	9.2	5	5.7	7.70	**5.3**	38
84	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		5	9.2	5	5.7	7.67	**5.35**	38
85	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		5	9.2	3	5.7	7.67	**5.4**	36

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Element responsible soucing						Element environment							Cost score				
										Panels	Cladding	Insulation	Lining	Structure	Total Panel Cladding Insulation Lining Structure	Wall panel and cladding	upper floor	Insulation	Internal wall		Time score	Environmental	Cost score	Adaptability	H&S	responsible sourcin	Sustainability score
86	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		6	9.2	7	5.7	7.70	**5.3**	41
87	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		5	9.2	6	5.7	7.67	**5.35**	39
88	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		5	9.2	5	5.7	7.67	**5.4**	38
89	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		6	9.2	2	5.7	7.88	**5.5**	36
90	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		5	9.2	2	5.7	7.84	**5.55**	35
91	TFpanel	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		5	9.2	1	5.7	7.84	**5.6**	34
92	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		5	10	7	6.3	7.53	**5.3**	41
93	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		5	10	6	6.3	7.49	**5.35**	40
94	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		5	10	4	6.3	7.49	**5.4**	38
95	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		6	10	8	6.3	7.53	**5.3**	43
96	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		5	10	8	6.3	7.49	**5.35**	42
97	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		5	10	6	6.3	7.49	**5.4**	40
98	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		6	10	3	6.3	7.70	**5.5**	39
99	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		5	10	2	6.3	7.67	**5.55**	37
100	TFpanel	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		5	10	1	6.3	7.67	**5.6**	36
101	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		5	9.2	5	5.7	7.70	**5.05**	38
102	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		5	9.2	4	5.7	7.67	**5.1**	37
103	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		5	9.2	3	5.7	7.67	**5.15**	36
104	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		6	9.2	7	5.7	7.70	**5.05**	41
105	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		5	9.2	6	5.7	7.67	**5.1**	39
106	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		5	9.2	5	5.7	7.67	**5.15**	38
107	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		6	9.2	2	5.7	7.88	**5.25**	36
108	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		5	9.2	1	5.7	7.84	**5.3**	34
109	TFpanel	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		5	9.2	1	5.7	7.84	**5.35**	34
110	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		4	9.2	5	6.2	7.79	**5.3**	37
111	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		3	9.2	5	6.2	7.75	**5.35**	37
112	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		3	9.2	3	6.2	7.75	**5.4**	35
113	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		4	9.2	7	6.2	7.79	**5.3**	39
114	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		3	9.2	6	6.2	7.75	**5.35**	38
115	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		3	9.2	5	6.2	7.75	**5.4**	37
116	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		4	9.2	2	6.2	7.96	**5.5**	35
117	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		3	9.2	1	6.2	7.93	**5.55**	33
118	TFpanel	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		3	9.2	1	6.2	7.93	**5.6**	33
119	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		4	10	7	6.8	7.61	**5.3**	41
120	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		3	10	6	6.8	7.57	**5.35**	39
121	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		3	10	4	6.8	7.57	**5.4**	37
122	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		4	10	8	6.8	7.61	**5.3**	42
123	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		3	10	8	6.8	7.57	**5.35**	41
124	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		3	10	6	6.8	7.57	**5.4**	39
125	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		4	10	3	6.8	7.79	**5.5**	37
126	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		3	10	2	6.8	7.75	**5.55**	35
127	TFpanel	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		3	10	1	6.8	7.75	**5.6**	34
128	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		4	9.2	5	6.2	7.79	**5.05**	37
129	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		3	9.2	4	6.2	7.75	**5.1**	35
130	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		3	9.2	3	6.2	7.75	**5.15**	34
131	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		4	9.2	7	6.2	7.79	**5.05**	39
132	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		3	9.2	6	6.2	7.75	**5.1**	37
133	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		3	9.2	4	6.2	7.75	**5.15**	35
134	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		4	9.2	2	6.2	7.96	**5.25**	35
135	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		3	9.2	1	6.2	7.93	**5.3**	33
136	TFpanel	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		3	9.2	1	6.2	7.93	**5.35**	33
137	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		4	9.2	3	5.7	7.82	**5.3**	35
138	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		4	9.2	2	5.7	7.79	**5.35**	34
139	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		4	9.2	2	5.7	7.79	**5.4**	34
140	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		4	9.2	4	5.7	7.82	**5.3**	36
141	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		4	9.2	4	5.7	7.79	**5.35**	36
142	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		4	9.2	2	5.7	7.79	**5.4**	34
143	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		4	9.2	1	5.7	8.00	**5.5**	33
144	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		4	9.2	1	5.7	7.96	**5.55**	33
145	TFpanel	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		4	9.2	1	5.7	7.96	**5.6**	33
146	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		4	10	4	5.7	7.65	**5.3**	37
147	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		4	10	4	5.7	7.61	**5.35**	37
148	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		4	10	2	5.7	7.61	**5.4**	35
149	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		4	10	6	5.7	7.65	**5.3**	39
150	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		4	10	5	5.7	7.61	**5.35**	38
151	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		4	10	4	5.7	7.61	**5.4**	37
152	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		4	10	1	5.7	7.82	**5.5**	34
153	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		4	10	1	5.7	7.79	**5.55**	34
154	TFpanel	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		4	10	1	5.7	7.79	**5.6**	34
155	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		4	9.2	2	5.7	7.82	**5.05**	34
156	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		4	9.2	2	5.7	7.79	**5.1**	34
157	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		4	9.2	1	5.7	7.79	**5.15**	33
158	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		4	9.2	4	5.7	7.82	**5.05**	36
159	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		4	9.2	4	5.7	7.79	**5.1**	36
160	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		4	9.2	2	5.7	7.79	**5.15**	34
161	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		4	9.2	1	5.7	8.00	**5.25**	33
162	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		4	9.2	1	5.7	7.96	**5.3**	33
163	TFpanel	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		4	9.2	0	5.7	7.96	**5.35**	32
164	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		6	9.2	6	6.3	7.62	**5.3**	40
165	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		6	9.2	6	6.3	7.58	**5.35**	40
166	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		6	9.2	4	6.3	7.58	**5.4**	38
167	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		7	9.2	8	6.3	7.62	**5.3**	43
168	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		6	9.2	8	6.3	7.58	**5.35**	42
169	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		6	9.2	6	6.3	7.58	**5.4**	40
170	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		7	9.2	2	6.3	7.80	**5.5**	38

