An analysis of carbon emissions for different end of life scenarios for virgin, recycled and low grade wood fibre

May 2010

Prepared by

1. Executive Summary

1.1. This report is concerned primarily with the net CO_2 emissions arising from competing uses for the UK's scarce and finite timber resources. The report has been commissioned on behalf of the industry by the Wood Panel Industries Federation (WPIF).

1.2. For the purposes of this report, "wood panels" cover particleboard (also known as chipboard), medium density fibreboard (MDF), and oriented strand board (OSB). Wood panels are produced using a range of wood sources, including small roundwood, chips, sawdust, and recovered or recycled wood. In the UK, wood panels are made by four companies – Egger, Kronospan, Norbord and Sonae – all subsidiaries of multi-national corporations domiciled overseas.

1.3. Until recently, the wood panel industry has sourced its timber domestically in the UK on a competitive basis. The competitive market began to be undermined in 2002 by the Government's introduction of a subsidy to compensate electricity generators for burning "renewable" fuel in the form of the Renewables Obligation Certificate (ROC).

1.4. The ROC subsidy is a distortion of the market in wood supplies which clearly puts the wood panel manufacturers at a disadvantage. A ROC is worth £54.37[1], equating to a subsidy of £81.55/MWh for electricity only generation which compares with about £25 for an equivalent volume of wood input that wood panel manufacturers pay.

1.5. As a result of the ROC subsidies, the projected demand for timber in the UK will outstrip supply by 2012 :

"The biological availability of British sourced wood fibre is forecast to increase up to about 2019 when it reaches just over 20 million tonnes per annum and then it is forecast to start decreasing".[2]

Demand during the same period is set to increase to 50 million tonnes as a result of proposed increases in biomass electricity generation.

1.6. Although the burning of timber is virtually carbon neutral *over the lifecycle* in comparison to fossil fuels, when compared to wood panel manufacture it is a significantly greater source of CO_2 emissions:

- The CO_2 emissions from the wood panel industry equate to 378kg CO_2 per tonne of timber processed.
- In comparison, the CO_2 emissions from the biomass industry consuming domestically sourced timber equates to 1905kg CO_2 per tonne of timber processed.

[1] OFGEM – Renewables Obligation: Annual Report 2008 -2009

[2] Clegg Report – Wood availability and demand in Britain 2007 - 2025

1.7. The Wood Panel Industry's consumption is relatively stable at between 3.5 to 4.5 million tonnes of timber per annum[3]. **If the Wood Panel Industry were displaced by the biomass industry, there would be an increase in net CO_2 emissions equivalent to 1527kg CO_2 per tonne of timber processed or 6 million tonnes CO_2 – a 1% increase in UK net CO_2 emissions each year[4].**

1.8. The distortion of the wood market, resulting from the ROC subsidy, risks the displacement of the Wood Panel Industry in the UK (and potentially other wood processing businesses), which in turn will result in an increase in the UK's net CO_2 emissions. From a carbon abatement point of view, the overarching need is to correct this distortion, which threatens to increase rather than decrease net CO_2 emissions.

1.9. Carbon River mapped the emissions associated with one tonne of timber through the wood panel production process and the biomass energy production process. The net emissions of wood panel production and biomass were analysed over a period out to 2120 before a combined process of timber being used in wood panels and then in biomass was also mapped out.

[3] Forestry Commission – UK Wood Production and Trade Figures – May 2010

[4] UK ONS – 2008 inventory data tables

2. Background to this report

The Wood Panel Industries Federation

2.1 This study was commissioned by the Wood Panel Industries Federation (WPIF, http://www.wpif.org.uk), located in Grantham, Lincolnshire. The WPIF exists largely to give a voice to its manufacturing members and to provide a clearing house of technical, environmental and regulatory information in support of its members' products and processes.

Carbon River

2.2 CarbonRiver™ uses a methodology of analysis called **Hybrid Life Cycle Assessment** (LCA), accredited and used by LCA practitioners, commercial entities and governments internationally since the late 1990s – and recommended by DEFRA as best practice in 2008.

2.3 CarbonRiver's Hybrid LCA approach can be accredited to the following standards:

- WRI/WBCSD GHG Protocol
- ISO 14064-1PAS 2050

2.4 CEDA®, the database that provides Economic Input Output (EIO) data for the process, is the only peer reviewed database of its kind, used by EC, UN, US EPA, DEFRA, US NIST/DOC and numerous corporates.

2.5 Hybrid LCA is a 'best of breed' approach combining economic data with detailed process data from your organisation to rapidly and cost-effectively deliver comprehensive direct and indirect emissions analysis - scope 1,2 + 3.

What was CarbonRiver™ asked to do?

2.6 To present the facts concerning carbon emissions as they relate to the following variables:

Wood use

- 300MW biomass energy plants
- 50 MW biomass energy plants
- Wood panel industry

Wood source

- Domestically (local to use)
- Via import from Continental Europe and beyond

Wood life stage

- Virgin Timber: wood fibre (roundwood or sawdust) that has not previously been used as a wood product
- Low grade Wood: wood fibre that cannot be used directly for panel manufacture by the wood panel industry
- Recycled wood: wood fibre that has been obtained from wood-based products that can be used directly for panel manufacture by the wood panel industry.

How should the information in this report be used?

2.7 The information in this report is prepared using a process based methodology to map emissions over a complete lifecycle in accordance with the Greenhouse Gas Protocol.

3 Wood Panels – Industry Description

3.1 The process of wood panel manufacture is undertaken by taking wood fibre in various forms (strands, chips, dust and fibres) and mixing with an adhesive, which are laid into a mat and pressed between heated platens to cure the adhesive.

