ENVIRONMENTAL PRODUCT DECLARATION

NORTH AMERICAN HARDBOARD

COMPOSITE PANEL ASSOCIATION

Hardboard/Engineered Wood Siding is a high density wood panel used in residential and commercial construction.

The Composite Panel Association (CPA) represent composite wood products manufacturers across North America. CPA is pleased to present this Environmental Product Declaration (EPD) for North American hardboard and engineered wood siding and trim (EWST).

EPDs enable comparison between products but do not themselves compare products. EPDs can only be used for comparison between different building products and systems if they have been assessed on the basis of the same functional unit and service life using the same Product Category Rule. Information in this EPD is provided using a declared unit and shall not be used for comparison.

The EPD includes life cycle assessment results for all processes up to the point that hardboard/EWST is packaged and ready for shipment at the manufacturing gate.

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ENVIRONMENTAL PRODUCT DECLARATION

Composite Panel Association

North American Hardboard/Engineered Wood Siding and Trim (EWST)
North American Structural and Architectural Wood Products

According to ISO 14025 and ISO 21930

This declaration is an environmental product declaration (EPD) in accordance with ISO 14025. EPDs rely on Life Cycle Assessment (LCA) to provide information on a number of environmental impacts of products over their life cycle. Exclusions: EPDs do not indicate that any environmental or social performance benchmarks are met, and there may be impacts that they do not encompass. LCAs do not typically address the site-specific environmental impacts of raw material extraction, nor are they meant to assess human health toxicity. EPDs can complement but cannot replace tools and certifications that are designed to address these impacts and/or set performance thresholds – e.g. Type 1 certifications, health assessments and declarations, environmental impact assessments, etc. Accuracy of Results: EPDs regularly rely on estimations of impacts, and the level of accuracy in estimation of effect differs for any particular product line and reported impact. Comparability: EPDs are not comparative assertions and are either not comparable or have limited comparability when they cover different life cycle stages, are based on different product category rules or are missing relevant environmental impacts. EPDs from different programs may not be comparable.

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	Composite Panel Association
DECLARATION NUMBER	4787549627.101.1
DECLARED PRODUCT	Hardboard/Engineered Wood Siding and Trim
REFERENCE PCR	North American Structural and Architectural Wood Products, FPInnovations, 2013, v1.1
DATE OF ISSUE	August 31, 2016
PERIOD OF VALIDITY	5 Years
CONTENTS OF THE DECLARATION	Product definition and information about building physics Information about basic material and the material's origin Description of the product's manufacture Indication of product processing Information about the in-use conditions Life cycle assessment results Testing results and verifications

The PCR review was conducted by:	PCR Review Panel Chair: Wayne B. Trusty www.fpinnovations.ca
This declaration was independently verified in accordance with ISO 14025 by Underwriters Laboratories ☐ INTERNAL ☒ EXTERNAL	Wade Stout, UL Environment
This life cycle assessment was independently verified in accordance with ISO 14044 and the reference PCR by:	Thomas Gloria, Industrial Ecology Consultants

Description of Industry and Product

Description of North American Hardboard Industry

The North American forest products industry is a major contributor to both the United States and Canadian economies. Wood manufacturing jobs, including those required to produce hardboards including engineered wood siding and trim (EWST) serve as the primary economic drivers throughout North America. In 2012, hardboard production in North America was 2.2 billion ft^2, 0.125 – inch basis (650 thousand m^3).

North American hardboard/EWST (referred to as hardboard from here) is used in residential and commercial construction. Hardboard is a non-structural panel product developed to utilize industrial wood residue. These woody biomass residues were historically burned for energy or sent to landfill to dispose of them as waste material. Hardboards are composite panels designed and manufactured to perform in applications with the appearance of traditional wood. Over the last several decades, hardboards have evolved into a highly engineered product designed to meet specific end-use requirements.

Manufacturers of hardboards in North American are members of the Composite Panel Association, Leesburg, Virginia. Four hardboard manufacturers contributed production data from the United States and Canada. No hardboard manufacturers were in operation in Mexico (Table 1).

Table 1. North American Hardboard/EWST Manufacturers (2012)

Manufacturer	City	State/Province, Country
Georgia Pacific	Phillips	Wisconsin, United States
Louisiana Pacific	Roaring River	North Carolina, United States
Louisiana Pacific	East River	Nova Scotia, Canada
Stimson Lumber Company	Forest Grove	Oregon, United States

Description of North American Hardboard Industry

Hardboard panels are composite panels designed and manufactured to perform in applications with the appearance of traditional wood. The production of hardboard falls into the North American Industry Classification System (NAICS) Code 321219—reconstituted wood products, which include other wood composite products such as cellulosic fiberboard, medium density fiberboard, particleboard, and oriented strandboard.