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Element responsible soucing						Element environment							Cost score				
										Panels	Cladding	Insulation	Lining	Structure	Total Panel Cladding Insulation Lining Structure	Wall panel and cladding	upper floor	Insulation	Internal wall		Time score	Environmental	Cost score	Adaptability	H&S	responsible sourcin	Sustainability score
171	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		6	9.2	2	6.3	7.76	5.55	37
172	TFpanel	TF/SIP	1800	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		6	9.2	1	6.3	7.76	5.6	36
173	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		6	10	8	6.9	7.44	5.3	44
174	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		6	10	7	6.9	7.41	5.35	43
175	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		6	10	6	6.9	7.41	5.4	42
176	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		7	10	9	6.9	7.44	5.3	46
177	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		6	10	9	6.9	7.41	5.35	45
178	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		6	10	8	6.9	7.41	5.4	44
179	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		7	10	4	6.9	7.62	5.5	41
180	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		6	10	3	6.9	7.58	5.55	39
181	TFpanel	TF/SIP	1800	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		6	10	2	6.9	7.58	5.6	38
182	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		6	9.2	6	6.3	7.62	5.05	40
183	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		6	9.2	6	6.3	7.58	5.1	40
184	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		6	9.2	4	6.3	7.58	5.15	38
185	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		7	9.2	8	6.3	7.62	5.05	43
186	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		6	9.2	8	6.3	7.58	5.1	42
187	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		6	9.2	6	6.3	7.58	5.15	40
188	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		7	9.2	2	6.3	7.80	5.25	38
189	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		6	9.2	2	6.3	7.76	5.3	37
190	TFpanel	TF/SIP	1800	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		6	9.2	1	6.3	7.76	5.35	36
191	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		10	9.2	8	6.6	7.70	5.3	47
192	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		9	9.2	8	6.6	7.67	5.35	46
193	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		9	9.2	6	6.6	7.67	5.4	44
194	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		10	9.2	9	6.6	7.70	5.3	48
195	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		9	9.2	9	6.6	7.67	5.35	47
196	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		9	9.2	8	6.6	7.67	5.4	46
197	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		10	9.2	4	6.6	7.88	5.5	43
198	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		9	9.2	3	6.6	7.84	5.55	41
199	TFpanel	TF/SIP	1800	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		9	9.2	2	6.6	7.84	5.6	40
200	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		10	10	9	7.2	7.53	5.3	49
201	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		9	10	9	7.2	7.49	5.35	48
202	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		9	10	8	7.2	7.49	5.4	47
203	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		10	10	10	7.2	7.53	5.3	50
204	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		9	10	10	7.2	7.49	5.35	49
205	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		9	10	9	7.2	7.49	5.4	48
206	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		10	10	6	7.2	7.70	5.5	46
207	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		9	10	5	7.2	7.67	5.55	44
208	TFpanel	TF/SIP	1800	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		9	10	3	7.2	7.67	5.6	42
209	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		10	9.2	8	6.6	7.70	5.05	47
210	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		9	9.2	7	6.6	7.67	5.1	45
211	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		9	9.2	6	6.6	7.67	5.15	44
212	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		10	9.2	9	6.6	7.70	5.05	48
213	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		9	9.2	9	6.6	7.67	5.1	47
214	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		9	9.2	8	6.6	7.67	5.15	46
215	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		10	9.2	4	6.6	7.88	5.25	43
216	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		9	9.2	3	6.6	7.84	5.3	41
217	TFpanel	TF/SIP	1800	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		9	9.2	2	6.6	7.84	5.35	40
218	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		7	9.2	7	5.6	7.74	5.3	42
219	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		7	9.2	7	5.6	7.70	5.35	42
220	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		7	9.2	6	5.6	7.70	5.4	41
221	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		7	9.2	9	5.6	7.74	5.3	44
222	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		7	9.2	8	5.6	7.70	5.35	43
223	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		7	9.2	7	5.6	7.70	5.4	42
224	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		7	9.2	3	5.6	7.92	5.5	38
225	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		7	9.2	3	5.6	7.88	5.55	38
226	TFpanel	TF/SIP	1800	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		7	9.2	2	5.6	7.88	5.6	37
227	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		7	10	9	5.6	7.56	5.3	44
228	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		7	10	8	5.6	7.53	5.35	43
229	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		7	10	7	5.6	7.53	5.4	43
230	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		7	10	10	5.6	7.56	5.3	45
231	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		7	10	10	5.6	7.53	5.35	45
232	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		7	10	8	5.6	7.53	5.4	44
233	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		7	10	5	5.6	7.74	5.5	41
234	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		7	10	4	5.6	7.70	5.55	40
235	TFpanel	TF/SIP	1800	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		7	10	3	5.6	7.70	5.6	39
236	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		7	9.2	7	5.6	7.74	5.05	42
237	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		7	9.2	7	5.6	7.70	5.1	42
238	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		7	9.2	5	5.6	7.70	5.15	40
239	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		7	9.2	9	5.6	7.74	5.05	44
240	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		7	9.2	8	5.6	7.70	5.1	43
241	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		7	9.2	7	5.6	7.70	5.15	42
242	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		7	9.2	3	5.6	7.92	5.25	38
243	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		7	9.2	3	5.6	7.88	5.3	38
244	TFpanel	TF/SIP	1800	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		7	9.2	2	5.6	7.88	5.35	37
245	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		9	9.2	7	6.2	7.62	5.3	44
246	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		8	9.2	7	6.2	7.58	5.35	43
247	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		8	9.2	6	6.2	7.58	5.4	42
248	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		9	9.2	9	6.2	7.62	5.3	46
249	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		8	9.2	8	6.2	7.58	5.35	44
250	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		8	9.2	7	6.2	7.58	5.4	43
251	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		9	9.2	3	6.2	7.80	5.5	41
252	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		8	9.2	3	6.2	7.76	5.55	40
253	TFpanel	TF/SIP	2400	Closed	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		8	9.2	2	6.2	7.76	5.6	39
254	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		9	10	9	6.8	7.44	5.3	48
255	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		8	10	8	6.8	7.41	5.35	46