3.2 The principal types of panel dealt with here are particleboard, medium density fibreboard (MDF) and oriented strand board (OSB).

- Particle board is typically produced from a mix of virgin softwood chips, recycled wood chips and sawdust.
- MDF is made by reducing steamed softwood chips to fibres which are subsequently dried and mixed with adhesives prior to the pressing process.
- OSB is made from wood strands formed in 3 layers with the strands in the surface layer orientated roughly in line with the length of the panel giving the panel greater mechanical strength.

3.3 Each type of panel has various applications in the construction, furniture and DIY sectors, including cladding, packaging, kitchen worktops and laminate flooring.

3.4 The average lifespan of the various products has been assessed at 40 years.

Timber Inputs

3.5 The basic process input is softwood. This is almost exclusively sourced domestically in the UK from sustainable forestry sources in the form of roundwood, sawmill co-products (chips and dust) and recycled timber (pallets, cable drums etc).

3.6 The total timber consumption by the industry is relatively stable between 3.5 and 4 million tonnes per annum. This equates to approximately 40% of the total UK timber harvest.

3.7 The industry recycles 1.2 million tonnes of waste timber – approximately 50% of total UK timber recycled.

Energy Inputs

3.8 The industry is a relatively high intensity energy user that has made large strides in reducing its energy consumption in recent years. WPIF members entered into a Climate Change Agreement with the UK Government which agreed targets to be achieved in each of several two-year periods.

3.9 The industry's actual specific energy consumption (SEC), measured as primary megawatt hours (MWhp) per cubic metre (M3) of panel output is set out in table below:

Period ending	MWH_p consumed	000 m^3 panel output	SEC (kWh/m^3)
2002	3,170,074	3,231	981
2004	3,130,272	3,609	867
2006	3,008,661	3,694	815
2008	2,550,761	3,258	783

Source: Climate Change Levy (CCL) report at milestone 4, 2008

3.10 The industry's performance against the targets set under the climate change agreement are set out in table below:

Period ending	Target Improvement	Actual Improvement
2002	1.3%	-1%
2004	3.5%	11%
2006	7.0%	23%
2008	10%	26%

Source: Climate Change Levy (CCL) report at milestone 4, 2008

3.11 The tables demonstrate both in absolute and relative terms the large improvement achieved to date by the industry in reducing its energy consumption.

3.12 A large portion of the industry's energy consumption is heat derived and the industry has invested heavily in recovering heat from its process derived biomass residues (timber offcuts, sander dust and bark etc). The industry derives 55% of its heat requirement from process derived biomass residues – a total of 1.6TWh in 2009.

4. UK Timber supply and demand projections

4.1. In May 2010, John Clegg & Sons published a report entitled "Wood Fibre Availability and Demand in Britain 2007 to 2025", assessing the supply demand balance within the UK timber market. The report collated the current and projected timber consumption from existing timber users (manufacturing and biomass energy) and prospective new entrants.

4.2. The results of this analysis depicted in the chart below show a startling mis-match between UK supply of and demand for timber, as early as 2012, and that by 2017 the shortfall in supply of timber in the UK could be as much as 30 million tonnes.

4.3. The rapid increase in timber demand is attributed in the report to the projected development of the UK biomass energy industry, supported by UK Government Renewables Obligation incentives – in the form of Renewable Obligation Certificates (ROCs).

4.4. In return for evidence of burning renewable fuel, generators receive ROCs which can be traded. In order to meet their obligations, suppliers must have enough ROCs or make a buy-out payment. Buy-out payments enter a fund which is redistributed to suppliers in proportion to the total number of ROCs that each has presented. The "worth" of an ROC is the sum of the buyout payment that is avoided by presenting the ROC, plus the portion of the buyout fund redistributed to the supplier that presented the ROC.

4.5. A ROC is worth £54.37[5], equating to a subsidy of £81.55/MWh for electricity only generation which compares with about £25 for an equivalent volume of wood input that wood panel manufacturers pay.

4.6. Clegg draws the conclusion that timber imports of wood chips and pellets will increase dramatically – from virtually nil in 2012 to 27 million tonnes in 2017 – to meet the increased demand. This implies a doubling of the current global trade in such products.

4.7. Clegg also points out:

"One practical issue that will have to be addressed if a virgin biomass import trade starts is bio-security. This might restrict the ability of companies to source virgin biomass from certain regions of the world."

4.8. Inevitably, economic and availability pressures will push the biomass sector to source UK grown timber where possible.

4.9. This will therefore place the subsidised biomass industry in direct competition with the non-subsidised wood panel industry, the future viability of which would be uncertain.

[5] OFGEM – Renewables Obligation: Annual Report 2008 -2009

5. Carbon Emission Analysis

5.1 In this section we will address the environmental impact from the point of view of carbon dioxide (CO_2) emissions from both the wood panel industry and the biomass industry. The analysis compares the direct CO_2 emissions per tonne of timber processed within the two industries and is summarised in table below:

Wood Source	From	Wood Panel industry (with CHP)	Wood Panel industry (without CHP)	Into biomass plant
Virgin	UK (local)	378	453	1,905
	Import	656	731	2,183
Recycled	UK (local)	371	446	1,898
	Import	645	720	2,172
Low Grade	UK (local)	NA	NA	1,898
	Import	NA	NA	2,172

Table 1. Carbon emissions for different import and end-of-life scenarios for virgin, recycled and low-grade wood fibre (kg CO_2 per tonne of wood)

5.2 The analysis clearly shows that the carbon footprint for any form of biomass combustion is significantly greater per tonne than wood panel-related activities.

5.3 Chart 1 below shows that when broken down by stage in the value chain, the difference in CO_2 emissions is largely driven by the combustion stage in the biomass.

