

Forestry Commission Scotland Greenhouse Gas Emissions Comparison - Carbon benefits of Timber in Construction







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Author	Jill Burnett	
Reviewed	Jess Lovell	
Approved	Richard Tipper Director Date: August 2006	
Contact	ECCM Ltd Tower Mains Studios 18F, Liberton Brae Edinburgh EH16 6AE Tel: +44 (0)131 666 5070 Fax: +44 (0)131 666 5055 The Edinburgh Centre for Carbon Management is part of the Energy for Sustainable Development (ESD Ltd) group of companies	

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Forestry Commission Scotland – Carbon benefits of Timber in Construction Greenhouse Gas Emissions Comparison

Executive Summary

Background

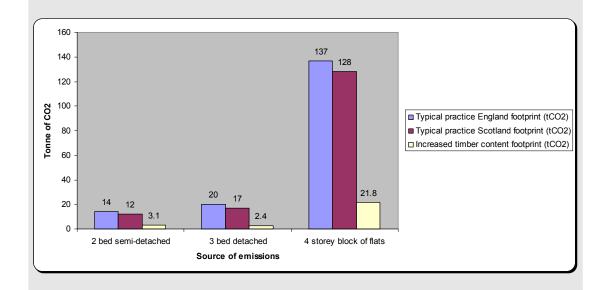
This assessment compares the greenhouse gas (GHG) emissions arising from the embodied energy¹ of a variety of different building materials that could be used in the construction of a 2 bed semi-detached house, a 3 bed detached house and a 4 storey block of flats. In addition this study quantifies the potential GHG benefits of increasing the timber content of the 3 types of accommodation.

The impact of transport on the overall GHG balance of timber is also assessed by comparing a range of hypothetical supply chains.

Summary of Emissions – Building Materials Assessment

ECCM estimates that, indicatively, there could be up to an 86% reduction in the GHG emissions associated with the embodied energy of building materials if timber internal and external structural elements and fittings are specified wherever possible rather than typical practice Scottish building materials.

For the purposes of comparison, examples of each house type using typical *English* building materials are also included; please see Appendix IV for details.



Summary of Emissions – Timber Transport Assessment

ECCM estimates that the two least carbon intensive methods of sourcing sawn timber for a company operating in the UK are by transporting it by train or by 44 tonne (28 tonne payload) lorry from a locally grown source.

¹ Embodied energy is the energy used during the 'cradle to gate' lifecycle of the material (extraction and manufacturing / processing)

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Scope and Methodology

The assessment methodology follows the guidelines provided by the World Business Council for Sustainable Development (WBCSD) Greenhouse Gas Protocol.

The assessment boundary of this study includes the GHG emissions associated with the embodied energy of a range of different building materials that may be used in the construction of a 2 bed semi-detached house, a 3 bed detached house and a 4 storey block of flats.

For the transportation of timber, this study focuses on fuel combustion emissions from timber transported by ship (small and large), train and lorry (44 and 60 tonne) from Canada, Scandinavia, Eastern Europe and the UK.

1. Introduction

1.1 Background

Climate change presents a serious challenge for responsible business leaders in the 21st century. Most scientists now agree that rising atmospheric concentrations of

greenhouse gases (GHGs), particularly carbon dioxide (CO₂), threaten to have severe impacts production, natural food ecosystems and human health the next 100 over vears. Industrialised rapidly and industrialising countries are the sources of greenhouse gases. However, the greatest impacts will be felt by people in developing countries, particularly those in low lying coastal regions and marginal agricultural areas.



Figure 1. Flooding in Bangladesh

In response to the threat of climate change, the Kyoto Protocol was adopted in December 1997. Under the Protocol, industrialised countries have a legally binding commitment to reduce their collective greenhouses gas emissions by at least 5% compared to 1990 levels by the period 2008-2012. Russia ratified the Kyoto Protocol

on 18th November 2004 and as a result it came into force

on February 16th 2005.



Figure 2. Kyoto Ratification -The UN Secretary General Kofi Annan receives Russia's instrument of ratification. Allowing the Kyoto Protocol to enter into force in early 2005. Picture taken from http://unfccc.int/2860.php.

The UK ratified the Kyoto Protocol in May 2002 as part of a joint ratification by European Union countries. The UK commitment is for a 12.5% reduction in Kyoto greenhouse gases, however the UK Government has pledged to reduce CO_2 emissions by 20% of their 1990 level by 2010. Total UK GHG emissions for 2003 for all sources (fossil fuel combustion, industrial processes and land use change and forestry) were 665 800 000 tonnes of CO_2 equivalent, 13.4% below 1990 levels (UNFCCC, 2003). The 2003 UK Government's Energy White Paper set an aspiration for the UK to reduce carbon emissions by 60%, and create a low carbon economy by 2050.

National governments and the EU are taking a variety of steps to reduce GHG emissions including the introduction of emissions trading schemes, voluntary reduction and reporting programs, carbon or energy taxes, and regulations and standards on energy efficiency and emissions. Increasingly, companies will need to understand and manage their GHG risks in order to maintain their license to operate, to ensure long-term success in a competitive business environment, and to

comply with national or regional policies aimed at reducing corporate GHG emissions (WBCSD/WRI 2004).

Materials used in construction have widely varying amounts of greenhouse gases associated with their extraction, refining, manufacture or processing and delivery. The production of cement and steel alone account for over 10% of global, annual greenhouse gas emissions. As new buildings become more energy efficient, the emissions associated with materials make up a greater proportion of their total climate change impact.

Planners, developers, architects and builders are becoming more aware of the climate change impacts of construction materials and are increasingly including climate change considerations in their selection of materials for building projects.

2. Assessment Methodology

2.1 General Procedure

The assessment methodology used here follows the reporting principles and guidelines provided by the Greenhouse Gas Protocol published by the World Business Council for Sustainable Development and the World Resources Institute (WBCSD/WRI Protocol).

In line with the WBCSD/WRI Protocol, ECCM have used the following procedure to undertake this study:

- 1. Establishment of the assessment boundaries (including the selection of: greenhouse gases and project boundaries).
- 2. Calculation of emissions using appropriate conversion factors.
- 3. Analysis of results.

The assessment procedure and a summary of results are presented in the main text of the report. A detailed description of emissions calculations and associated assumptions are presented in Appendices II and III.

A glossary of climate change terms is found in Appendix I.

2.2 Greenhouse Gases - Overview

An assessment such as this can include all six greenhouse gases covered by the Kyoto Protocol. The six Kyoto gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O_3), sulphur hexaflouride (SF_6), perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs).

The global warming potential (GWP) of each greenhouse gas may be expressed in CO_2 equivalents (see Table 1). For those gases with a high global warming potential, a relatively small emission can have a considerable impact.

Table 1. The global warming potential of the Kyoto gases

Kyoto gas	GWP*	*Note: the 'global warming potential' of a gas is its relative
carbon dioxide (CO ₂)	1	potential of a gas is its relative potential contribution to climate
methane (CH ₄)	23	change over a 100 year period, where CO ₂ =1 (see Glossary for a
nitrous oxide (N ₂ O)	296	full definition). Source: IPCC
sulphur hexaflouride (SF ₆)	22,200	(2001).
perfluorocarbons (PFCs)	4,800 – 9,200	
hydrofluorocarbons (HFCs)	12 - 12,000	

2.3 Greenhouse Gases

This assessment covers the CO_2 emissions arising from the embodied energy of building materials and from transport fuel combustion. CH_4 and N_2O factors have not been included in this assessment as conversion factors are not available for all materials that have been assessed as part of this study, and their relative contribution to overall GHG emissions will be small.

2.4 Scope of Assessment

The scope of this study encompasses the embodied emissions of a selection of construction materials and the emissions arising from a range of different modes of timber transport.

This study does not consider or compare the varying lifetimes of different construction materials, and the impact that this may have on the lifetime carbon footprint of the building.

In addition, the carbon benefits of increasing timber in construction illustrated in this report relate to new buildings only. This report does not seek to recommend replacing existing buildings with increased timber content alternatives.

2.5 Reporting Approach

ECCM does not base its emissions assessments on direct measurement of emissions, but on estimates of material and energy consumption (principally weight or volume of fuel, but also weight or volume of waste and material) from which estimates of emissions can be derived, by the application of relevant conversion factors (i.e. amount of CO_2 produced per unit of fuel consumed). This approach is considered the most pragmatic, since the quantity of key greenhouse gases produced in most combustion and manufacturing processes is well understood. However, the certainty of waste emission estimates is lower, but direct measurement is rarely a realistic option.

The validity of all estimates depends on the accuracy, relevance and completeness of the data and on the conversion factors used. ECCM's approach is to set out as clearly as possible all the assumptions and conversion factors used, so that the report is as transparent as possible and the estimate of emissions is founded on 'best evidence'.

ECCM is guided by the precautionary principle. Where there is any doubt over activities undertaken, or where there is a choice of published figures available for calculating greenhouse gas emissions, a conservative 'worst case' scenario is assumed, unless otherwise specified.

2.6 Emission factors

Emissions factors for the lifecycle of building materials were taken from standard data provided by the UK Building Research Establishment (BRE), the Finnish Building Information Foundation and the European Plastics Industry and applied where appropriate.

In order to establish the tonnes of CO_2 emitted from fuel consumption default conversion factors were applied. These were taken from 'Environmental Reporting: guidelines for company reporting on greenhouse gas emissions' published by the UK government (DEFRA 2005).

3. Data

3.1 Data Sources

The quantities and dimensions of construction materials, upon which the emissions calculations were based are not taken from actual architects specifications. Rather they are estimates created by ECCM based on previous carbon footprinting projects and standard structural engineering reference works (See references).

The previous carbon footprinting projects can not be named for reasons of confidentiality.

3.2 Data Assumptions

All assumptions underlying the emission calculations are detailed in Appendices II - ${\sf IV}$.

4. Results

Building materials comparison

ECCM have detailed a range of potential building materials that may be used in the construction of a 2 bed semi-detached house², a 3 bed detached house and a 4 story block of flats and have calculated the GHG emissions associated with each. These are presented in Appendix II.

In order to illustrate the GHG reductions that can be achieved by increasing the timber content of a 2 bed semi-detached house, a 3 bed detached house and a 4 story block of flats, ECCM have presented a 'typical building materials (Scotland)' scenario and an 'increased timber content' scenario for each of the accommodation types. These are shown in Tables 2-7 below³.

2 bed semi detached -building materials comparison

Typical materials (Scotland)

Building material	Tonnes of CO ₂
Foundations	_
Concrete	0.9
Flooring	
Hardcore, concrete slab, screed, chipboard, extruded polystyrene insulation	2.0
Ceilings	
Plasterboard	0.2
Joists	
Timber I joists	-0.12
External walls	
Timber frame, brick work, plywood sheathing, glasswool insulation and plasterboard	4.9
Internal walls	
Timber frame and plasterboard	0.2
Stairs	
Timber	-0.1
Windows	
Glass	0.1
PVC frame	0.03
Internal doors	
Panel doors (chipboard)	-0.1
External doors	
PVC	0.1
Roof	
Timber rafters, rock wool insulation and Marley plain concrete (BRE element profile)	4.0
Total	12.2

Table 2. 2 bed semi-detached – typical materials (Scotland)

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² It is assumed that a semi detached complex is composed of two dwellings sharing one wall. Only one dwelling has been assessed in this study.