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Element responsible soucing						Element environment							Cost score				
										Panels	Cladding	Insulation	Lining	Structure	Total Panel Cladding Insulation Lining Structure	Wall panel and cladding	upper floor	Insulation	internal wall		Time score	Environmental	Cost score	Adaptability	H&S	responsible sourcin	Sustainability score
256	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		8	10	7	6.8	7.41	5.4	45
257	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		9	10	10	6.8	7.44	5.3	49
258	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		8	10	10	6.8	7.41	5.35	48
259	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		8	10	8	6.8	7.41	5.4	46
260	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		9	10	5	6.8	7.62	5.5	44
261	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		8	10	4	6.8	7.58	5.55	42
262	TFpanel	TF/SIP	2400	Closed	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		8	10	3	6.8	7.58	5.6	41
263	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		9	9.2	7	6.2	7.62	5.05	44
264	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		8	9.2	7	6.2	7.58	5.1	43
265	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		8	9.2	5	6.2	7.58	5.15	41
266	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		9	9.2	9	6.2	7.62	5.05	46
267	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		8	9.2	8	6.2	7.58	5.1	44
268	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		8	9.2	7	6.2	7.58	5.15	43
269	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		9	9.2	3	6.2	7.80	5.25	40
270	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		8	9.2	3	6.2	7.76	5.3	39
271	TFpanel	TF/SIP	2400	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		8	9.2	2	6.2	7.76	5.35	39
272	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		10	9.2	9	6.4	7.70	5.3	48
273	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		10	9.2	8	6.4	7.67	5.35	47
274	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		10	9.2	7	6.4	7.67	5.4	46
275	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		10	9.2	10	6.4	7.70	5.3	49
276	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		10	9.2	10	6.4	7.67	5.35	49
277	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		10	9.2	8	6.4	7.67	5.4	47
278	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		10	9.2	5	6.4	7.88	5.5	44
279	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		10	9.2	4	6.4	7.84	5.55	43
280	TFpanel	TF/SIP	2400	Open	OPCL	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		10	9.2	3	6.4	7.84	5.6	42
281	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		10	10	10	7	7.53	5.3	50
282	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		10	10	9	7	7.49	5.35	49
283	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		10	10	8	7	7.49	5.4	48
284	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		10	10	10	7	7.53	5.3	50
285	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		10	10	10	7	7.49	5.35	50
286	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		10	10	9	7	7.49	5.4	49
287	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		10	10	6	7	7.70	5.5	46
288	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		10	10	6	7	7.67	5.55	46
289	TFpanel	TF/SIP	2400	Open	OPCL	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		10	10	4	7	7.67	5.6	44
290	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		10	9.2	9	6.4	7.70	5.05	47
291	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		10	9.2	8	6.4	7.67	5.1	46
292	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		10	9.2	7	6.4	7.67	5.15	45
293	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		10	9.2	10	6.4	7.70	5.05	48
294	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		10	9.2	9	6.4	7.67	5.1	47
295	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		10	9.2	8	6.4	7.67	5.15	46
296	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		10	9.2	4	6.4	7.88	5.25	43
297	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		10	9.2	4	6.4	7.84	5.3	43
298	TFpanel	TF/SIP	2400	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		10	9.2	3	6.4	7.84	5.35	42
299	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		8	9.2	9	5.4	7.74	5.3	45
300	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		7	9.2	9	5.4	7.70	5.35	44