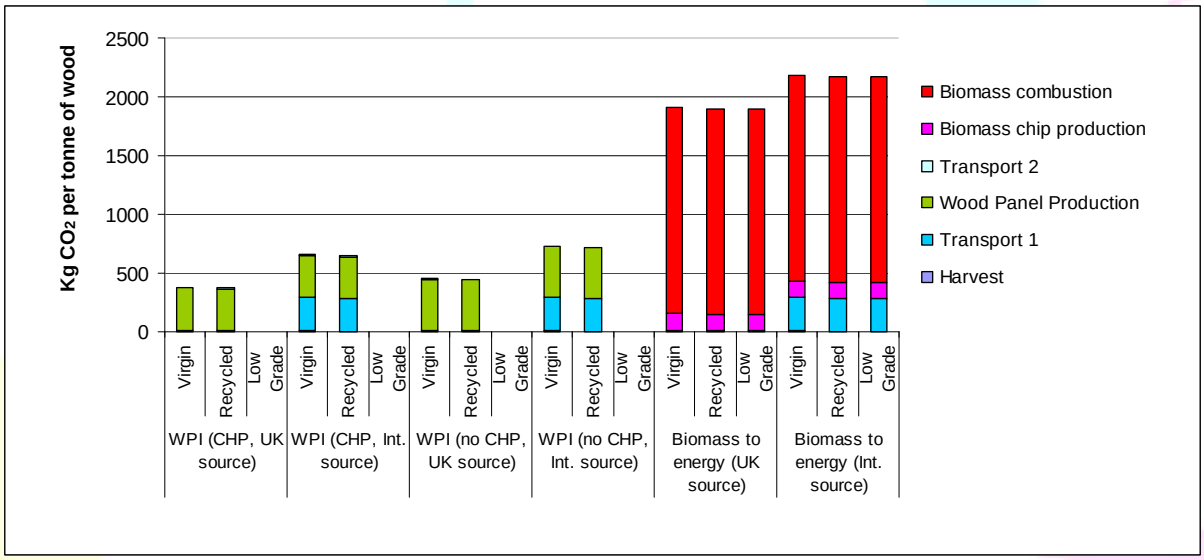


Chart 1. Net emissions for each value chain by source of wood

5.4 It is clear from this analysis that the switch to imported timber from domestic will, proportionally, have a limited impact on CO_2 emissions from biomass. However, for the wood panel industry the impact is an increase in emissions of between 60 and 70% as shown in Table 2.

Wood Source	From	Wood Panel industry (with CHP)	Wood Panel industry (without CHP)	Into biomass plant
Virgin	Import % increase	74	62	15
Recycled	Import % increase	74	61	14
Low Grade	Import % increase	NA	NA	14

Table 2. Relative increase in carbon emissions attributable to import of timber

Climate Change Abatement potential

5.5 Throughout the growth cycle of a forest, CO_2 from the atmosphere is absorbed by the tree such that 1,747kgCO_2 is absorbed per tonne of timber over its lifecycle.

Biomass Energy

5.6 The CO_2 emissions incurred from harvesting, transporting, processing and burning timber in a biomass energy plant are shown in Table 3 below:

	Biomass to energy (UK source)			Biomass to energy (Int. source)		
Lifecycle stage	**Virgin**	**Recycled**	**Low Grade**	**Virgin**	**Recycled**	**Low Grade**
Harvest	6	0	0	6	0	0
Transport 1	9	8	8	288	282	282
Wood Panel Production	0	0	0	0	0	0
Transport 2	0	0	0	0	0	0
Biomass chip production	142	142	142	142	142	142
Biomass combustion	1,747	1,747	1,747	1,747	1,747	1,747
Total carbon captured	1,747	0	0	1,747	0	0
Total carbon emitted	1,905	1,898	1,898	2,183	2,172	2,172
Net emissions of carbon dioxide	**157**	**1,898**	**1,898**	**436**	**2,172**	**2,172**

Table 3. Biomass carbon footprint analysis

5.7 Over the lifecycle of the tree, the net emission is 157kgCO_2 per tonne of timber processed in the biomass industry as shown in Chart 2 below:

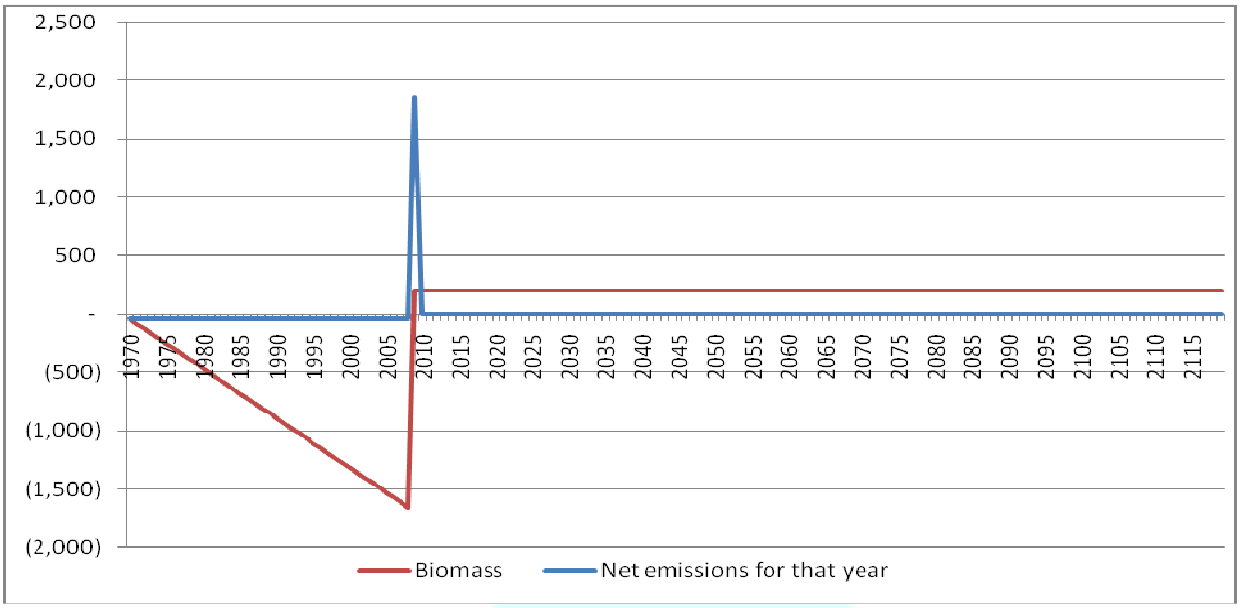


Chart2. Net emissions (kg CO_2) for biomass each year and cumulatively from one tree growth in 1970 through to 2120

Wood Panel Manufacture

5.8 The CO_2 emissions incurred from harvesting, transporting, processing and manufacturing wood panels are shown in Table 4 below:

Table4. Wood Panel Industry carbon footprint analysis

Lifecycle stage	WPI (CHP, UK source)			WPI (no CHP, UK source)		
	Virgin	Recycled	Low Grade	Virgin	Recycled	Low Grade
Harvest	6	0	NA	6	0	NA
Transport 1	9	8	NA	9	8	NA
Wood Panel Production	356	356	NA	431	431	NA
Transport 2	7	7	NA	7	7	NA
Biomass chip production	0	0	NA	0	0	NA
Biomass combustion	0	0	NA	0	0	NA
Total carbon captured	1,747	0	NA	1,747	0	NA
Total carbon emitted	378	371	NA	453	446	NA
Net emissions of carbon dioxide	-1,370	371	NA	-1,295	446	NA

5.9 Over the lifecycle of the tree, 1,370kgCO_2 is sequestered per tonne of timber processed in the wood panel industry, as shown in Chart 3 below:

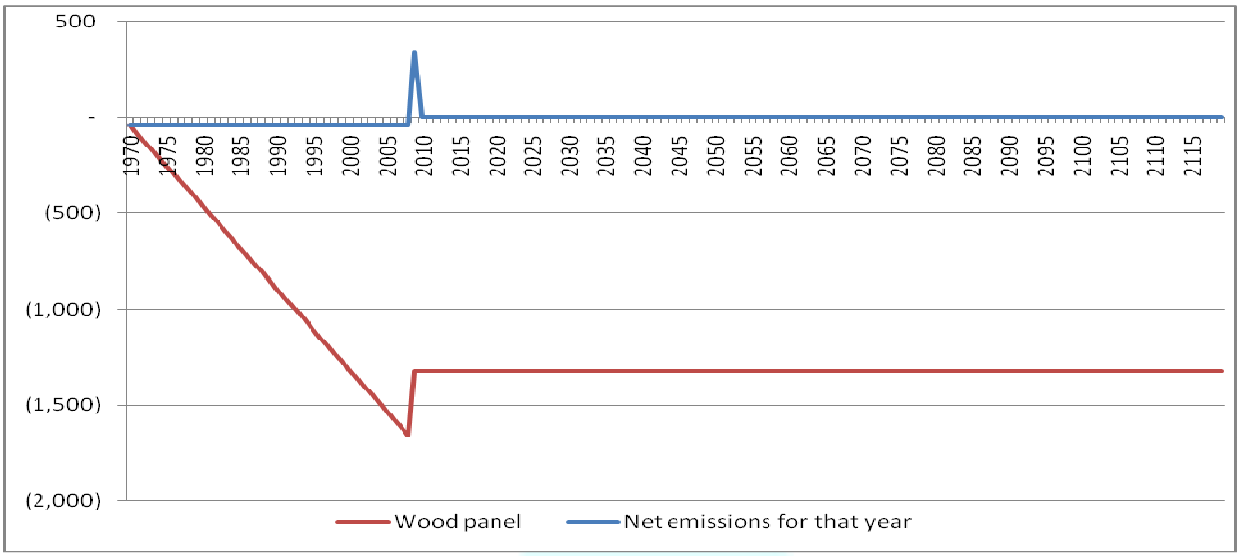


Chart3. Net emissions (kg CO_2) for wood panel each year and cumulatively from one tree growth in 1970 through to 2120

5.10 The average life span of wood panel products is assessed as 40 years. The cycle is therefore repeated with additional carbon sequestration attributable to forest growth incurred, as shown in Chart 4:

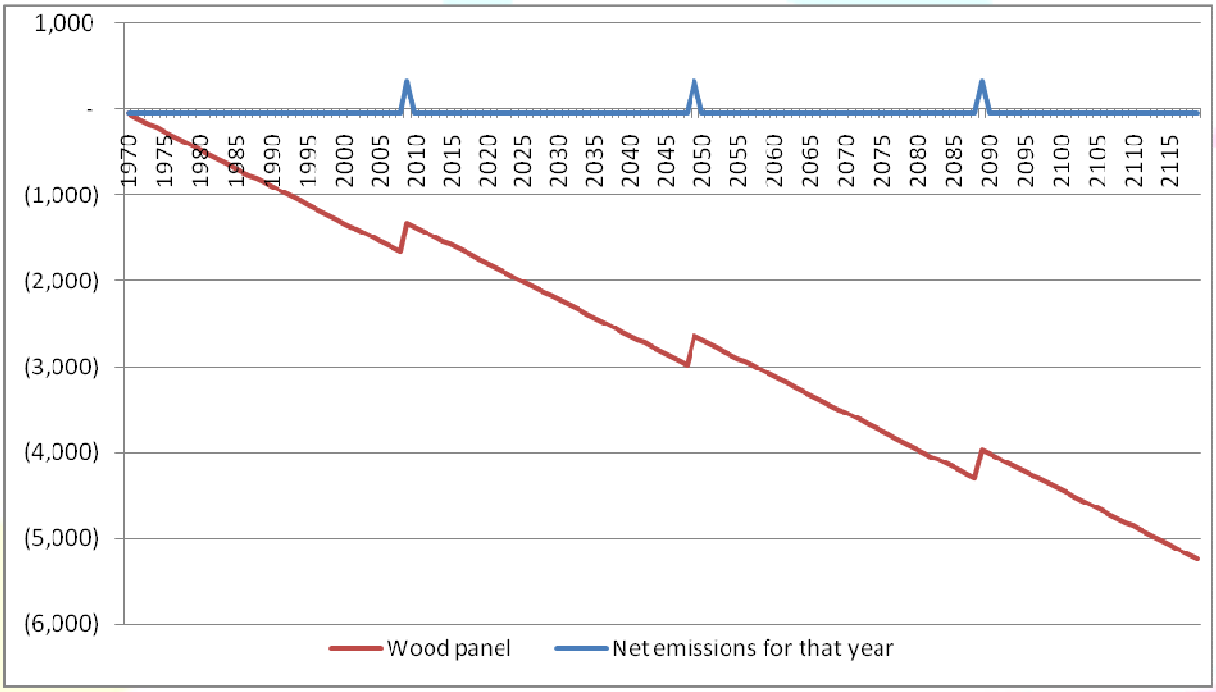


Chart 4. Net emissions (kg CO_2) for wood panel each year and cumulatively from sequential tree growth in 1970 through to 2120

5.11 At the end of the useful life of the wood panel product, the energy can be recovered for biomass energy, with the effect on net emissions demonstrated in Chart 5 below:

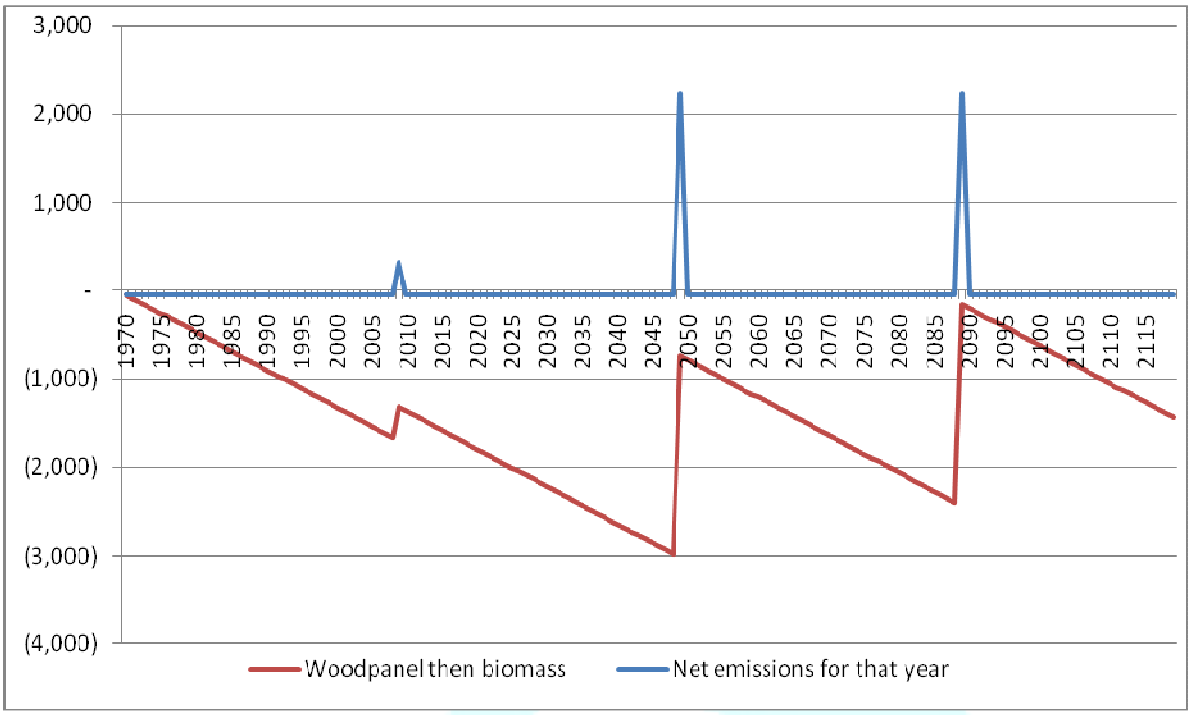
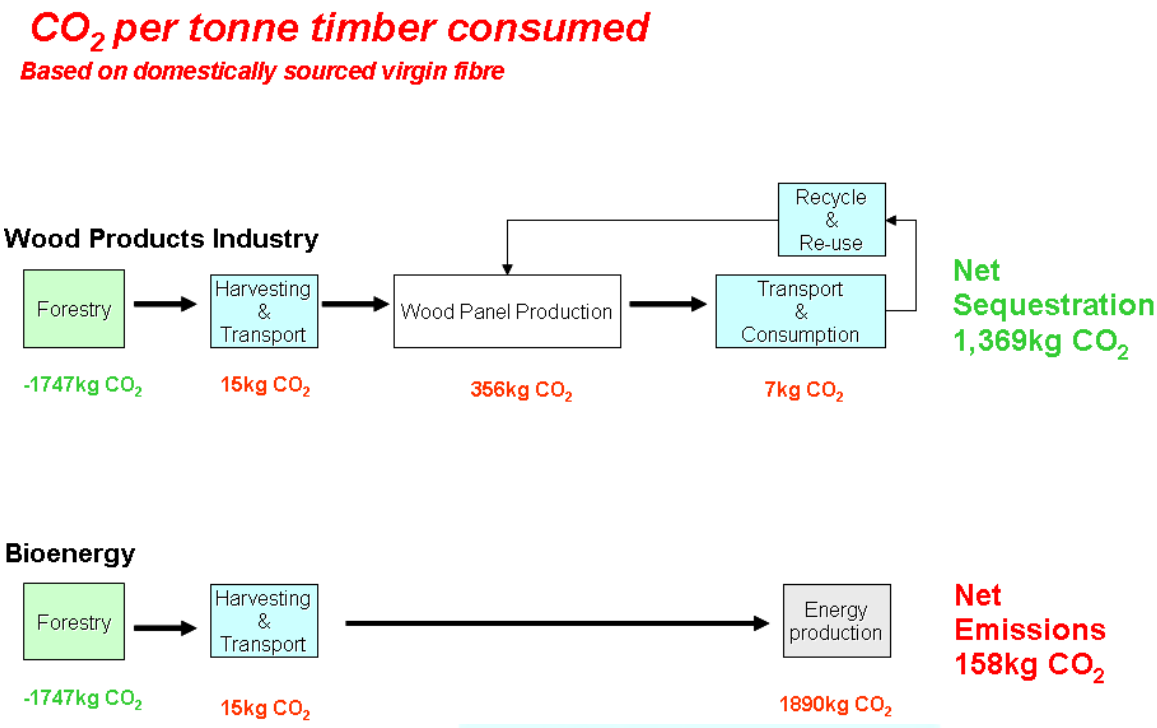