^{3□}The emissions associated with the roof are calculated using BRE 'element profiles' which includes emissions from embodied energy of the frame, insulation and roof tiles.

Increased Timber content

Building material	Tonnes of CO ₂
Foundations	
Concrete	0.9
Flooring	
Hardcore, concrete slab, timber floor, EPS insulation	1.0
Ceilings	
Plasterboard	0.2
Joists	
Timber I joists	-0.12
External walls	
Timber frame, timber clad, panelvent board, cellulose insulation and plasterboard	-1.9
Internal walls	
Timber frame and plasterboard	0.2
Stairs	
Timber	-0.1
Windows	
Glass	0.1
Wooden frames	-0.02
Internal doors	
Panel doors (chipboard)	-0.1
External doors	
Timber	-0.1
Roof	
Timber rafters, rock wool insulation, felt, battens and clay tiles (BRE element profile)	2.9
Total	3.1

Table 3. 2 bed semi-detached – increased timber content

3 bed detached – building materials comparison

Typical materials (Scotland)

Building material	Tonnes of CO ₂
Foundations	2
Concrete	1.7
Flooring	
Hardcore, concrete slab, screed, chipboard, extruded polystyrene insulation	1.9
Ceilings	
Plasterboard	0.4
Joists	
Timber I joists	-0.59
External walls	
Timber frame, brick work, plywood sheathing, glasswool insulation and plasterboard	8.4
Internal walls	
Timberframe and plasterboard	0.27
Stairs	
Timber	-0.1
Windows	
Glass	0.1
PVC frame	0.06
Internal doors	
Panel doors (chipboard)	-0.02
External doors	
PVC	0.1
Roof	
Timber rafters, rock wool insulation and Marley plain concrete (BRE element profile)	4.5
Total	16.8

Table 4. 3 bed detached - typical materials (Scotland)

Increased Timber content

Building material	Tonnes of CO ₂
Foundations	
Concrete	1.7
Flooring	
Hardcore, concrete slab, timber floor, EPS insulation	0.7
Ceilings	
Plasterboard	0.4
Joists	
Timber I joists	-0.59
External walls	
Timber frame, timber clad, panelvent board, cellulose insulation and plasterboard	-3.3
Internal walls	
Timber frame and plasterboard	0.3
Stairs	
Timber	-0.1
Windows	
Glass	0.1
Wooden frames	-0.04
Internal doors	
Panel doors (chipboard)	0.0
External doors	
Timber	-0.1
Roof	
Timber rafters, rock wool insulation, felt, battens and clay tiles (BRE element profile)	3.3
Total	2.4

Table 5. 3 bed detached - increased timber content

4 storey block of flats – building materials comparison

Typical materials (Scotland)

Building material	Tonnes of CO ₂
Foundations	_
Concrete	4.7
Flooring	
Hardcore, concrete slab, screed, chipboard, extruded polystyrene insulation	39.9
Ceilings	
Plasterboard	2.3
Structural Steel	
Steel	15.44
External walls	
Brick outer leaf with block internal leaf, glasswool insulation and plasterboard	32.1
Internal walls	
Timber frame and plasterboard	8.7
Stairs	
Concrete	1.1
Windows	
Glass	0.3
PVC frame	0.29
Internal doors	
Panel doors (chipboard)	-0.4
External doors	
PVC	0.6
Roof	
Timber rafters, rock wool insulation and Marley plain concrete (BRE element profile)	23.4
Total	128.3

Table 6. 4 storey block of flats – typical materials (Scotland)

Increased Timber content

Building material	Tonnes of CO ₂
Foundations	
Concrete	4.7
Flooring	
Hardcore, concrete slab, timber floor, EPS insulation	1.0
Ceilings	
Plasterboard	2.3
Joists	
Timber I joists	-3.17
External walls	
Timber frame, timber clad, panelvent board, cellulose insulation and plasterboard	-9
Internal walls	
Timber frame and plasterboard	8.7
Stairs	
Concrete	1.1
Windows	
Glass	0.3
Wooden frames	-0.18
Internal doors	
Panel doors (chipboard)	-0.4
External doors	
Timber	-0.4
Roof	
Timber rafters, rock wool insulation, felt, battens and clay tiles (BRE element profile)	17.3
Total	21.8

Table 7. 4 storey block of flats - increased timber content

For the purposes of comparison, examples of each house type using typical *English* building materials are shown in Appendix IV.

The savings that can be achieved by increasing the timber content in the 3 types of house are illustrated in Table 8 and Figure 3 below.

Type of building		Increased timber content footprint	Difference	Percentage saving (%)
2 bed semi-detached	12.2	3.1	9.2	75%
3 bed detached	16.8	2.4	14.4	86%
4 storey block of flats	128.3	21.8	106.5	83%
Average	-	•	-	81%

Table 8. Building materials carbon footprint comparison

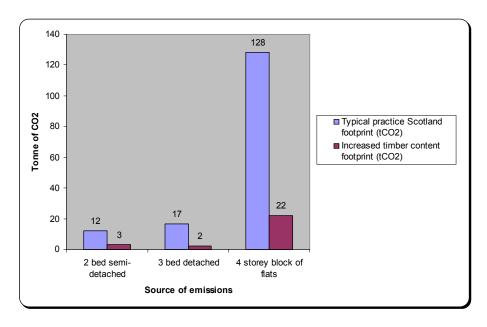


Figure 3. Building materials carbon footprint comparison

Timber transport

In order to quantify the contribution of transport to the GHG balance of timber, ECCM calculated the emissions that would be associated with UK, Swedish, Canadian and Latvian sawn timber supply chains. The GHG emissions arising from a variety of modes of transport were quantified. These include small and large boat, train and 44 tonne (28 tonne payload), and 60 tonne (40 tonne payload) lorries. The resulting matrix and all assumptions used are shown in Appendix III.

To illustrate the savings achieved by sourcing local sawn timber and using the most fuel efficient mode of transport, ECCM created four example routes by which timber is transported. These are presented in Tables 9-13.

		Total tCO ₂ per
		tonne
Example journey - Sweden to Scotland	Methods of transport	transported
Vaxjo - Gothenburg - Newcastle - Perth	60 tonne lorry, large ship, 44 tonne lorry.	0.038

Table 9. Timber transportation emissions - Sweden to Scotland

		Total tCO ₂ per
		tonne
Example journey - Latvia to Scotland	Methods of transport	transported
Gulbene - Riga - Newcastle - Perth	Train, small ship, 44 tonne lorry.	0.128

Table 10. Timber transportation emissions – Latvia to Scotland

		Total tCO ₂ per
		tonne
Example journey - Canada to Scotland	Methods of transport	transported
Shawinigan - Montreal - Liverpool - Perth	44 tonne lorry, Large ship, 44 tonne lorry	0.134

Table 11. Timber transportation emissions – Canada to Scotland

		Total tCO2 per
		tonne transported
		from origin to
Example journey - Scotland (locally sourced)	Methods of transport	Perth
Fort William - Perth	44 tonne lorry	0.007

Table 12. Timber transportation emissions – Scotland (locally sourced)

Of these routes, the least carbon intensive route for a company operating in the UK is from a UK supplier transporting by 44 tonne (28 tonne payload) lorry.

Transporting timber by train is not always an option. However, of all modes of transport assessed as part of this study, trains have the lowest associated GHG emissions. ECCM have compared the emissions associated with sawn timber transported from Crianlarich to Chirk by train and by 44 tonne (28 tonne payload) lorry to illustrate this, and the results are presented in Table 13 below.

Source of emissions	Emissions Metric kg CO ₂ /tonne.km	Tonnes of CO₂/tonne of
Crianlarich - Chirk		
Road freight (44 tonne articulated lorry)	0.04	0.021
Train freight	0.03	0.015

Table 13. Timber transportation emissions – Rail and 44 tonne lorry comparison

Timber milling efficiencies will vary from country to country and this will impact on the overall carbon footprint of sawn timber. This is however beyond the scope of this assessment.

5. Analysis of Results

For all building types that have been assessed as part of this study, GHG emissions associated with the embodied energy of construction materials are lower if the timber content is increased. This study has demonstrated that, indicatively, it is possible to achieve up to an 86% reduction in GHG emissions by increasing the amount of timber specified in buildings.

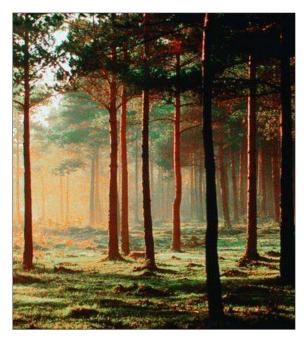


Figure 4. As trees grow, they sequester carbon from the atmosphere giving them a negative carbon intensity.

This study has shown that it is possible to reduce GHG emissions associated with construction materials by incorporating wood in to buildings wherever possible. To further reduce emissions, it should also be considered where the timber is sourced from. This study has shown that timber that is sourced locally has the lowest associated GHG emissions.

These emissions reductions are achieved as timber is used to replace building materials that have high carbon intensity such as concrete and steel. These materials have high GHG emissions associated with extraction, refining, processing and manufacture.

Wood has a negative carbon intensity because while a tree is growing, carbon is sequestered and stored, meaning that CO₂ is taken from the atmosphere, rather than being emitted into it during production of the material. It should be noted that emissions reductions resulting from the use of timber in construction will only be achieved if the timber is taken from a sustainably managed source.



Figure 5. Timber transported by lorry

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Appendix I

Glossary

Glossary

Carbon Dioxide Equivalent (CO_2e). The universal unit of measurement used to indicate the global warming potential (GWP) of each of the 6 Kyoto greenhouse gases. It is used to evaluate the impacts of releasing (or avoiding the release of) different greenhouse gases.

Climate change. A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability over comparable time periods (Source: United Nations Framework Convention on Climate Change).

Control. The ability of a company to direct the operating policies of a facility or organisation. Usually, if the company owns more than 50% of the voting interests, this implies control. The holder of the operating licence often exerts control, however, holding the operating licence is not a sufficient criteria for being able to direct the operating policies of a facility or organisation. In practice, the actual exercise of dominant influence itself is enough to satisfy the definition of control without requiring any formal power or ability through which it arises.

Direct emissions. Emissions that are produced by organisation-owned equipment or emissions from organisation-owned premises, such as carbon dioxide from electricity generators, gas boilers and vehicles, or methane from landfill sites.

Equity share. The percentage of economic interest in/benefit derived from an organisation.

Global warming The continuous gradual rise of the earth's surface temperature thought to be caused by the greenhouse effect and responsible for changes in global climate patterns (see also Climate Change).