301	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		8	9.2	7	5.4	7.70	5.4	43
302	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	6		8	9.2	10	5.4	7.74	5.3	46
303	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	6		7	9.2	10	5.4	7.70	5.35	45
304	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	6		8	9.2	9	5.4	7.70	5.4	45
305	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	6		8	9.2	5	5.4	7.92	5.5	41
306	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	6		7	9.2	4	5.4	7.88	5.55	39
307	TFpanel	TF/SIP	2400	Volumetric	volume	90x240mm glulam	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	6		8	9.2	3	5.4	7.88	5.6	39
308	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		8	10	10	5.4	7.56	5.3	46
309	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		7	10	10	5.4	7.53	5.35	45
310	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		8	10	8	5.4	7.53	5.4	44
311	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	3	5.3	10		10	10		8	10	10	5.4	7.56	5.3	46
312	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	3	5.35	10		10	10		7	10	10	5.4	7.53	5.35	45
313	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	3	5.4	10		10	10		8	10	10	5.4	7.53	5.4	46
314	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	3	5.5	10		10	10		8	10	7	5.4	7.74	5.5	44
315	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	3	5.55	10		10	10		7	10	6	5.4	7.70	5.55	42
316	TFpanel	TF/SIP	2400	Volumetric	volume	Non-structural	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	3	5.6	10		10	10		8	10	4	5.4	7.70	5.6	41
317	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		8	9.2	9	5.4	7.74	5.05	44
318	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		7	9.2	8	5.4	7.70	5.1	42
319	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		8	9.2	7	5.4	7.70	5.15	42
320	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Warmcell	Warmcell	3	2	2	2.00	0.5	5.05	10		10	6		8	9.2	10	5.4	7.74	5.05	45
321	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Rockwool	3	2	2.5	2.00	0.5	5.1	10		10	6		7	9.2	10	5.4	7.70	5.1	44
322	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	2	3	2.00	0.5	5.15	10		10	6		8	9.2	9	5.4	7.70	5.15	44
323	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Warmcell	Warmcell	3	3	2	2.00	0.5	5.25	10		10	6		8	9.2	5	5.4	7.92	5.25	41
324	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Rockwool	3	3	2.5	2.00	0.5	5.3	10		10	6		7	9.2	4	5.4	7.88	5.3	39
325	TFpanel	TF/SIP	2400	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	Batts (sheepwool or Rockwool)	Sheep wool	3	3	3	2.00	0.5	5.35	10		10	6		8	9.2	3	5.4	7.88	5.35	39
326	**SIP Panel**	TF/SIP	600	Closed	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		5	9.2	8	5.5	7.70	5.1	41
327	**SIP Panel**	TF/SIP	600	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		5	9.2	10	5.5	7.70	5.1	43
328	**SIP Panel**	TF/SIP	600	Closed	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	6		5	9.2	4	5.5	7.88	5.3	37
329	**SIP Panel**	TF/SIP	600	Closed	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		5	10	9	6.1	7.53	5.1	43
330	**SIP Panel**	TF/SIP	600	Closed	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		5	10	10	6.1	7.53	5.1	44
331	**SIP Panel**	TF/SIP	600	Closed	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	10		5	10	6	6.1	7.70	5.3	40
332	**SIP Panel**	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		5	9.2	8	5.5	7.70	4.85	40
333	**SIP Panel**	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		5	9.2	9	5.5	7.70	4.85	41
334	**SIP Panel**	TF/SIP	600	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	0.5	5.05	10		10	6		5	9.2	4	5.5	7.88	5.05	37
335	**SIP Panel**	TF/SIP	600	Open	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		2	9.2	8	6	7.79	5.1	38
336	**SIP Panel**	TF/SIP	600	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		2	9.2	9	6	7.79	5.1	39
337	**SIP Panel**	TF/SIP	600	Open	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	6		2	9.2	4	6	7.96	5.3	34
338	**SIP Panel**	TF/SIP	600	Open	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		2	10	9	6.6	7.61	5.1	40
339	**SIP Panel**	TF/SIP	600	Open	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		2	10	10	6.6	7.61	5.1	41
340	**SIP Panel**	TF/SIP	600	Open	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	10		2	10	6	6.6	7.79	5.3	38