Board production is measured on a thousand ft^2, 0.125 in basis (92.9 m^2, 3.2-mm basis). The panels are typically produced in 0.125 up to 0.75 in (3.2–19.5 mm) thicknesses and in widths of 4.0 feet (1.22 m) and lengths of 8.0 (2.44 m). The most common finished dimension of hardboard panels is 0.125-inch (3.2 mm) thick, 4.0 feet (1.22 m) wide, and 8.0 (2.44 m) long. Density for the final products ranges from 800 to 1,100 kg/m^3 (based on “as is” moisture content). Thickness, width, length and density all vary to meet end-use requirements.

This EPD does not make a distinction between hardboard and EWST except for the engineering standards used to produce these products. North American hardboards are classified by the following standards:

- The American Standard Institute - ANSI A135.4 for basic Hardboard defines hardboard, covers requirements and test methods for water absorption, thickness swelling, modulus of rupture, tensile strength, surface finish, dimensions, squareness, moisture content, and edge straightness of five classes of basic hardboard (Tempered, Standard, Service-Tempered, Service, and Industrialite).
- ANSI A135.5 for Prefinished Hardboard Paneling the requirements and methods of testing for dimensions, squareness, edge straightness, and moisture content of prefinished hardboard paneling and for the finish of the paneling.
- ANSI A135.6 for Engineered Wood Siding defines quality and dimensional attributes for siding products. Third party certification is required for many applications.
- ANSI A135.7 for Engineered Wood Trim covers requirements and methods of testing for exterior durability and physical and mechanical properties.

The product profile presented in this EPD is for a declared unit of 1 cubic meter of hardboard. One cubic meter of average North American hardboard weighs approximately 768 kg excluding moisture. The product composition is presented below and represents the weighted average of the wood fiber and additives used in hardboard manufacturing.

–	Wood: oven dry	722	kg	94.01%
–	Phenol-formaldehyde resin	15.3	kg	1.99%
–	Paraffin/wax emulsion	13.6	kg	1.77%
–	Zinc borate	6.9	kg	0.90%
–	Alum	5.1	kg	0.66%
–	Compregnite	4.2	kg	0.55%
–	Release agent	0.5	kg	0.07%
–	Slack wax	0.3	kg	0.04%
–	Linseed oil	0.1	kg	0.01%
	TOTAL	768	kg	100%

This EPD is based on LCA studies that considered the entire range of hardboard product, sizes and function. For reference purposes the results are provided for 1 cubic meter of finished product, which is equal to 35.31 cubic feet.