Global Warming Potential (GWP) The GWP is an index that compares the relative potential (to CO_2) of the 6 greenhouse gases to contribute to global warming i.e. the additional heat/energy which is retained in the Earth's ecosystem through the release of this gas into the atmosphere. The additional heat/energy impact of all other greenhouse gases are compared with the impacts of carbon dioxide (CO_2) and referred to in terms of a CO_2 equivalent (CO_2 e) e.g. Carbon dioxide has been designated a GWP of 1, Methane has a GWP of 21.

Greenhouse gases. The current IPCC inventory includes six major greenhouse gases. These are Carbon dioxide (CO_2) , Methane (CH_4) , Nitrous oxide (N_2O) , Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur hexafluoride (SF₆).

IPCC. The Intergovernmental Panel on Climate Change. A special intergovernmental body established by the United Nations Environment Programme (UNEP) and the World Meteorological Organisation (WMO) to provide assessments of the results of climate change research to policy makers. The Greenhouse Gas Inventory Guidelines are being developed under the auspices of the IPCC and will be recommended for use by parties to the Framework Convention on Climate Change.

Indirect emissions. Emissions that are a consequence of the activities of the reporting company but occur from sources owned or controlled by another organisation or individual. They include all outsourced power generation (e.g. electricity, hot water), outsourced services (e.g. waste disposal, business travel, transport of company-owned goods) and outsourced manufacturing processes. Indirect emissions also cover the activities of franchised companies and the emissions associated with downstream and/or upstream manufacture, transport and disposal of products used by the organisation, referred to as product life-cycle emissions.

Kyoto Protocol. The Kyoto Protocol originated at the 3rd Conference of the Parties (COP) to the United Nations Convention on Climate Change held in Kyoto, Japan in December 1997. It specifies the level of emission reductions, deadlines and methodologies that signatory countries (i.e. countries who have signed the Kyoto Protocol) are to achieve.

Appendix II

Emissions Calculations and Assumptions – Building materials

MATERIALS LIFECYCLE EMISSIONS - 2 BED SEMI-DETACHED HOUSE

			Amount of each material	
			option that would be	Equivalent CO ₂
	Material options	Unit of measure	necessary per unit	emissions (tonnes)
Foundations				
	Concrete	m ³	2.1	0.9
			•	
Flooring				
Ground floor	Timber	tonnes	0.3	-0.4
	Chipboard	m ³	0.5	-0.4
	Concrete (150mm thick slab)	m ³	4.2	1.8
	EPS insulation	tonnes	0.04	0.0
	Extruded polystyrene insulation	tonnes	0.04	0.0
	Hardcore	tonnes	12.0	0.05
		m ³	2.1	0.03
0.4 //	Concrete screed on top of slab (75mm for ground floor)			-0.4
Other floors	Timber	tonnes m ³	0.3	
	Chipboard	m ⁻	0.5	-0.4
Ceilings		3		
	Plasterboard	m ³	0.7	0.2
Joists				
	Timber I joists	tonnes	0.1	-0.1
External walls				
Timber frame and timber clad	Timber cladding	tonnes	0.85	-1.02
	Panelvent board	m ³	0.87	-0.59
	Timber frame	m ²	14.55	-0.02
	Cellulose insulation	tonnes	0.58	-0.71
	Plasterboard	m ³	1.21	0.42
Timber frame with brick outer leaf	Brickwork	m ²	97.00	4.75
	Sheathing (plywood)	m ³	0.87	-0.59
	Timber frame	m ²	14.55	-0.02
	Glasswool insulation	tonnes	0.34	0.37
	Plasterboard	m ³	1.21	0.42
Brick outer leaf with block internal leaf	Brickwork	m ²	97.00	4.75
Brick outer lear war block internal lear	Glasswool insulation	tonnes	0.24	0.27
	Blockwork	tonnes	4.90	1.18
	Plasterboard	m ³	1.26	0.44
	Plasterboard		1.26	0.44
Internal walls				
internal walls	Blockwork	tonnes	1	0.3
	Timber frame	m ²	4	0.0
		m ³	· ·	
	Plasterboard	m:	0.35	0.12
Doors - internal		3		
	Chipboard panel door	m ³	0.110	-0.1
Doors - external	21/2			
	PVC	tonnes	0.1	0.1
	Wood	tonnes	0.1	-0.1
ue i				
Windows				
	Glass	tonnes	0.089	0.1
	Wood frame	tonnes	0.014	-0.02
	PVC frame	tonnes	0.023	0.0

Stairs				
	Timber	tonnes	0.056	-0.1
Roof				
	Timber rafters, rock wool insulation and Marley plain concrete	m ²	41.7	4.0
	Timber rafters, rock wool insulation, felt, battens and clay tiles	m ²	41.7	2.9

<u>Assumptions</u>			
Building dimensions			
		2	
Foundation volume:		2.1 m³ (working estimate)	
Floor area:		56 m² (working estimate)	
External wall area:		97 m² (working estimate)	
Internal partition wall area:		28 m² (working estimate)	
Dimensions of joists:	length:	61.541 metres (working estimate)	
	height:	0.10 metres (working estimate)	
	width:	0.04 metres (working estimate)	
Number of internal doors per unit:		8 (working estimate)	
Number of external doors per unit:		2 (working estimate)	
Area of each door:		2.152 m² (working estimate)	
Assumed thickness of door:		0.044 metres (Building Construction Handbook 1998)	
Height of staircase:		2.6 metres	
Assumed number of steps and risers in staircase:		22 (working estimate)	
Assumed dimensions of steps and risers:	length:	0.8 metres (working estimate)	
	thickness:	0.02 metres (working estimate)	
A	width:	0.2 metres (working estimate)	
Assumed dimensions of runners:	length:	2.2 metres (working estimate)	
	thickness:	0.04 metres (working estimate)	
	width:	0.4 metres (working estimate)	
Area of windows:		4.65 m² (working estimate)	
Assumed thickness of glass used:		0.004 metres (working estimate)	
Roof area:		41.7 m ² (working estimate)	
Timber frame with brick outer leaf			
Thickness of Brick:		102 mm	
Thickness of sheathing (plywood):		9 mm	
Emissions factors are not available for plywood so emissions are assumed to be equivalent to those a	ssociated with chipboard		
Thickness of glasswool insulation:		140 mm	
Thickness of plasterboard:		12.5 mm	
Cross section dimension of timber stud (regularised timber):		140 mm	
		44 mm	
Length of stud:		2.4 m	
Studs at centres of:		600 mm	
Assume that total area of stud equals 15% of the total wall area:		15% (TRADA technology 2001 timber frame construction)	
Brick outer leaf with block internal leaf			
Thickness of brick:		102 mm	
Thickness of glasswool insulation:		100 mm	
Thickness of aerated concrete block:		100 mm	
Thickness of plasterboard:		13 mm	
Timber frame with timber cladding			
Thickness of timber cladding:		22 mm	
Thickness of panelvent board:		9 mm	
Emissions factors are not available for panelvent so emissions are assumed to be equivalent to those	associated with chipboard		
Thickness of cellulose insulation:		140 mm	