Chart 5. Net emissions (kg CO_2) for wood panel followed by biomass each year and cumulatively from sequential tree growth in 1970 through to 2120

Value Chains



5.12 The diagram above compares the processes in the supply chains for both the Wood Panel Industry and the Biomass industry and compares the corresponding lifecycle carbon footprints.

5.13 It demonstrates clearly that processing timber to manufacture products acts a carbon sink – sequestering 1,369kgCO_2 – as opposed to biomass energy, which has a net emission of 158kgCO_2.

5.14 If the UK biomass industry were to displace the UK wood panel industry as primary consumers of 4 million tonnes of UK sourced timber, the net CO_2 emissions for the UK would rise by 6 million tonnes – more than 1% of the UK's reported emissions in 2008.[6]

[6] UK ONS – 2008 inventory data tables

6. Data Tables

6.1 The following tables analyse the carbon emissions attributable to the various points in the supply chain of different forms of biomass originating from various sources utilised in both the biomass and wood panel industries.

Biomass Energy

Lifecycle stage	Biomass to energy (UK source)			Biomass to energy (Int. source)		
	Virgin	Recycled	Low Grade	Virgin	Recycled	Low Grade
Harvest	6	0	0	6	0	0
Transport 1	9	8	8	288	282	282
Wood Panel Production	0	0	0	0	0	0
Transport 2	0	0	0	0	0	0
Biomass chip production	142	142	142	142	142	142
Biomass combustion	1,747	1,747	1,747	1,747	1,747	1,747
Total carbon captured	1,747	0	0	1,747	0	0
Total carbon emitted	1,905	1,898	1,898	2,183	2,172	2,172
Net emissions of carbon dioxide	157	1,898	1,898	436	2,172	2,172

Wood Panel Industry

Lifecycle stage	WPI (CHP, UK source)		WPI (CHP, Int. source)		WPI (no CHP, UK source)		WPI (no CHP, Int. source)	
	Virgin	Recycled	Virgin	Recycled	Virgin	Recycled	Virgin	Recycled
Harvest	6	0	6	0	6	0	6	0
Transport 1	9	8	288	282	9	8	288	282
Wood Panel Production	356	356	356	356	431	431	431	431
Transport 2	7	7	7	7	7	7	7	7
Biomass chip production	0	0	0	0	0	0	0	0
Biomass combustion	0	0	0	0	0	0	0	0
Total carbon captured	1,747	0	1,747	0	1,747	0	1,747	0
Total carbon emitted	378	371	656	645	453	446	731	720
Net emissions of CO_2	**-1,370**	**371**	**-1,091**	**645**	**-1,295**	**446**	**-1,016**	**720**