	timber /sip		Panel size (600/1200/1800/2400)	Open/Closed/ Volumetric		Structure (glulam /steel/none)	Cladding (red cedar/stone/zinc)		Insulation	Element responsible soucing						Element environment							Cost score				
										Panels	Cladding	Insulation	Lining	Structure	Total Panel Cladding Insulation Lining Structure	Wall panel and cladding	upper floor	Insulation	Internal wall		Time score	Environmental	Cost score	**Adaptability**	**H&S**	**responsible sourcin**	**Sustainbility score**
341	**SIP Panel**	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		2	9.2	8	6	7.79	**4.85**	38
342	**SIP Panel**	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		2	9.2	9	6	7.79	**4.85**	39
343	**SIP Panel**	TF/SIP	600	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	0.5	5.05	10		10	6		2	9.2	4	6	7.96	**5.05**	34
344	**SIP Panel**	TF/SIP	600	Volumetric	volume	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		1	9.2	7	5.6	7.82	**5.1**	36
345	**SIP Panel**	TF/SIP	600	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		1	9.2	9	5.6	7.82	**5.1**	38
346	**SIP Panel**	TF/SIP	600	Volumetric	volume	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	6		1	9.2	3	5.6	8.00	**5.3**	32
347	**SIP Panel**	TF/SIP	600	Volumetric	volume	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		1	10	8	5.6	7.65	**5.1**	37
348	**SIP Panel**	TF/SIP	600	Volumetric	volume	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		1	10	10	5.6	7.65	**5.1**	39
349	**SIP Panel**	TF/SIP	600	Volumetric	volume	Non-structural	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	10		1	10	4	5.6	7.82	**5.3**	34
350	**SIP Panel**	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		1	9.2	7	5.6	7.82	**4.85**	35
351	**SIP Panel**	TF/SIP	600	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		1	9.2	9	5.6	7.82	**4.85**	37
352	**SIP Panel**	TF/SIP	**600**	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	0.5	5.05	10		10	6		1	9.2	3	5.6	8.00	**5.05**	32
353	**SIP Panel**	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		9	9.2	9	5.5	7.70	**5.1**	46
354	**SIP Panel**	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		9	9.2	10	5.5	7.70	**5.1**	47
355	**SIP Panel**	TF/SIP	1200	Closed	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	6		9	9.2	5	5.5	7.88	**5.3**	42
356	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		9	10	10	6.1	7.53	**5.1**	48
357	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		9	10	10	6.1	7.53	**5.1**	48
358	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	10		9	10	7	6.1	7.70	**5.3**	45
359	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		9	9.2	9	5.5	7.70	**4.85**	45
360	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		9	9.2	10	5.5	7.70	**4.85**	46
361	**SIP Panel**	TF/SIP	1200	Closed	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	0.5	5.05	10		10	6		9	9.2	5	5.5	7.88	**5.05**	42
362	**SIP Panel**	TF/SIP	1200	Open	OPCL	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		5	9.2	9	6	7.79	**5.1**	42
363	**SIP Panel**	TF/SIP	1200	Open	OPCL	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		5	9.2	10	6	7.79	**5.1**	43
364	**SIP Panel**	TF/SIP	1200	Open	OPCL	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	6		5	9.2	5	6	7.96	**5.3**	38
365	**SIP Panel**	TF/SIP	1200	Open	OPCL	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		5	10	10	6.6	7.61	**5.1**	44
366	**SIP Panel**	TF/SIP	1200	Open	OPCL	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		5	10	10	6.6	7.61	**5.1**	44
367	**SIP Panel**	TF/SIP	1200	Open	OPCL	Non-structural	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	10		5	10	7	6.6	7.79	**5.3**	42
368	**SIP Panel**	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		5	9.2	9	6	7.79	**4.85**	42
369	**SIP Panel**	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		5	9.2	10	6	7.79	**4.85**	43
370	**SIP Panel**	TF/SIP	1200	Open	OPCL	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	0.5	5.05	10		10	6		5	9.2	5	6	7.96	**5.05**	38
371	**SIP Panel**	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		6	9.2	9	5.6	7.82	**5.1**	43
372	**SIP Panel**	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	6		6	9.2	10	5.6	7.82	**5.1**	44
373	**SIP Panel**	TF/SIP	1200	Volumetric	volume	90x240mm glulam	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	6		6	9.2	6	5.6	8.00	**5.3**	40
374	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Non-structural	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		6	10	10	5.7	7.65	**5.1**	44
375	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Non-structural	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	3	5.1	10		10	10		6	10	10	5.7	7.65	**5.1**	44
376	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Non-structural	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	3	5.3	10		10	10		6	10	7	5.7	7.82	**5.3**	42
377	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Western Red Cedar	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		6	9.2	9	5.6	7.82	**4.85**	42
378	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Z-shaped stone cladding	EPS	EPS density 20kg/	3	2	0	2.00	0.5	4.85	10		10	6		6	9.2	10	5.6	7.82	**4.85**	43
379	**SIP Panel**	TF/SIP	1200	Volumetric	volume	Steel rsj beam 203*133	Zinc cladding	EPS	EPS density 20kg/	3	3	0	2.00	0.5	5.05	10		10	6		6	9.2	6	5.6	8.00	**5.05**	40