This desired places became of places became of content and top glasted family: Legist of stabl. Legi		
Length of state: Length of st	Thickness of plasterboard:	12.5 mm
Length of stude 2.4 mm	Cross section dimension of timber stud (regularised timber):	140 mm
Stakes are control and of and equals 19% of the total wall areas: 15% (TRADA methnology 2001 imber frame construction) TAG Washington that total areas of and equals 19% of the total wall areas: 15% (TRADA methnology 2001 imber frame construction) TAG Washington Control TAG Washington Cont		44 mm
Name to late and stool areas of stool equals 15% of the Istal wall areas: Name of Information Frame construction) Name of Information Frame construction (Information Frame construction) Name of Information Frame (Information Frame Construction) Name of Information Praintenders (Information Framedors (Informati	Length of stud:	2.4 m
Material details TAG Weatherdecks Accumed indexes of the TSG weatherdeck filer: Accumed indexes of converse decided filer: Accumed filerial fi	Studs at centres of:	600 mm
Table Weatherdeck Assumed intrivine of the TSG weatherdeck floor: Assumed floring of affective used: Concrete Concrete Concrete Concrete State Concre	Assume that total area of stud equals 15% of the total wall area:	15% (TRADA technology 2001 timber frame construction)
Table Weatherdeck Assumed intrivine of the TSG weatherdeck floor: Assumed floring of affective used: Concrete Concrete Concrete Concrete State Concre		
Assumed entropy for the T&O washerdors (floor Assumed entropy of their used: 400 laym* (RRE 1970b) Concrete Equivalent COpy of missions for pouring concrete Assumed finithers of concrete sizes. 4.015 missions for graining concrete Assumed finithers of concrete sizes. 4.015 missions for graining sufficients Assumed finithers of concrete sizes. 4.015 missions for graining sufficients Assumed finithers of concrete sizes. 4.015 missions for graining sufficients Assumed finithers of concrete sizes. 4.025 laym* (Finish Building Information Foundation 2004) 4.025 laym* (Finish Building Informat	Material details	
Assumed defanely of interior used: Concrete Figuration CO_consistant for pour procental: (A158 CO_CO_primal procental Firmin Building Information Foundation 2004) Figuration CO_consistant for provide streams of concrete screens. (A158 CO_CO_Primal procental for provide streams) Assumed Historiess of concrete screens. (A158 CO_CO_Primal procental for provide screens. (A158 CO_CO_Primal procental for provide screens. (A158 CO_CO_Primal procental for provide screens. (A158 CO_CO_Primal provide provide provide provide provide screens. (A158 CO_CO_Primal provide	T&G Weatherdeck	
Concrete Equivalent CO, emissions for pouring concretes: Equivalent CO, emissions for pouring concretes: Assumed shickness of concrete state. Assumed shickness of gravel: Equivalent CO, emissions for gravel: Description of production of production of gravel: Description of graveling of g	Assumed thickness of the T&G weatherdeck floor:	0.03 metres (working estimate)
Equivalent CQ, emissions for projung concreise Assumed fishcrease of concreise statis Assumed richerse of presentation of concreise of concreise statis Assumed richerse of presentation of the concreise of concreise blocks Biochacore	Assumed density of timber used:	400 kg/m³ (BRE 1999e)
Equivalent CQ, emissions for projung concreise Assumed fishcrease of concreise statis Assumed richerse of presentation of concreise of concreise statis Assumed richerse of presentation of the concreise of concreise blocks Biochacore	Concrete	
Assumed thickness of concrete salach Assumed thickness of pasked granular sub-base: Blockwork		0.425 tCΩ ₂ /m ³ concrete (Finnish Building Information Foundation 2004)
Assumed directly of brained used: Hardcore Figurieller (CO, emissions for gravel: Density of packed gravulus sub-base: Density of blockwork:		
Hardcore Equivalent CQ, emissions for gravet: Density of profiles granular sub-base: 10 0.0038 kgCQ_/kg (Finnish Building Information Foundation 2004) 100 mm Finnish Building Information Foundation Foundation 2004) 100 mm Finnish Building Information Foundation Foundation 2004) 100 mm Finnish Bui		
Equivalent CO ₂ emissions for graves: 0,0038 kg/CO ₂ /kg (Finish Building Information Foundation 2004) Decivity of packed granular sub-base: 1,50 mm Thickness of hardcore: 150 mm Blockwork 505 kg/m² (BRE 1999c) Elimented with of avairated concrete blocks: 0,14 metres Elimented with of avairated concrete blocks: 0,14 metres Elimente CO ₂ emissions for blockwork: 0,24 LO ₂ M avairated blockwork used (BRE 1999c) Brickwork 2,200 kg/m² (BRE 1999c) Brickwork 0,44 motors Equivalent CO ₂ emissions for blockwork: 0,49 LO ₂ M² brick used (BRE 1999b) Timber 400 kg/m² (BRE 1999c) Assumed density of limber used: 400 kg/m² (BRE 1999c) Equivalent CO ₂ emissions for brickwork: 1,2 LO ₂ M² brick used (BRE 1999c) Equivalent CO ₂ emissions for trained intheir frames: -1,2 LO ₂ M² brick used (BRE 1999c) Equivalent CO ₂ emissions for trained intheir frames: -1,2 LO ₂ M² brick used (BRE 1999c) Equivalent CO ₂ emissions for trained intheir frames: -1,2 LO ₂ M² brick used (BRE 1999c) Pactive Color (C) emissions for trained intheir frames: -1,2 LO ₂ M² brick used (BRE 1999c) Sequivalent CO ₂ emissions for trail with color	Assumed unioniess of concrete screed.	0.073 There's (working estimate)
Density of packed granular sub-base: Thickness of harbardore: 150 mm Blockwork Blockwork Blockwork Estimated with of a seasted concrete blocks Estimated with of a serial extensions for brickwork: Estimated don't extensions for brickwork: Estimated don't extensions for brickwork: 1049 (CO ₂ /m² brick used (BRE 1999c) Timber Assumed don't extensions for internal timber frames: 11 kgCO ₂ /m² (BRE 1999c) 12 kgCO ₂ /m² (BRE 1999c) 13 kgCo ₂ /m² (BRE 1999c) 14 kgCO ₂ /m² (BRE 1999c) 15 kgCo ₂ /m² (BRE 1999c) 15 kgCo ₂ /m² (BRE 1999c) 16 kgCo ₂ /m² (BRE 1999c) 17 kgCO ₂ /m² (BRE 1999c) 18 kgCo ₂ /m² (BRE 1999c) 18 kgCo ₂ /m² (BRE 1999c) 19 kgCo ₂ /m² (BRE 1999c) 19 kgCo ₂ /m² (BRE 1999c) 10 kgCo ₂ /m² (BRE 1999c) 11 kgCo ₂ /m² (BRE 1999c) 12 kgCo ₂ /m² (BRE 1999c) 12 kgCo ₂ /m² (BRE 1999c) 13 kgCo ₂ /m² (BRE 1999c) 14 kgCo ₂ /m² (BRE 1999c) 15 kgCo ₂ /m² (BRE 1999c) 15 kgCo ₂ /m² (BRE 1999c) 16 kgCo ₂ /m² (BRE 1999c) 17 kgCO ₂ /m² (BRE 1999c) 18 kgCo ₂ /m² (BRE 1999c) 18 kgCo ₂ /m² (BRE 1999c) 19 kgCo ₂ /m² (BRE 1999c) 10 kgCo ₂		
Thickness of hardcore: Blockwork is assumed to be aerated concrete blocks: Solid kylm* [BRE 1990c.] Seminated with of aerated concrete blocks: Club meters Club m		
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Blockwork is assumed to be aerated concrete blocks Estimated with of aerated concrete blocks: Estimated With of aerated concrete blocks: Equivalent CQ, emissions for brickwork: Brickwork Brickw	Blockwork	
Density of blockwork: Equivalent CO2 emissions for blockwork: Equivalent CO2 emissions for blockwork: Equivalent CO2 emissions for blockwork: Equivalent CO2 emissions for brickwork: Equivalent CO2 emissions for brickwork: Equivalent CO2 emissions for kind definitive used: Equivalent CO3 emissions for steel work: Equivalent CO3 emissions for chipboard: Assumed discloses of chipboard: Assumed discloses of chipboard: Equivalent CO3 emissions for platerboard: Equivalent CO4 emissions for platerboard: Equivalent CO5 emissions for platerboard		
Eliminated width of aerated concrete blocks: Equivalent CO ₂ emissions for blockwork: Brickwork Equivalent CO ₂ emissions for blockwork: Brickwork Equivalent CO ₂ emissions for brickwork: Brickwork Equivalent CO ₂ emissions for brickwork: Claysian CO ₂ emissions for brickwork: Claysian CO ₂ emissions for brickwork: Claysian CO ₂ emissions for kink died ulmber: Equivalent CO ₃ emissions for steel work: Claysian CO ₄ emissions for steel work: Equivalent CO ₂ emissions for steel work: Equivalent CO ₃ emissions for steel work: Equivalent CO ₃ emissions for dipboard: Assumed thickness of chipboard: Equivalent CO ₃ emissions for dipboard: Assumed thickness of chipboard: Equivalent CO ₂ emissions for platerboard: Equivalent CO ₃ emissions for PVC: Assumed thickness of platerboard: Equivalent CO ₃ emissions for PVC: Assumed thickness of PVC: Equivalent CO ₃ emissions for PVC: Equivalent CO ₄ emissions for PVC:		505 kg/m ³ /RRF 1999c)
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Width of sides and base: Height of door: 0.914 m (working estimate) Width of door: 0.914 m (working estimate) 0.914 m (working estimate) Steel Equivalent CO ₂ emissions for steel work: 0.66 tCO _{2x} /tonne steel used (RTS 1999a) Equivalent CO ₂ emissions for steel work: 5.16 tCO _{2x} /m³ steel used (Finnish Building Information Foundation 2004) Chipboard Equivalent CO ₂ emissions for chipboard: -0.673 tCO _{2x} /m³ chipboard used (Finnish Building Information Foundation 2004) Assumed thickness of chipboard floor: 0.019 m (CIBSE Guide A 2006) Plasterboard Assumed thickness of plasterboard: 0.0125 m (working estimate) 0.346 tCO _{2x} /m³ plasterboard used (Finnish Building Information Foundation 2004) PVC Equivalent CO ₂ emissions for PVC: 4.2 tCO _{2x} /m² pVC used (Plastic Europe) 650 kg/m² (working estimate)		
Height of door: Width of door: 2.04 m (working estimate) 0.914 m (working estimate) Steel Equivalent CO ₂ emissions for steel work: Equivalent CO ₂ emissions for steel work: Chipboard Equivalent CO ₂ emissions for chipboard: Assumed thickness of chipboard floor: Plasterboard Assumed thickness of plasterboard: Equivalent CO ₂ emissions for PVC: Equivalent CO ₂ emissions for PVC: 1.2 tCO ₂ e/t PVC used (Plastic Europe) 650 kg/m³ (working estimate)	Thickness of chipboard:	0.003 m (working estimate)
Width of door: Steel Equivalent CO ₂ emissions for steel work: Equivalent CO ₂ emissions for steel work: Chipboard Equivalent CO ₂ emissions for chipboard: Equivalent CO ₂ emissions for chipboard: Equivalent CO ₂ emissions for chipboard floor: Plasterboard Assumed thickness of plasterboard: Equivalent CO ₂ emissions for PVC: Assumed density of PVC: 1.2 tCO ₂ et/t PVC used (Plastic Europe) 650 kg/m³ (working estimate)	Width of sides and base:	0.045 m (working estimate)
Steel Equivalent CO ₂ emissions for steel work: Chipboard Equivalent CO ₂ emissions for chipboard: Equivalent CO ₂ emissions for chipboard: Equivalent CO ₂ emissions for chipboard: Assumed thickness of chipboard: Assumed thickness of plasterboard: Equivalent CO ₂ emissions for PVC: Equivalent CO ₂ emissions for PVC: 650 kg/m³ (working estimate)	Height of door:	2.04 m (working estimate)
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Chipboard Equivalent CO ₂ emissions for chipboard: Assumed thickness of chipboard floor: Plasterboard Assumed thickness of plasterboard: Assumed thickness of plasterboard: Civil plasterboard Assumed thickness of plasterboard: Civil plasterboard: Assumed thickness of plasterboard: Civil plasterboard: Civil plasterboard: Civil plasterboard working estimate) Civil plasterboard used (Finnish Building Information Foundation 2004) PVC Equivalent CO ₂ emissions for PVC: Civil plasterboard used (Finnish Building Information Foundation 2004) 1.2 tCO ₂ et/n PVC used (Plastic Europe) 650 kg/m³ (working estimate)		
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Equivalent CO ₂ emissions for plasterboard: PVC Equivalent CO ₂ emissions for PVC: 4.2 tCO ₂ el/t PVC used (Plastic Europe) 650 kg/m³ (working estimate)	Assumed thickness of plasterboard:	0.0125 m (working estimate)
Equivalent CO ₂ emissions for PVC: Assumed density of PVC: 1.2 tCO ₂ e/t PVC used (Plastic Europe) 650 kg/m³ (working estimate)		
Equivalent CO ₂ emissions for PVC: Assumed density of PVC: 650 kg/m³ (working estimate)	DIA	
Assumed density of PVC: 650 kg/m³ (working estimate)		4.0 MO of FIVO word (Plantin Funcar)
Windows	Assumed density of PVC:	650 kg/m² (working estimate)
	Windows	

Density of glass: CO ₂ emissions for glass: Assumed thickness of glass doors: Assumed percentage of opening area to be frame: Assumed percentage of opening area to be glass: Assumed thickness of window frame:	2,800 kg/m³ (www.allmeasures.com) 600 kgCO₂/tonne glass 0.01 m (working estimate) 15% (working estimate) 85% (working estimate) 0.050 m (working estimate)
Insulation	
Thickness of polystyrene insulation:	100 mm
Glasswool:	1,100 kgCO₂/tonne (BRE 1999)
Cellulose:	-1.22 tCO ₂ /tonne (Finnish Building Information Foundation 2004)
EPS:	2.60 gCO ₂ /kg (Plastics Europe 2006)
Extruded polystyrene - factors are not available so they assumed to be equivalent to EPS:	2.60 gCO ₂ /kg (Plastics Europe 2006)
Density of glasswool insulation:	25 kg/m³ (CIBSE Guide A 2006)
Density of cellulose insulation:	43 kg/m³ (CIBSE Guide A 2006)
Density of EPS insulation:	15 kg/m³ (CIBSE Guide A 2006)
Density of extruded polystyrene insulation:	40 kg/m³ (CIBSE Guide A 2006)
Roof	
CO ₂ emissions for timber rafters, rock wool insulation and Marley plain concrete roof:	95 kgCO ₂ e/m² (BRE 1999)
CO ₂ emissions for timber rafters, rock wool insulation, felt, battens and clay tiles roof:	70 kgCO ₂ e/m² (BRE 1999)