6.2 Low grade material is not suitable for wood panel manufacture and is excluded from the above table.

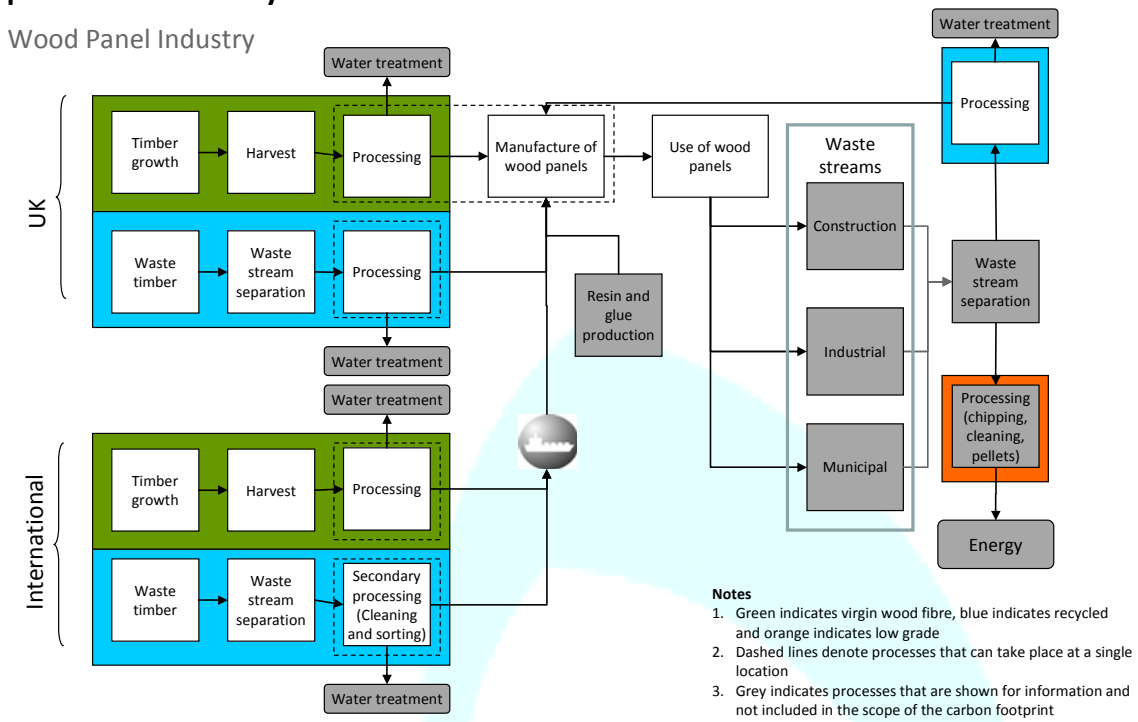
7. Measure and Evaluate

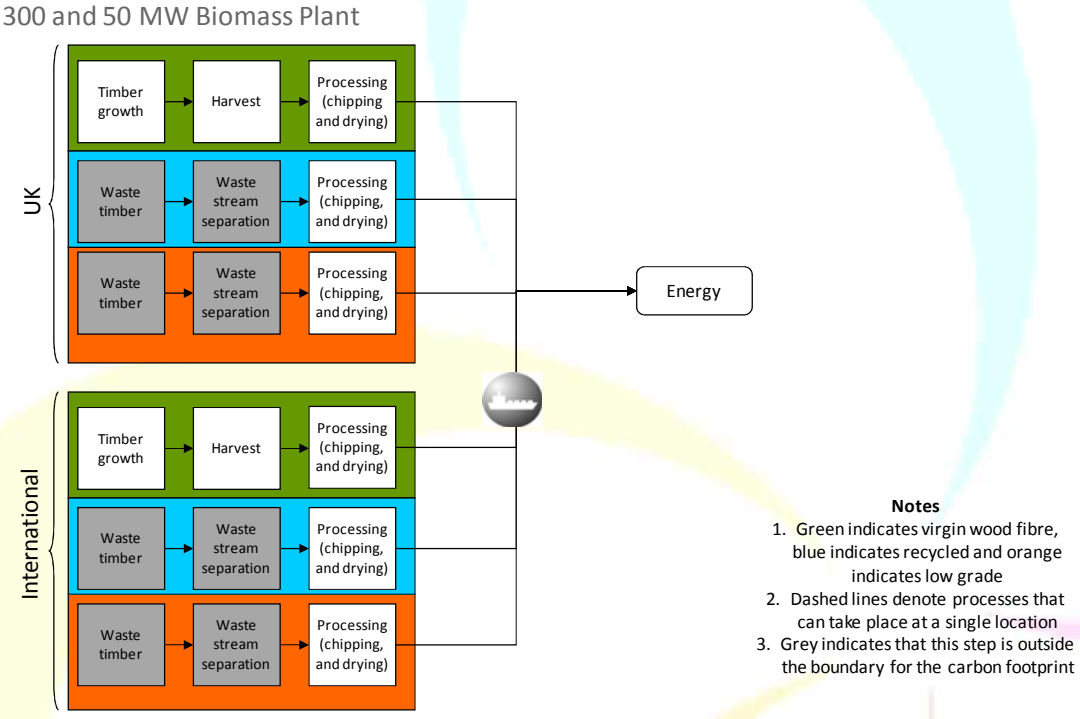
Supporting Explanations

Organizational Boundary

Not applicable

Operational Boundary





Exclusions

The only GHG considered for the purposes of this proposal is carbon dioxide. There are no other known significant sources of other GHGs within the proposed operational boundary. Standard amounts of methane and nitrous oxide will be released as part of fossil fuel combustion.

The only potential source of significant unaccounted for GHGs is associated with the:

1. Manufacture of glue and resin (scope 3) and
2. Emissions of vapours from the glues and resins during the curing of wood panels (scope 1)

Period Covered

The study is based on data for the financial year 08 - 09. As this is the first study conducted the results will form the Base year for future comparisons.

Calculation Approach

To enable comparison between the different biomass options:

1. All CO_2 data has been normalised against a tonne of wood input in to the system
2. Calculation of CO_2 emissions has been achieved using:
    a. Standard emission factors from DEFRA (2009) and the
    b. GHG Protocol.
3. The quantities of carbon dioxide reported are almost exclusively based on energy data for actual operations. For example, information about the amount of carbon emitted when a recycled wood stream is used for the different scenarios is based on the energy consumption data for inbound supplies of recycled wood to the production site.
4. Data for the sourcing of wood fibre from international sources assumes that:
    a. Wood fibre comes from North America;
    b. Wood fibre is shipped from Halifax, Canada on a medium Bulk Carrier carrying 15,000 tonnes per 3,227 km journey to Hull (UK);
    c. The journey in the UK from the port to manufacture (or Drax Power Station) is by train.
5. Emissions of CO_2 for the Wood Panel industry (with CHP) have been calculated using the consumption of natural gas, electricity and biomass within the sector.
6. Emissions of CO_2 for the Wood Panel industry (without CHP) have been calculated using the consumption of natural gas, electricity and biomass from within the sector as well as:
    a. Calculating the amount of natural gas required to generate that heat derived from the CHP, and
    b. Calculating the amount of additional grid electricity required to replace the electricity generated by the CHP
7. It has been assumed that 40% of the total energy is used during processing and 60% during manufacture.