J TRADITONAL CONSTRUCTION

J.1 TRADITIONAL CONSTRUCTION MATERIALS

Element	Material	Specification	Dimensions
Ground floor	Hardcore	(Barry's pg. 85) Specification : Usually 100-300mm deep	Floor area 4200*7000
	Insulation	Mineral wool	Floor area 4200*7000
	DPM	Polythene >0.25mm	(4200+((2*(100+102.5+100)))* (7000+((2*(100+102.5+100)))
	Concrete floor slab/ Screed	Concrete >150mm Screed >12mm	Floor area 4200*7000
External wall	External brick work	Clay brick Brick standard size 215 x 102.5 x 65mm with 10mm mortar joint Compressive strength 5N/mm2	
	Mortar (ready mix: sand and cement	10mm joint	
	Void Wall ties	2.47 per square metre	
	Insulation	Mineral wool	
	Internal block (pg. 173)	440*215x100mm Compressive strength2.8N/mm2 (Approved Doc A, from Barry's pg.	
	Plaster	One/two undercoat 12mm Finishing coat 3mm	
Internal upper floor	Gypsum skim	2-5mm	
	Gypsum base board	900x12209.5mm	
	Timber joist Beam Struts	Struts Pg. 116 Barry 50*38mm, nailed: herring bone strutting Spacing 450mm Span 3.6-4.0m	
	Insulation 100mm	38-75mm thick 75-235deep	
	21mm softwood floor boarding /chipboard	21*600*2400 Chipboard	
Roof	Rafters and trusses	Barry pg274	
	Insulation		
	Roof sarking	1.5m x 50m - 75.00m2	

	Battens	38x19mm battens 100gauge	
	Plain tiles (burned clay) Ridge tiles	265*165mm	
Internal wall (structural)	Internal block (pg. 173)	440*215x100mm Compressive strength2.8N/mm2 (Approved Doc A, from Barry's pg.	
	Plaster	One/two undercoat 12mm Finishing coat 3mm	
Internal wall (non-structural)	Clay block	290x215*100mm	

K EMAIL COMMUNICATION

Email communication

Ric Frankland richard@dwelle.co.uk via liverpool.ac.uk

29 Jun 2015, 08:58

to Gordy, Ruth

Hi Gordy

I've uploaded the latest CAD drawing to Dropbox ("urban dwelle.ing"). Although it's very much a working drawing, hopefully it's clear enough. I've also added the "timber panels" drawing. This hopefully shows you my proposed "kit-of-parts".