Doors - internal

Doors - external

Windows

Stairs

MATERIALS LIFECYCLE EMISSIONS - 3 BED DETACHED HOUSE

	Makadal dakad	11-3-4-4	A	Equivalent C
Foundations	Material detail	Unit of measure	Amount used per unit	emissions (tonn
oundations	Concrete	m ³	4	
	Concrete	·	4]	
Flooring				
Ground floor	Timber	tonnes	0.4	
	Chipboard	m ³	0.6	
	Concrete (150mm thick slab)	m ³	4.9	
	EPS insulation	tonnes	0.05	
	Extruded polystyrene insulation	tonnes	0.1	
	Hardcore	tonnes	14.0	
	Concrete screed on top of slab (75mm for ground floor)	m ³	2.5	
Other floors	Timber	tonnes	0.8	
	Chipboard	m ³	1.2	
			-	
Ceilings		m ³		
	Plasterboard	m ⁻	1.2	
Joists				
JUISIS	Timber I joists	tonnes	0.5	
	Timber Helde	torinoo	0.0	
External walls				
Timber frame and timber clad	Timber cladding	tonnes	1.45	
	Panelvent board	m ³	1.49	
	Timber frame	m ²	24.75	
	Cellulose insulation	tonnes	0.99	
	Plasterboard	m ³	2.06	
Timber frame with brick outer leaf	Brickwork	m ²	165	
	Sheathing (plywood)	m ³	1.49	
	Timber frame	m ²	24.75	
	Glasswool insulation	tonnes	0.58	
	Plasterboard	m ³	2.06	
Brick outer leaf with block internal leaf	Brickwork	m ²	165	
	Glasswool insulation	tonnes	0.41	
	Blockwork	tonnes	8.33	
	Plasterboard	m ³	2.15	
nternal walls				
	Blockwork	tonnes	2	

Timber frame

PVC Wood

Glass Wood frame PVC frame

Plasterboard (12.5 mm thick)

Chipboard panel door

m ³	0.03	-0.02
tonnes	0.1	0.1
tonnes	0.08	-0.1
tonnes	0.1	0.1
tonnes	0.03	0.0
tonnes	0.1	0.1

-0.01

0.14

	Timber	tonnes	0.068	-0.1
Roof				
	Timber rafters, rock wool insulation and Marley plain concrete	m²	47.3	4.5
	Timber rafters, rock wool insulation, felt, battens and clay tiles	m ²	47.3	3.3

Assumptions		
Building dimensions		
Building dimensions		
Floor area per unit:		98 m² (working estimate)
Area of internal partition walls per unit:		32 m² (working estimate)
Area of external walls per unit:		165 m² (Working estimate)
Assumed dimensions of the timber joists:	length:	305.511 metres (working estimate)
· · · · · · · · · · · · · · · · · · ·	height:	0.10 metres (working estimate)
	width:	0.04 metres (working estimate)
Number of internal doors per unit:		16 (working estimate)
Number of external doors per unit:		2 (working estimate)
Area of each door:		2.152 m² (working estimate)
Assumed thickness of door:		0.044 metres (Building Construction Handbook 1998)
Number of staircase stories:		2 (working estimate)
Height of one staircase:		2.6 metres
Assumed number of steps and risers in one staircase:		14
Assumed number of kites in one staircase:		1 (working estimate)
Assumed dimensions of steps and risers:	length:	0.8 metres (working estimate)
	thickness:	0.02 metres (working estimate)
A 12 1 114	width:	0.2 metres (working estimate)
Assumed dimension of kite:	diagonal one: thickness:	0.82 metres (working estimate)
	diagonal two:	0.02 metres (working estimate) 0.28 metres (working estimate)
Assumed dimensions of runners:	length:	2.2 metres (working estimate)
Assumed dimensions of runners.	thickness:	0.04 metres (working estimate)
	width:	0.4 metres (working estimate)
Area of windows:	widu.	10.4 m ² (working estimate)
Assumed thickness of glass used:		0.004 metres (working estimate)
Area of roof:		47.3 m² (working estimate)
		,
Timber frame with brick outer leaf		
Thickness of Brick:		102 mm
Thickness of sheathing (plywood):		9 mm
Emissions factors are not available for plywood so emissions are assumed to be equivalent to those ass	ociated with chipboard	
Thickness of glasswool insulation:		140 mm
Thickness of plasterboard:		12.5 mm
Cross section dimension of timber stud (regularised timber):		140 mm
I amount of stands		44 mm
Length of stud: Studs at centres of:		2.4 m 600 mm
Assume that total area of stud equals 15% of the total wall area (timber frame construction)		15% (TRADA technology 2001 timber frame construction)
Assume that total area of stud equals 10% of the total wall area (ulfiber frame constitution)		(TOTAL CUITOGY 2001 under name constitution)
Brick outer leaf with block internal leaf		
Thickness of Brick:		102 mm
Thickness of glasswool insulation:		102 mm
Thickness of glasswood insulation. Thickness of aerated concrete block:		100 mm
Thickness of plasterboard:		13 mm
Timber frame with timber cladding		
Thickness of timber cladding:		22 mm
Thiodicas of amort deducing.		£ 11011

Envisers for this includior: Thisters of place includior: Thisters of collection of trans wild (regularised finither): Largeth of stude. Largeth of stude of stude (apail 19% of the total well area. Largeth of stude. Largeth		
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Thickness of planetrocard: 100 mm 10	Emissions factors are not available for panelvent so emissions are assumed to be equivalent to those associated with chipboard	
Cross section dimension of timber shad (regularised timber) 44 mm 144 mm	Thickness of cellulose insulation:	140 mm
Lergin of stud: Study at currens of Study at current of Study at c	Thickness of plasterboard:	12.5 mm
Langth of status Assurant bit total area of stut deguals 15% of the total wall area: ***Assurant destroys are total area of stut deguals 15% of the total wall area: ***Assurant destroys are thinkness of the TAG weatherdock floor: ***Assurant distroys of concrete: ***Capitalent CQ, emissions for concrete: ***Assurant distriptions of concrete slabt: ***Assurant distriptions of ristriptions of concrete slabt: ***Assurant distriptions of ristriptions of risk distriptions of risk distr	Cross section dimension of timber stud (regularised timber):	140 mm
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Assumed thickness of concrete screed: ##################################		
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Assume thickness of external timber: Chipboard Equivalent CO ₂ emissions for chipboard: Assumed thickness of chipboard floor: Panel door Thickness of chipboard: Width of sides and base: Height of door: Width of sides and base: Height of door: Width of sides and base: Height of door: Plasterboard Assumed thickness of plasterboard: O.0125 m (working estimate) O.022 m (working estimate) O.027 m (vorking estimate) O.028 m (working estimate) O.029 m (clBSE Guide A 2006) O.030 m (working estimate) O.045 m (working estimate) O.045 m (working estimate) O.046 m (working estimate) O.047 m (working estimate) O.048 m (working estimate) O.049 m (working estimate) O.049 m (working estimate) O.040 m (working estimate)		
Chipboard Equivalent CO ₂ emissions for chipboard: Assumed thickness of chipboard floor: Panel door Thickness of chipboard: Width of sides and base: Height of door: Width of door: Plasterboard Assumed thickness of plasterboard: O.003 m (working estimate) O.045 m (working estimate) O.091 m (working estimate) O.045 m (working estimate) O.091 m (working estimate)		
Equivalent CO ₂ emissions for chipboard: Assumed thickness of chipboard floor: Panel door Thickness of chipboard: Width of sides and base: Height of door: Width of sides and base: Width of sides and base: Height of door: Width of sides and base: Height of door: Width of sides and base: Under thickness of chipboard: Width of sides and base: Height of door: Width of sides and base: Under thickness of lasterboard: Width of sides and base: Under thickness of lasterboard: Under thickness of plasterboard: Under thickness of plasterboard used (Finnish Building Information Foundation 2004)	Assume thickness of external timber:	0.022 m (working estimate)
Equivalent CO2 emissions for chipboard: Assumed thickness of chipboard (Finnish Building Information Foundation 2004) Assumed thickness of chipboard (Finnish Building Information Foundation 2004) Panel door Thickness of chipboard: Width of sides and base: Height of door: Width of sides and base: Height of door: Width of sides and base: Height of door: Width of door: Width of sides and base: Under (Width) Description:		
Assumed thickness of chipboard floor: Panel door Thickness of chipboard: Width of sides and base: Height of door: Width of door: Width of door: Plasterboard Assumed thickness of plasterboard: Assumed thickness of plasterboard: Equivalent CO ₂ emissions for plasterboard: 0.019 m (CIBSE Guide A 2006) 0.003 m (working estimate) 0.004 m (working estimate) 0.014 m (working estimate) 0.0125 m (working estimate) 0.0126 m (working estimate) 0.0126 m (working estimate)		3
Panel door Thickness of chipboard: Width of sides and base: Height of door: Understand the control of the contr		
Thickness of chipboard: Width of sides and base: Width of door: Under the control of sides and base: O.045 m (working estimate) Legistro door: Under the control of working estimate) Under the control of working estimate) Plasterboard Assumed thickness of plasterboard: Under the control of working estimate) O.0125 m (working estimate) O.0125 m (working estimate) O.0125 m (working estimate) O.0126 m (working estimate)	Assumed thickness of chipboard floor:	0.019 m (CIBSE Guide A 2006)
Thickness of chipboard: Width of sides and base: Width of door: Under the control of sides and base: O.045 m (working estimate) Legistro door: Under the control of working estimate) Under the control of working estimate) Plasterboard Assumed thickness of plasterboard: Under the control of working estimate) O.0125 m (working estimate) O.0125 m (working estimate) O.0125 m (working estimate) O.0126 m (working estimate)		
Width of sides and base: Height of door: Width of door: Plasterboard Assumed thickness of plasterboard: Equivalent CO ₂ emissions for plasterboard: 0.045 m (working estimate) 0.914 m (working estimate) 0.0125 m (working estimate) 0.0125 m (working estimate) 0.0126 m (working estimate)	Panel door	
Width of sides and base: Height of door: Width of oor: 2.04 m (working estimate) 9.914 m (working estimate) 9.914 m (working estimate) Plasterboard Assumed thickness of plasterboard: Equivalent CO ₂ emissions for plasterboard: 0.0125 m (working estimate) 0.0126 m (working estimate) 0.0126 m (working estimate) 0.0127 m (working estimate)	Thickness of chipboard:	0.003 m (working estimate)
Height of door: Width of door: Plasterboard Assumed thickness of plasterboard: Equivalent CO ₂ emissions for plasterboard: 0.0125 m (working estimate) 0.0125 m (working estimate) 0.0126 m (working estimate) 0.0126 m (working estimate) 0.0127 m (working estimate) 0.0128 m (working estimate)	Width of sides and base:	
Width of door: Plasterboard Assumed thickness of plasterboard: Equivalent CO ₂ emissions for plasterboard: 0.0125 m (working estimate) 0.346 tCO ₂ e/m³ plasterboard used (Finnish Building Information Foundation 2004)		
Plasterboard Assumed thickness of plasterboard: Equivalent CO ₂ emissions for plasterboard: 0.0125 m (working estimate) 0.346 tCO ₂ e/m³ plasterboard used (Finnish Building Information Foundation 2004)		
Assumed thickness of plasterboard: Equivalent CO ₂ emissions for plasterboard: 0.0125 m (working estimate) 0.346 tCO ₂ e/m³ plasterboard used (Finnish Building Information Foundation 2004)		
Assumed thickness of plasterboard: Equivalent CO ₂ emissions for plasterboard: 0.0125 m (working estimate) 0.346 tCO ₂ e/m³ plasterboard used (Finnish Building Information Foundation 2004)	Plasterboard	
Equivalent CO ₂ emissions for plasterboard: 0.346 tCO ₂ e/m³ plasterboard used (Finnish Building Information Foundation 2004)		0.0125 m (working estimate)
nue.	Equivalent 602 ennissions for plasterbodiu.	0.040 (CO26/III plasterboard used (Fiffilish Duliding Information Foundation 2004)
	DI/C	
PVC This later CO professions for DVC		4.0 400 at 10 10 and (District Funds)
Equivalent CO ₂ emissions for PVC: 1.2 tCO ₂ e/t PVC used (Plastic Europe)		
Assumed density of PVC: 650 kg/m³ (working estimate)	Assumed density of PVC:	650 kg/m² (working estimate)
Windows		
Density of glass: 2800 kg/m³ (www.allmeasures.com)	Density of glass:	2800 kg/m³ (www.allmeasures.com)