Core Assumptions

End of Life Considerations

See operational boundary

Intensity Management

Analysis has been completed to deliver the level of emissions per tonne of timber

Base Year

This is the first measurement of the carbon footprint therefore it will be used as the Base Year for future comparisons.

Data Quality Target

The results are suitable for third party verification.

Materiality Threshold

A threshold has not been set and no activities have been excluded on the basis of materiality.

Third Party Verification

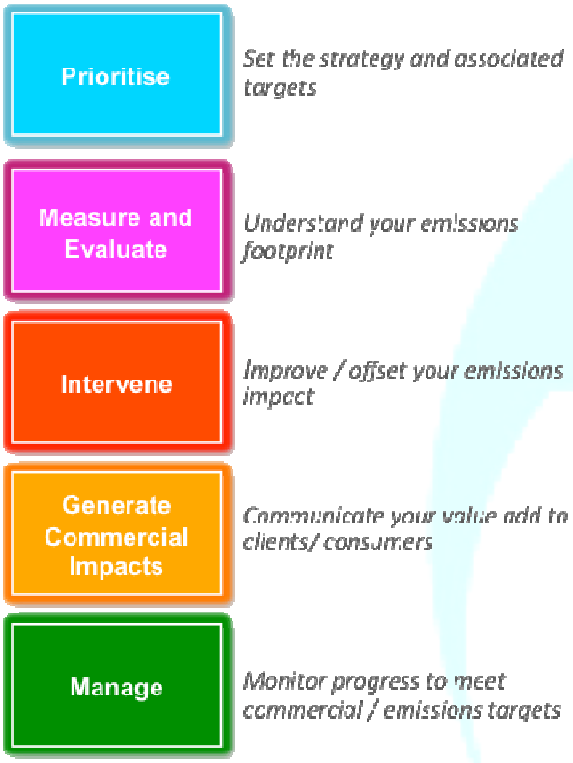
Third Party Verification is not being sought for this measurement.

8. Methodologies

CarbonRiver's Approach to Carbon Accounting

High Integrity, Rapid and Low-Cost Emissions Management of all 6 Kyoto gasses (measurement, analysis, abatement and ongoing tracking) of **Products and Services. Enterprise and Supply Chain.**

CarbonRiver Sustainable Commerce Systems (SCS) recognise five stages for its key offerings:



SCS provide a number of strong financial and sales/marketing related benefits:

Understanding of the carbon footprint for an entire organisation or individual products and services

Opportunities to improve operating efficiencies and reduce energy / carbon consumption to realise **immediate cost savings**

Capability for the organisation or their clients **to offset the carbon footprint** via CRiver's offsetting service

Marketing opportunities to use a "Carbon Neutral" positioning to improve client retention and acquisition

Bespoke environmental reporting as a value added service or to comply with their CSR requirements

Potential to generate an income stream for the client company by developing carbon capture projects funded where carbon savings can be verified and additionality assured

Methodology

CarbonRiver™ uses a methodology of analysis called **Hybrid Life Cycle Assessment** (LCA). Accredited and used by LCA practitioners, commercial entities and governments internationally since the late 1990s – and recommended by DEFRA as best practice in 2008.

Hybrid LCA is a 'best of breed' approach combining economic data with detailed process data from your organisation to rapidly and cost-effectively deliver comprehensive direct and indirect emissions analysis - scope 1,2 + 3.

We are Experts in "Scope 3" Emissions

Many firms can only provide carbon data from direct emissions ("Scope 1") and electricity use ("Scope 2"), but this is not the whole picture. In fact, less than 20% of a company's carbon footprint typically comes from these sources.

We help you target the 80% related to your supply chain and products - that means product and service analysis, and because we we can easily see the **whole** picture, we can easily identify your emissions hotspots which will more easily yield **cost, energy & emissions savings – and generate a powerful marketing message** for you.

Introducing CEDA®

Hybrid LCA requires an Economic Input/Output database which ties emissions to economic flows. CEDA® is probably the best such database in the world and is the cornerstone of our system. Developed by our Chief Scientist, Dr. Sangwon Suh (UNEP, WRI/WBCSD). The Comprehensive Environmental Data Archive for Economic and Environmental Systems Analysis ("CEDA® 3.0 Climate"), known as CEDA®, has been used by Government bodies in the USA, UK and EU, and is unique in that it is the only database of its kind that is peer-reviewed by scientists from around the world.

Our scientists and mathematicians continually expand and refine CEDA® by integrating appropriate environmental databases and real-world project data. **No other firm in the UK has access to this valuable data** and the expertise required to develop and maintain the information.

Dr. Sangwon Suh – CarbonRiver's Chief Scientist

Sangwon is the creator of CarbonRiver's core database and is recognised as a top expert on the computational aspects of life cycle assessment.

- UNEP: Panel member, *International Panel for Sustainable Resource Management*, United Nations Environmental Program
- (WRI) and World Business Council for Sustainable Development (WBCSD): Member, *Working Group for Greenhouse Gas Protocol*, World Resources Institute
- Chair-elect, Gordon Research Conference for Industrial Ecology
- Councillor, *International Society for Industrial Ecology*
- *SETAC: Member liaison to ISO's standardization activity on carbon footprinting*.
- Co-editor of Ecoinvent database, World largest public LCA database managed by Ecoinvent foundation in Switzerland.