Originally I designed the frame and panels based on the following principles:

90x240 glulam (or LVL if necessary) portal frames at roughly 2.4-3m centres;

glulam beam at ground floor level connects across to create a fully connected portal;

90x240 I-joists connect across portal at intermediate floor levels (lighter in weight, cheaper and easier to run services through);

timber panels are around 1.2x2.4m in size;

(closed) panels are typically made up using 11mm OSB and 240mm I-joists at 400mm centres;

timber roof and floor panels span across between portals, whereas the wall panels are upright;

wall, roof and ground floor panel connections are made using Walco connectors fixed into glulam portals and 45mm LVL along the edges of the panels;

intermediate floor panels are fixed using Simpson Strongtie hangers; and

internal walls and fins (made from 89mm SW between 2 layers of 12.5mm Fermacell) positioned within the portal provide rigidity.

There's a sketch of the general idea in Dropbox. Now I'm considering the following, to keep the material cost down:

90x240 glulam (or LVL if necessary) portal frames at roughly 2.4-3m centres;

glulam beam at ground floor level connects across to create a fully connected portal;

90x240 I-joists connect across portal at intermediate floor levels;

with differences...

timber panels are around 1.2x2.4m in size, although depending on weight, could make some of the wall panels slightly bigger (2.4x2.4m, so one full panel fits between the portals and the floors);

(closed) panels are typically made up using 11mm OSB and 240mm I-joists at greater 600mm centres (?), with floor panels still at 400mm centres;

timber roof and floor panels span across between portals - wall panels could also span lengthways, for easier fixing? - no twisting in the centres;

wall, roof and ground floor panel connections are made by simply screwing through the wood fibre insulation and OSB into the glulam portal, replacing the 45mm LVL along the edges of the panels with insulated I-joists;

and still the same...

intermediate floor panels are fixed using Simpson Strongtie hangers; and

internal walls and fins (made from 89mm SW between 2 layers of 12.5mm Fermacell) positioned within the portal provide rigidity.

Items I'm unclear about and need some direction to enable me to include in the costs are as follows:

sub base design / foundation design - how are the portals supported off the foundations, allowing different options for the foundations (for Cornwall the foundations will be standards across the site but we've not had details yet, possibly precast beams, whereas for the Skippets maybe we could use http://www.abcanchors.co.uk)?

connection plates for the portals - are they bespoke or is there something off-the-shelf we can use from Rothoblaas or Simpson Strongtie?

requirement for ridge beam? - ideally would like flues to terminate through the apex of the roof.

Any queries at all, please call me on my mobile.

Best regards

Ric

Ric Frankland, Director

dwelle.

BUDGET QUOTATION

To:	Ruth	**From:**	Emma Laing
Company:	Dwelle	**Pages:**	Five
E-Mail:		**Date:**	01.07.15
Ref:	Crane Quotation – Manchester		

Dear Sirs / Madam,

Further to our recent site visit, please find below our quotation for the provision of Contract Lift Services at the above site location. This quotation is provided following a preliminary site visit and either uses actual information that has been provided by the client or uses evaluation that will require confirmation prior to the operation being planned. The following price may need to be revised in the event of any unpredictable changes that may occur prior to the actual lift operation.

All Hewden Crane Hire Contract Lifts are carried out in accordance with BS7121 Part 3 Code of Practice for Safe Use of Cranes, LOLER Regulations 1998 and CPA Standard Terms and Conditions for a contract for the Lifting and Movement of Goods Involving Crane Operation.

Please note that any insurance referred to below may not cover the value of the item being moved, therefore it is the clients responsibility to ensure that adequate insurance is obtained for any / all items being lifted during the operation.

The ground pressure loadings assigned to the standing / lifting area of the procedure are required as essential information for the Method Statement that is required for the planned operation.

A cancellation charge of £150.00p may be incurred if the work is cancelled following the issue of the Method Statement and Risk Assessment documents should they have been provided to / received by the client following the receipt of a Purchase Order number.

1.0 Technical Proposal

1.1 Scope of Work (based on maximum weights provided by client):

Specification:

Provision of Mobile Crane

Provision of Lift Supervisor

Provision of Slinger

1.2 Specialist Lifting Tackle – not carried as standard equipment with crane.

2.0 Commercial Proposal

2.1 To supply the equipment as detailed in Section 1: -

£1,342.00 for 8 hours on site work – weekday working (Daytime)

Or

£1,702.00 for 8 hours on site work – weekend working (Daytime)

2.2 The above price allows for up to 8 hours work on site per day. Hours worked in excess of 8 would be chargeable at £170.00 per each additional hour.

2.3 The above price allows for transportation of crane and equipment to and from site, and includes for standard rigging and de-rigging of the crane.

2.4 The above price includes for experienced supervision and labour to execute the lifts.

2.5 The above price includes for the provision of a Method Statement, which will be supplied upon receipt of a Purchase Order.

2.6 The above price includes for provision of an Appointed Person to plan and arrange supervision of the lifting operation/s.