CO ₂ emissions for glass:	600 kgCO ₂ /tonne glass
Assumed percentage of opening area to be frame:	15% (working estimate)
Assumed percentage of opening area to be glass:	85% (working estimate)
Assumed thickness of window frame:	0.050 m (working estimate)
Steel	
Equivalent CO ₂ emissions for steel work:	0.66 tCO _{2e} /tonne steel used (RTS 1999a)
Equivalent CO ₂ emissions for steel work:	5.16 tCO _{2e} /m3 steel used (Finnish Building Information Foundation 2004)
Glass	2800 kg/m³ (www.allmeasures.com)
Density of glass:	
CO ₂ emissions for glass:	600 kgCO _z /tonne glass
Assumed thickness of glass doors:	0.01 m (working estimate)
Insulation	
Thickness of polystyrene insulation:	100 mm
Glass wool:	1,100 kgCO ₂ /tonne (BRE 1999)
Cellulose:	-1.22 tCO ₂ /tonne (Finnish Building Information Foundation 2004)
EPS:	2.60 qCO ₂ /kg (Plastics Europe 2006)
Extruded polystyrene - factors are not available so they assumed to be equivalent to EPS:	2.60 gCO ₂ /kg (Plastics Europe 2006)
Assumed thickness of insulation:	0.05 m (working estimate)
	25 kg/m ³ (CIBSE Guide A 2006)
Density of glass wool insulation:	
Density of cellulose insulation:	43 kg/m³ (CIBSE Guide A 2006)
Density of EPS insulation:	15 kg/m³ (CIBSE Guide A 2006)
Density of extruded polystyrene insulation:	40 kg/m³ (CIBSE Guide A 2006)
Roof	
CO ₂ emissions for timber rafters, rock wool insulation and Marley plain concrete roof:	95 kgCO ₂ e/m ² (BRE 1999)
CO ₂ emissions for timber rafters, rock wool insulation, felt, battens and clay tiles roof:	70 kqCO ₂ e/m² (BRE 1999)
CO ₂ emissions for timber ratters, rock woor insulation, reit, batters and day tiles root:	10 kgCO₂e/III (DKC 1999)

Material Material detail Unit of measure	MATERIALS LIFECYCLE EMISSIONS -	4 STOREY FLAT			
Foundations					Equivalent CO
Concrete m² 11,02 4.7	Material	Material detail	Unit of measure	Amount used per unit	emissions (tonnes
Flooring	Foundations				
Timber T		Concrete	m ³	11.02	4.7
Timber T	Flooring				
Concrete (15mm thick slab) m³ 19.5 8.	Ground floor	Timber	tonnes	1.6	-1.9
EPS instalation		Chipboard		2.5	-1.5
Extruded polysprene insulation tonnes 0.5 0.0 Anaboxe tonnes 56.6 0.2 Concrete screed on top of slab (Firm for ground filcor) m³ 9.9 4.1 Timber tonnes 4.8 5.5 Concrete m³ 7.6 5.5 Concrete m³ 7.5 5.5 Concrete m³					8.4
Hardcore See					
Concrete screed on top of slab (75mm for ground floor) m³ 9.9 4.8 5.5 Concrete m³ 7.6 5.5 Concrete m³ 6.6 2.2 Joists					
Timber T					
Ceitings	Other floors				-5.7
Plasterboard m³ 6.6 2.2					-5.1
Plasterboard m³ 6.6 2.		Concrete	m ³	79.5	33.8
Plasterboard m³ 6.6 2.	Callings				
Structural steel Steel Ionnes 2.64 -3.	cenngs	Plasterhoard	m ³	66	23
Structural steel Steel tonnes 2.64 3.3		Flasterboard		0.0	2.0
Structural steel Steel tonnes 23.50 15.	Joists				
Steel tonnes 23.50 15.		Timber I joists	tonnes	2.64	-3.2
Steel tonnes 23.50 15.					
External walls Timber frame and timber clad Timber cladding tonnes 4.13 4.49 Panelvent board m³ 4.22 2.8 Timber frame m² 70.39 -0.1 Cellulose insulation tonnes 2.82 -3.4 Plasterboard m³ 5.87 2.0 Plasterboard m³ 5.87 2.0 Timber frame with brick outer leaf Sheakhor m³ 4.22 2.8 Timber frame m² 70.39 -0.1 Timber frame m³ 5.87 2.0 Timber frame Timber fram	Structural steel	Cloal	tonnon	22.50	45 /
Timber frame and timber clad Timber cladding tonnes 4.13 4.9 Panelvent board m³ 4.22 2.2 2.2 Timber frame m² 70.39 -0.1 Cellulose insulation tonnes 2.82 3.3 4.2 2.8 3.4 Plasterboard m³ 5.87 2.0 Plasterboard m³ 5.87 2.0 Plasterboard m³ 4.22 2.2 2.8 Plasterboard m³ 4.22 2.2 2.8 Plasterboard m³ 4.22 2.2 Plasterboard m³ 4.22 2.2 Plasterboard m³ 4.22 2.2 Plasterboard m³ 4.22 2.3 Plasterboard m³ 4.22 2.3 Plasterboard m³ 4.22 2.3 Plasterboard m³ 5.87 2.0 Plasterboard m³ 5.87 2.0 Plasterboard m³ 5.87 2.0 Plasterboard m³ 5.87 2.0 Plasterboard m³ 6.10 2.1 Plasterboard 2.5 Plasterboard m³ 6.10 2.1 Plasterboard 2.5 Plasterboard		Steer	torines	23.30	15.4
Panelvent board m³ 4.22 2.8 Timber frame m² 70.39 0.1 Cellubose insulation tonnes 2.82 3.4 Plasterboard m³ 5.87 2.0 Plasterboard m³ 5.87 2.0 Plasterboard m³ 4.22 2.8 Sheathing (plywood) m³ 4.22 2.8 Timber frame m² 70.39 0.1 Glasswool insulation tonnes 1.64 1.8 Plasterboard m³ 5.87 2.0 Glasswool insulation tonnes 1.64 1.8 Plasterboard m³ 5.87 2.0 Glasswool insulation tonnes 1.17 1.2 Blockwork tonnes 23.70 5.6 Plasterboard m³ 6.10 2.1 Internal walls Timber frame m² 155 -0.0 Blockwork tonnes 5.2 1.2 Plasterboard (12.5 mm thick) m³ 12.95 4.4 Doors - external PVC tonnes 0.5 0.0 Wood tonnes 0.3 -0.0 Windows Glass tonnes 0.5 0.0 Wood tonnes 0.5 0.0	External walls				
Timber frame m² 70,39 -0.1	Timber frame and timber clad				-4.96
Cellulose insulation tonnes 2.82 -3.4 Plasterboard m³ 5.87 2.0 Timber frame with brick outer leaf Brickwork m² 469 22.9 Sheathing (plywood) m³ 4.22 -2.8 Timber frame m² 70.39 -0.1 Glasswool insulation tonnes 1.64 1.8 Plasterboard m³ 5.87 2.0 Brick outer leaf with block internal leaf Brickwork m² 469 22.9 Glasswool insulation tonnes 1.17 1.2 Blockwork tonnes 23.70 5.6 Plasterboard m³ 6.10 2.1 Internal walls Timber frame m² 155 -0.0 Blockwork tonnes 52 12 Plasterboard (12.5 mm thick) m³ 12.95 4.4 Doors - internal PVC tonnes 0.5 0.0 Wood tonnes 0.3 -0.0 Windows Glass tonnes 0.5 0.0 Wood frame tonnes 0.5 0.0 Wood frame tonnes 0.5 0.0 Uniformal Tonnes 0.5 0.0 Wood frame tonnes 0.5 0.0 Uniformal Tonnes 0.5 0.0 Uniformal Tonnes 0.5 0.0 Wood frame Tonnes 0.5 0.0 Uniformal Tonnes 0.5 0.0 Wood frame Tonnes 0.5 0.0 Uniformal T					-2.84
Plasterboard m³ 5.87 2.0					
Timber frame with brick outer leaf Brickwork m² 469 22.9					
Sheathing (plywood) m³ 4.22 2.8 Timber frame m² 70.39 -0.1 Glasswool insulation tonnes 1.64 1.8 Plasterboard m³ 5.67 2.0 Brick outer leaf with block internal leaf Brickwork m² 469 22.9 Glasswool insulation tonnes 1.17 1.2 Blockwork tonnes 23.70 5.6 Plasterboard m³ 6.10 2.1 Internal walls Timber frame m² 155 -0.0 Plasterboard (12.5 mm thick) m³ 12.95 4.4 Doors - internal	Timber frame with brick outer leaf				
Timber frame m² 70.39					-2.84
Plasterboard m³ 5.87 2.0			m ²	70.39	-0.12
Brick outer leaf with block internal leaf Brickwork m² 469 22.9 Glasswool insulation tonnes 1.17 1.2 Blockwork tonnes 23.70 5.6 Plasterboard m³ 6.10 2.1 Internal walls					1.81
Glasswool insulation tonnes 1.17 1.2 Blockwork tonnes 23.70 5.6 Plasterboard m³ 6.10 2.1 Internal walls	<u> </u>				2.03
Blockwork tonnes 23.70 5.6 Plasterboard m³ 6.10 2.1 Internal walls	Brick outer leaf with block internal leaf				
Plasterboard m³ 6.10 2.1					
Timber frame m² 155 -0. Blockwork tonnes 52 12. Plasterboard (12.5 mm thick) m³ 12.95 4.4					
Timber frame m² 155 -0. Blockwork tonnes 52 12. Plasterboard (12.5 mm thick) m³ 12.95 4.4 Doors - Internal				•	
Blockwork tonnes 52 12.	Internal walls				
Plasterboard (12.5 mm thick) m³ 12.95 4.4					
Chipboard panel door m³ 0.7 -0. Doors - external					
Chipboard panel door m³ 0.7 -0. Doors - external		riasterboard (12.0 min anox)		12.50	7.70
PVC tonnes 0.5 0	Doors - internal				
PVC tonnes 0.5 0		Chipboard panel door	m ³	0.7	-0.4
PVC tonnes 0.5 0	Doors - external				
Windows Glass tonnes 0.5 0.1 0.0 0.1 0.0 0.1 0.0 0.1 0.0 0.1 0.0 0.1 0.0 0.0	Door Saleman	PVC	tonnes	0.5	0.6
Glass tonnes 0.5 0. Wood frame tonnes 0.1 -0.					-0.4
Glass tonnes 0.5 0. Wood frame tonnes 0.1 -0.					
Wood frame tonnes 0.1 -0.	windows	Class	tonnes	0.6	0.1
					-0.2
		PVC frame			0.3

Stairs				
	Concrete	m ³	2.6	1.1
Roof				
	Timber rafters, rock wool insulation and Marley plain concrete	m²	246.7	23.4
	Timber rafters, rock wool insulation, felt, battens and clay tiles	m ²	246.7	17.3

Assumptions	
Assessed that the light discounting of a decrease flat are considered to the second decrease of the second decreas	
Assume that the joist dimensions of a 4 storey flat are proportionally equivalent to that of a three bed detached house. Ratio of floor area to timber joists - three bed detached:	3.2 (working estimate)
Ratio of noor area to unnoer joists - trinee oea detached: Ratio of floor area to total joist length - three bed detached:	3.2 (working estimate) 3.1 (working estimate)
Ratio of moor area to total joist length - three bed detached.	3.1 (working estimate)
Building dimensions	
Number of flats per block:	8 (working estimate)
Total floor area:	530.0 m ² (working estimate)
Total internal partition wall area:	1036.2 m² (working estimate)
Total external wall area:	469.2 m² (working estimate)
Total roof area:	246.69 m² (working estimate)
Number of internal doors per flat:	6 (working estimate)
Number of external doors per flat:	1 (working estimate)
Number of additional external door per block:	2 (working estimate)
Area of each door:	2.152 m2 (working estimate)
Assumed thickness of door:	0.044 metres (Building Construction Handbook 1998)
Number of staircases:	4 (working estimate)
Height of one staircase:	2.6 metres
Assumed number of steps and risers in staircase:	15
Assumed dimensions of steps and risers: length:	1 metres (Scottish Building Regulations)
thickness:	0.17 metres (Scottish Building Regulations)
width:	0.25 metres (Scottish Building Regulations)
Total area of windows:	49.27 m ² (working estimate)
Structural Steel	
Dimension of column:	152 mm (working estimate)
	152 mm (working estimate)
Density of column:	37 kg/m (working estimate)
Number of columns: length:	17 m (working estimate)
number per floor:	3 (working estimate)
length:	8 m (working estimate)
number per floor:	5 (working estimate)
Total height:	12 m (working estimate)
number of vertical columns:	15 (working estimate)
Number of structural levels:	5
Timber frame with brick outer leaf	
Thickness of Brick:	102 mm
Thickness of sheathing (plywood):	9 mm
Emissions factors are not available for plywood so emissions are assumed to be equivalent to those associated with chipboard	
Thickness of glasswool insulation:	140 mm
Thickness of plasterboard:	12.5 mm
Cross section dimension of timber stud (regularised timber):	140 mm
	44 mm
Length of stud:	2.4 m
Studs at centres of:	600 mm
Assume that total area of stud equals 15% of the total wall area (timber frame construction)	15% (TRADA technology 2001 timber frame construction)

Thickness of Brick: Thickness of assembly converse block: Thickness of passembly converse block: Thickness of of block metabolic the passembly converse block because and the passembly converse block blo	Brick outer leaf with block internal leaf	
Trickness of passed invasions Trickness of passed converteducts Trickness of passed converted co	Brick outer lear with block internal lear	
Trickness of passed invasions Trickness of passed converteducts Trickness of passed converted co	Thickness of Brick:	102 mm
Timber fame with intimor claiding: Thickness of placethrough claiding: Thickness of promisers board. Thickness of promisers of promisers board. Thickness of promisers of promisers board. Thickness of promisers of promisers of promisers board. Thickness of promisers of promisers board. Thickness of promisers of promisers board. Thickness of promisers of promisers of promisers board. Thickness of promisers of p	Thickness of glasswool insulation:	100 mm
Thickness of Inter-citacking. Thickness of Inter-citacking. Thickness of Inter-citacking. Thickness of Inter-citacking. Emissions Status are not evaluate for pareviert so emissions are assumed to be equivaent to more associated with chipboard Emissions Status are not evaluate for pareviert so emissions are assumed to be equivaent to more associated with chipboard Emissions Status are not evaluate for pareviert so emissions are assumed to be equivaent to more associated with chipboard Emissions Status are not evaluate for pareviert so emissions are assumed to be equivaent to find a find of status are not evaluated for the find of status are status are assumed to the equivaent of finds of status are assumed to the equivaent of finds of status are assumed to the equivaent of finds are assumed to status as assumed to status are assumed to status as assumed to status as assumed to status are assume	Thickness of aerated concrete block:	100 mm
Thickness of intered calcuting: Ensistance are true available for paracheret so emissions are assumed to be equivalent to those associated with chipboard Thickness of enchange resistance. Thickness of enchange resistance of interer and (engularised tember): Length of stable Consess account emissions are true available for paracheret so emissions are assumed to be equivalent to those associated with chipboard Thickness of enchange of interer and (engularised tember): Length of stable Consess account emissions of interer and (engularised tember): Length of stable Consess account emissions of the true of engularised tember): Length of stable Consess account emissions of the first total area of stable and acquain 15% of the total area (tember frame construction) Thickness of enchange of the first total area of stable and acquain 15% of the total area (tember frame construction) Thickness of enchange of the first total area of stable and acquain 15% of the total area (tember frame construction) Thickness of enchange of the first total area (tember frame construction) Thickness of enchange of the first total area (tember frame construction) Thickness of enchange of the first total area (tember frame construction) Thickness of enchange of the first total area (tember frame) Thickness of enchange of the first total area (tember frame) Length of the total area (tember	Thickness of plasterboard:	13 mm
Thickness of parabletrs board Finishment for the ment available for practivent as or assistance of the propertient as or assistance of calcinors includence. Finishment of calcinors includence. Finishment of calcinors includence. Largel of datable. Material desirable. Ma	Timber frame with timber cladding	
Thickness of parabletrs board Finishment for the ment available for practivent as or assistance of the propertient as or assistance of calcinors includence. Finishment of calcinors includence. Finishment of calcinors includence. Largel of datable. Material desirable. Ma	Thickness of timber eladding:	22 mm
Emissions factors are not available for parehers as emissions are assumed to those associated with chipboard Trichices of plantification addition. Trichices of plantification of inferth and (egiplatrised inher): Longin of stud: Longin of	· · · · · · · · · · · · · · · · · · ·	
Trikiness of cellulation insulation. Class and cellulation insulation. Class action dimension of direbe stud (regularised finither): Length of state. Substa occurries of: Substa centres of: Substa cen		3 mm
Cores section dimension of timber stud (regularized timber): Largin of stud: Largin of stud: Largin of stud: Assumed shid alread stud arguels 15% of the total wall area (limber frame construction) Timber		140 mm
Largin of stud: Souts at comines of: Souts at comines of: Assume that bott olerand stud equals 15% of the total wall area (timber frame construction) Macrola details Timber Timber Assumed thickness of the TAG weatherdook floor: Assumed deficity of innite used. Assumed children of the total wall area (timber frame construction) Assumed deficity of innite used. Assumed thickness of the TAG weatherdook floor: Assumed deficity of innite used. Assumed with of innite studies frames: Concrete	Thickness of plasterboard:	12.5 mm
Largin of stud: Souts at comines of: Souts at comines of: Assume that bott olerand stud equals 15% of the total wall area (timber frame construction) Macrola details Timber Timber Assumed thickness of the TAG weatherdook floor: Assumed deficity of innite used. Assumed children of the total wall area (timber frame construction) Assumed deficity of innite used. Assumed thickness of the TAG weatherdook floor: Assumed deficity of innite used. Assumed with of innite studies frames: Concrete		140 mm
Such at ordinate of Assume that folds are ad state equals 15% of the total wall area (ferther frame construction) ***Assume that folds area of state equals 15% of the total wall area (ferther frame construction) ***Assumed total area of that departs of the TAG weather-dock floor: **Assumed folds ones of the TAG weather-dock floor: **Assumed folds ones of the TAG weather-dock floor: **Assumed dividences of the TAG weather-dock floor: **Capitaliser LOC, emissions for internal simber frames: **Assumed with others of conscious for the internal simber frames: **Assumed with others of or conscious floor: **Capitaliser LOC, emissions for or conscious floor: **Assumed with others of or conscious floor: **Capitaliser LOC, emissions for or conscious floor: **Assumed with others of conscious floor: **Capitaliser LOC, emissions for or conscious floor: **Assumed with others of conscious floor: **Capitaliser LOC, emissions for gravel: **Default of packed granular sub-base: **Thickness of chipboard: **Assumed without sub-dock floor: **Capitaliser LOC, emissions for brickwork: **Capitaliser LOC, e		44 mm
Assumed thickness of transition from construction) Material details Timber Assumed filterious of the TAG weatherforck floor: Assumed formative of interious of the TAG weatherforck floor: Equivalent CO ₆ missions for this dried filther: Equivalent CO ₆ missions for this dried filther: Equivalent CO ₇ missions for this dried filther: Equivalent CO ₇ missions for this dried filther: Equivalent CO ₇ missions for to noncreate: Equivalent CO ₇ missions for to noncreate: Equivalent CO ₇ missions for concrete: Equivalent CO ₇ missions for concrete (Fernish Bulding Information Foundation 2004) Assumed thioloness of concrete accred: Assumed thioloness of concrete accred: Assumed thioloness of concrete accred: Assumed thioloness of concrete for raids - upper floors: 10.005 metres (working estimate) **Concrete** **Co	Length of stud:	2.4 m
Material details Timber Assumed thickness of his T&O washindock floor: Assumed shortees of his T&O washindock floor: Assumed with distinct wash Equivalent CO ₂ emissions for intered inther: Equivalent CO ₃ emissions for intered inther transes: 4.12 CO ₂ /m ² concrete (Finnish Building Information Foundation 2004) Equivalent CO ₃ emissions for concrete: Concrete Equivalent CO ₅ emissions for concrete (Finnish Building Information Foundation 2004) Assumed hishories of concrete subsequent and the upper floors: Concrete Equivalent CO ₅ emissions for gravel: Concrete Equivalent CO ₅ emissions for gravel: Concrete Concrete Equivalent CO ₅ emissions for gravel: Concrete Concrete Concrete Equivalent CO ₅ emissions for prayel: Concrete (working estimate) Concrete (working estim	Studs at centres of:	600 mm
Assured thickness of the T&G weatherdeck floor: Assured definition of the T&G weatherdeck floor: Assured derivative of themer used: Equivalent CO ₀ emissions for list indied timber: Equivalent CO ₀ emissions for list indied timber: 1.2 (CO ₀ X timber used (RRE 1998e) 1.2 (CO ₀ X) timber used (RRE 1999e)	Assume that total area of stud equals 15% of the total wall area (timber frame construction)	15% (TRADA technology 2001 timber frame construction)
Assumed thickness of the TaS weatherdock floor: Assumed to file the state: Equivalent CO, emissions for kink died fimber: Concrete Equivalent CO, emissions for to concrete: Concrete Equivalent CO, emissions for concrete: 0.425 TCO ₂₀ /m³ concrete (Finish Building Information Foundation 2004) Assumed thickness of concretes labo: 0.015 metres (working estimate) Assumed thickness of concrete state: 0.025 MgCO, Mg (Finish Building Information Foundation 2004) Assumed thickness of concrete floor sibs - upper floors: Equivalent CO, emissions for gravel: 0.038 MgCO, Mg (Finish Building Information Foundation 2004) Density of packed granular sub-base: Thickness of hardore: Chipboard Chipboard Chipboard Chipboard Chipboard Milding side and base: 0.003 m (morth specimate) 0.003 m (morthing estimate) 0.003 m (morthing estimate) 0.005 m (morthing estimate) 0.005 m (morthing estimate) 0.007 m (morthing estimate) 0.008 m (morthing estimate) 0.009 m (Material details	
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Assumed thickness of plasterboard: 0.0125 m (working estimate)		
Assumed thickness of plasterboard: 0.0125 m (working estimate)	Distantaged	
		0.0125 m (working estimate)
	Equivalent CO ₂ emissions for plasterboard:	0.346 tCO ₂ e/m³ plasterboard used (Finnish Building Information Foundation 2004)