2.7 Insurance cover as set out in the C.P.A. Standard Terms and Conditions for a Contract for the Lifting and Movement of Goods Involving Crane Operation is provided for in this quotation – refer to section 7.0 for specific details.

2.8 No retention to be withheld on completion of contract.

3.0 Additional Items

Pending Site Visit

4.0 Access/Authority

We would draw your attention to the following:

4.1 Free and unrestricted access to all areas of operation.

4.2 Any Traffic Management required should be in place in good time.

4.3 It is the Clients responsibility to ensure all necessary authorities/permits are obtained.

4.4 Failure to comply with the above will leave the Client liable for the full contract charges, should the job be aborted.

5.0 General Conditions

5.1 This quotation is subject to the CPA Standard Terms and Conditions for Contract for the Lifting and Movement of Goods Involving Crane Operation (copies enclosed).

5.2 These Terms and Conditions shall not be varied, except with our Company's written agreement and signed by a person authorised thereto by our Company.

5.3 This quotation is based upon lifting the items detailed in the scope of works. Should additional lifts be required which fall outside this scope of works then the contract would revert to the CPA Model Conditions for the Hiring of Plant.

5.4 Unless otherwise specified by our Company in writing, every quotation is open for acceptance for a period of thirty days, after which the quotation will be subject to confirmation by our Company.

5.5 V.A.T. will be charged at the prevailing rate.

5.6 Any technical literature or drawing supplied by Hewden Crane Hire Limited is supplied without liability and any defects will not affect the conditions of hire.

5.7 Availability - this offer is made subject to the availability of the equipment and the receipt of a written order. Additionally, we can accept no consequential losses incurred due to Police or Local Authority actions in delaying authorised movements of machines in the process of travelling to your site from our depot or previous contract.

6.0 Specific Conditions

Your attention is drawn to Clause 7 of the CPA Standard Terms and Conditions for a Contract for the Lifting and Movement of Goods Involving Crane Operation. ***In particular the client should note the following:***

6.1 Any defect in the contract goods including any design defect and any defect relating to lifting points on the contract goods.

6.2 Any defect in equipment provided by the client.

6.3 Unexpected and unforeseen subsidence or unstable ground conditions.

6.4 Delay in commencing or completing the contract work due to circumstances beyond our Company's control including, but not limited to any strike or other industrial action. In particular costs arising from delays due to inclement weather i.e. wind speeds that are in excess of the design limitations for the crane configuration being used.

7.0 Insurance

7.1 Our Company's liability, if any, arising from or in connection with the lifting contract will be limited to:

7.1(a) For loss or destruction of or damage to the contract goods will be limited to a total of £25,000.00 (twenty five thousand pounds sterling).

7.1(b) For any other loss, damage or injury will be limited to a total sum of £5,000,000.00 (five million pounds sterling).

7.2 Our Company can on request, prior to the commencement of the contract, provide quotations to increase the amounts stated in Clauses 7.1(a) and 7.1(b). This must be agreed in writing prior to the commencement of the lifting contract.

7.3 We recommend that the client contact their insurance advisors to confirm that they have sufficient cover for our Company's exclusion of liability.

7.4 The client should also ensure that they have sufficient Public Liability Insurance Cover to provide indemnity for our Company's plant/equipment caused by the client's negligence either in whole or part.

Please Note – This quotation is based on client information only and is subject to a Hewden site visit.

We trust that we have interpreted your requirements correctly, should you require any further clarification or assistance, please do not hesitate to contact the undersigned.

If you should require any further assistance, please do not hesitate to contact the below.

Yours faithfully

For and on behalf of HEWDEN

Emma

Emma Laing

Hire Controller – Cranes

RE: Construction Waste Disposal Liverpool University Research

Inbox

x

Customer Care <customercare@jwswaste.co.uk>

Thu, 24 Sep 2015, 12:53

to Ruth

Hi Ruth

We don't normally agree to help with research but please find rates below.

Contracted weekly removal of waste from a factory. Costs per tonne for timber, plasterboard and "other general mixed waste" Approximately 0.5 tonne per week.

Timber £85.00 per tonne

Plasterboard £100.00 per tonne

General Mixed Recyclable Waste £90.00 per tonne

General Mixed Non-recyclable Waste £105.00 per tonne although bulky items for landfill are £120.00 per tonne

The above rates would be based on you tipping into our facility. For an 8yd skip to an 'M' postcode for recyclable construction waste the rate would be £180.00.

Plasterboard needs to be kept separate so would be charged on a separate transport of roughly £60.00 to an 'M' postcode then the disposal above (minimum 1 tonne).

Prices are subject to VAT.

Kind regards

Jane Eustace, Customer Services Manager, JWS Waste and Recycling Services Ltd