Steel Equivalent CO_2 emissions for steel work: Equivalent CO_2 emissions for steel work:	 0.66 tCO₂/tonne steel used (RTS 1999a) 5.16 tCO₂/m3 steel used (Finnish Building Information Foundation 2004)
PVC Equivalent CO₂ emissions for PVC: Assumed density of PVC used:	1.2 tCO2e/t PVC used (Plastic Europe) 650 kg/m³ (working estimate)
Glass Assumed thickness of glass used: Density of glass: CO ₂ emissions for glass: Assumed percentage of opening area to be frame: Assumed percentage of opening area to be glass: Assumed thickness of window frame:	0.004 metres (working estimate) 2800 kg/m³ (www.allmeasures.com) 600 kgCO₂/tonne glass (working estimate) 15% (working estimate) 85% (working estimate) 0.05 m (working estimate)
Insulation Thickness of polystyrene insulation: Glass wool: Cellulose: EPS: Extruded polystyrene - factors are not available so they assumed to be equivalent to EPS: Density of glass wool insulation: Density of cellulose insulation: Density of EPS insulation: Density of EPS insulation: Density of extruded polystyrene insulation:	100 mm 1,100 kgCO ₂ /tonne (BRE 1999) -1,22 tCO ₂ /tonne (Finnish Building Information Foundation 2004) 2,60 gCO ₂ /kg (Plastics Europe 2006) 2,60 gCO ₂ /kg (Plastics Europe 2006) 2,5 kg/m³ (CIBSE Guide A 2006) 43 kg/m³ (CIBSE Guide A 2006) 15 kg/m³ (CIBSE Guide A 2006) 40 kg/m³ (CIBSE Guide A 2006)
Roof CO ₂ emissions for timber rafters, rock wool insulation and Marley plain concrete roof: CO ₂ emissions for timber rafters, rock wool insulation, felt, battens and clay tiles roof:	95 kgCO ₂ e/m² (BRE 1999) 70 kgCO ₂ e/m² (BRE 1999)

Appendix III

Emissions Calculations and Assumptions – Timber transportation

Forestry Commission - Timber Transportation Emissions

	Emissions Metric			E	xample journeys (to	onnes of CO2/tonne	of timber transporte	ed)			
Source of emissions	kg CO2/tonne.km	ternal Swedish journe	Sweden to the UK	Internal Latvian journey	Latvia to UK		Internal UK journe	eys	Internal Cana	adian journey	Canada to the UK
		Vaxjo - Gothenburg	Gothenburg - Newcastle	Gulbene - Riga	Riga - Newcastle	Newcastle - Perth	Liverpool - Perth	Fort William - Perth	Shawinigar	n - Montreal	Montreal - Liverpool
		tCO2/ tonne		tCO2/ tonne	tCO2/ tonne	tCO2/ tonne	kgCO2/ tonne	tCO2/ tonne			tCO2/ tonne
		transported	tCO2/ tonne transported	transported	transported	transported	transported	transported	tCO2/ tonne	transported	transported
Small ship (1,268 tonnes)	0.06		0.054	-	0.11						0.33
Large ship (4,478 tonnes)	0.02		0.018		0.04						0.11
Road freight (44 tonne articulated lorry)	0.04	0.01		0.009		0.01	0.02	0.01	0.	01	
Road freight (60 tonne articulated lorry)	0.03	0.01		0.006							
Train freight	0.03	0.01		0.006		0.008	0.013	0.005	0.0	004	

Assumptions	
Assumblyis	
Distance from Gothenburg (Sweden) - Newcastle (UK):	488 nautical miles
	904 km
Distance from Montreal (Canada) - Liverpool (UK):	2.979 nautical miles
Distance from Worklean (Canada) - Everpoor (OK).	5.517 km
Distance from Riga (Latvia) - Newcastle (UK):	995 nautical miles
	1,843 km
Distance from Newcastle - Perth:	270 km
Distance from Liverpool - Perth:	430 km
Distance from Fort William - Perth:	164 km
Distance from Vaxjo - Gothenburg:	265 km
Distance from Gulbene - Riqa:	204 km
Distance from Shawinigan - Montreal:	133 km (timeanddate.com)
Payload of a 44 tonne articulated lorry:	28 tonnes (Freight Shepherd road haulage)
Payload of a 60 tonne articiulated lorry (Scandinavia):	40 tonnes (VTT Communities and Infrastructure 2000)
Fuel consumption of an articulated lorry (44 tonne) 100% weight laden:	0.448 litres/km (DEFRA 2005)
Fuel consumption of an articulated lorry (44 tonne) 100% weight laden: Fuel consumption of an articulated lorry (60 tonne) 100% weight laden:	0.48 litres/km (VTT Communities and Infrastructure 2000)
	and the second second
CO2 emissions for diesel:	2.63 kg of CO2 per litre (DEFRA 2005)
Nautical miles to km:	1.85
reduction miles to kin.	1.00

Example journeys - Destination Perth

		Total tCO2 pe
		tonne transporte
		from origin to
Example journey - Sweden to Scotland	Methods of transport	Pert
Vaxjo - Gothenburg - Newcastle - Perth	60 tonne lorry, large ship, 44 tonne lorry.	0.03
		Total tCO2 pe
		tonne transporte
		from origin t
Example journey - Latvia to Scotland	Methods of transport	Pert
Gulbene - Riga - Newcastle - Perth	Train, small ship, 44 tonne lorry.	0.12
		Total tCO2 pe
		tonne transporte
		from origin t
Example journey - Canada to Scotland	Methods of transport	Pert
Shawinigan - Montreal - Liverpool - Perth	44 tonne lorry, Large ship, 44 tonne lorry	0.13
		Total tCO2 pe
		Total tCO2 pe
		tonne transporte
Example journey - Scotland (locally sourced)	Methods of transport	

Example journeys - The benefits of transporting timber by train

Source of emissions	Emissions Metric kg CO ₂ /tonne.km	Tonnes of CO₂/tonne of
Crianlarich - Chirk		
Road freight (44 tonne articulated lorry)	0.04	0.021
Train freight	0.03	0.015

Distance from Crianlarich (Scotland) - Chirk (Wales): Payload of a 44 tonne articulated lorry: Fuel consumption of an articulated lorry (44 tonne) 100% weight laden: CO2 emissions for diesel:

504 km 28 tonnes (Freight Shepherd road haulage) 0.448 litres/km (DEFRA 2005) 2.63 kg of CO2 per litre (DEFRA 2005)

Appendix IV

Emissions Calculations and Assumptions – Typical English Building Materials

Typical practice (England) - 2 bed semi-detached house

Building material	Tonnes of CO ₂
Foundations	
Concrete	0.9
Flooring	
Hardcore, concrete slab, screed, chipboard, extruded polystyrene insulation	2.0
Ceilings	
Plasterboard	0.2
Joists	
Timber I joists	-0.12
External walls	
Brick outer leaf with block internal leaf, glasswool insulation and plasterboard	6.6
Internal walls	
Block and plasterboard	0.6
Stairs	
Timber	-0.1
Windows	
Glass	0.1
PVC frame	0.03
Internal doors	
Panel doors (chipboard)	-0.1
External doors	
PVC	0.1
Roof	
Timber rafters, rock wool insulation and Marley plain concrete (BRE element profile)	4.0
Total	14.3

Typical practice (England) - 3 bed detached house

Building material	Tonnes of CO ₂
Foundations	_
Concrete	1.7
Flooring	
Hardcore, concrete slab, screed, chipboard, extruded polystyrene insulation	1.9
Ceilings	
Plasterboard	0.4
Joists	
Timber I joists	-0.59
External walls	
Brick outer leaf with block internal leaf, glasswool insulation and plasterboard	11.3
Internal walls	
Block and plasterboard	0.66
Stairs	
Timber	-0.1
Windows	
Glass	0.1
PVC frame	0.06
Internal doors	
Panel doors (chipboard)	-0.02
External doors	
PVC	0.1
Roof	
Timber rafters, rock wool insulation and Marley plain concrete (BRE element profile)	4.5
Total	20.1

Typical practice (England) - 4 story block of flats

Building material	Tonnes of CO ₂
Foundations	
Concrete	4.7
Flooring	
Hardcore, concrete slab, screed, chipboard, extruded polystyrene insulation	39.9
Ceilings	
Plasterboard	2.3
Structural Steel	
Steel	15.44
External walls	
Brick outer leaf with block internal leaf, glasswool insulation and plasterboard	32.1
Internal walls	
Block and plasterboard	17.3
Stairs	
Concrete	1.1
Windows	
Glass	0.3
PVC frame	0.29
Internal doors	
Panel doors (chipboard)	-0.4
External doors	
PVC	0.6
Roof	
Timber rafters, rock wool insulation and Marley plain concrete (BRE element profile)	23.4
Total	136.9