Cradle-to-Gate Life Cycle of Hardboard Production

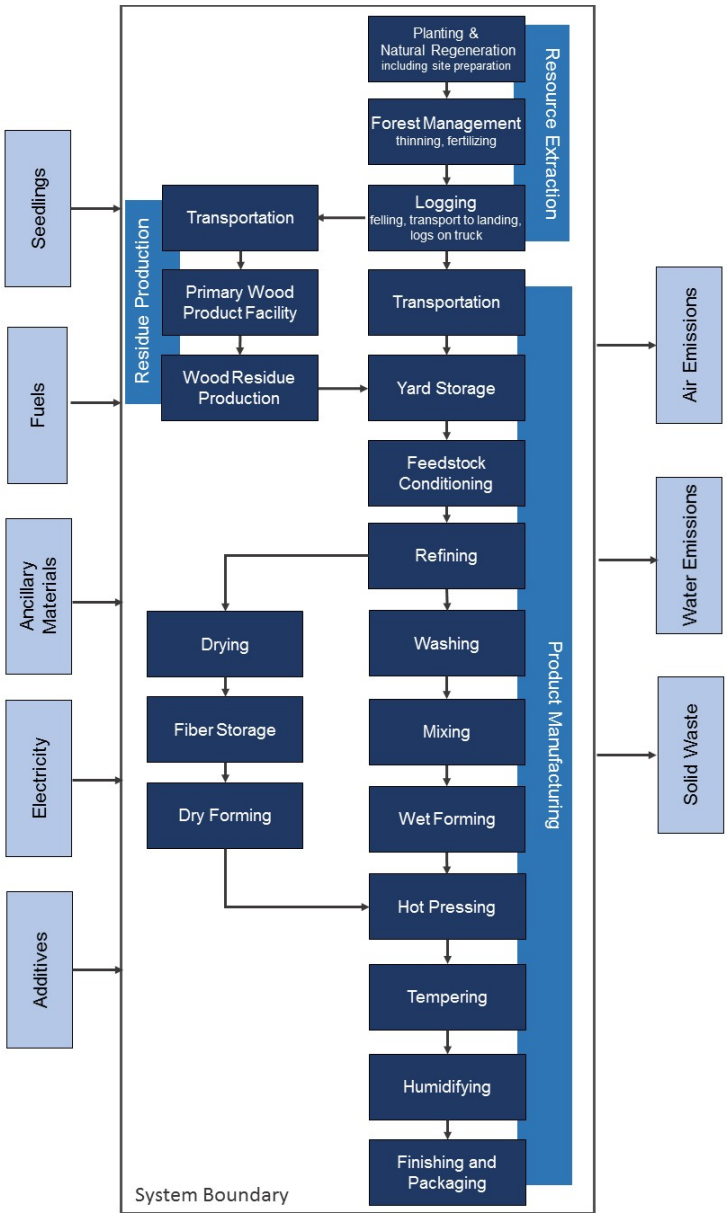


Figure 1 Cradle to gate system boundary for hardboard/EWST

Forest Operations

The PCR requires that the production system include extraction of raw materials including reforestation activities. Therefore, the life cycle assessment of a wood product includes the energy use and emissions from all forestry operations which include plantation establishment, management, and harvesting. In the EPD for hardboard, the cradle-to-gate product system begins with the establishment of a natural or managed forest by natural regeneration or planting of seedlings, respectively. The boundary also encompasses all forest management activities which may include site preparation, thinning, and fertilization.

Hardboard Production

The process begins by the wood material arriving by truck to manufacturing facility. The material is sorted and moisture content determined. From there the materials is processed and conditioned to be a homogenous feedstock. The feedstock is mechanically refined with heat to separate the wood into fibers. Hardboard manufacturing can be made either by dry or wet processes. The wet process has water as the conveying medium. Contrarily, for dry-process hardboard, air is the conveying medium. In addition, both processes require additions of phenol-formaldehyde (PF) resins and a variety of additives (resin system) for bonding. The dry- and wet-processes were merged into a single system based on weighted average plant production to develop the LCA. Hardboard manufacture involves breaking down wood into its basic fibers then placing the wood back together with the fibers repositioned along with a resin system to form hard panels that have their own set of separate and distinct properties. The panels are pressed to cure the wood and resin system and to remove any moisture remaining. Panels are then tempered, finished by surfacing either one of two sides, trimmed to dimension and packaged for shipment.

Packaging of Hardboard

Packaging materials represent around 1.0 percent of the cumulative mass of the model flow. Wrapping material can vary between products and manufacturer. Hardboard sheets are packaged in bundles of 4 boards with a layer of foam between the two inside pieces. The bundles of 4-6 boards are wrapped with a stretch wrap completely sealing the product. For shipping, there can up to 27-36 bundles per pallet or 108-160 boards single pallet (unit). Units can measure on average 46.5 inches in width, 192 inches in length, 20.5 inches in height and the pallets are again wrapped in hardboard sheets for protection from damage during shipment. A total of 23-27 units can be shipped on flat-bed trucks or 20-22 units in closed containers for water transport. For rail transport, up to 72 units can fit in on a single rail car. Pallet production and transportation of packaged hardboard are excluded from this EPD.

Methodology of Underlying LCA

Business-to-business EPD and Cradle-to-Gate LCA

Business-to-business (B-to-B) EPDs include the life cycle of the product up to the point that the product has been manufactured and is ready for shipment. This is commonly referred to as a cradle-to-gate life cycle assessment. The cradle-to-gate processes included in this EPD are outlined in Figure 1. The use phase and end of life scenarios can be omitted in a B-to-B EPD.

This Type III environmental declaration is developed according to ISO 21930 and 14025 for hardboard. This EPD reports environmental impacts based on established life cycle impact assessment methods. The reported environmental impacts are estimates, and their level of accuracy may differ for a particular product line and reported impact. LCAs do not generally address site-specific environmental issues of related to resource extraction or toxic effects of products on human health. Unreported environmental impacts include (but are not limited to) factors attributable to human health, land use change and habitat destruction. Forest certification systems and government regulations address some of these issues. In this EPD, the woody residues used in the production of hardboard coming from Canadian and US forests are harvested under the applicable federal, provincial, and state laws. EPDs do not report product environmental performance against any benchmark.

Declared Unit

In accordance with the PCR, the declared unit for hardboard is one cubic meter (m^3) which is equal to 35.31 cubic feet. The average density of North American hardboard including additives is 768 kg/m^3 oven dry mass. Hardboards produced in North America have between 2-9 percent moisture content at the plant gate when it is ready for shipment. Moisture content of hardboards are quite stable due to the high temperatures used during the manufacturing process.

System Boundaries

The system boundary begins with the planting, growth and harvest of trees in North American and ends with hardboard packaged to leave the mill gate. The forest resources system boundary includes: forest regeneration and stand management, felling the trees, removing limbs, transportation of logs to landing, and cutting to shipping lengths as needed. Excluded from forestry operations are maintenance and repair of equipment, and building and maintenance of logging roads, logging camps, and weigh stations. The transportation of logs from the woods to the mill is accounted for with the hardboard manufacturing. Hardboard production includes feedstock collection, storage (wood residues, whole logs), processing, and packaging. Outputs include 1 m^3 of hardboard ready to be shipped, air and water emissions, solid waste, and co-products.

Cut-Off rules

The cut-off criteria for flows to be considered within the system boundary are as follows:

- Mass – if a flow is less than 1% of the cumulative mass of the model flows, it may be excluded, provided its environmental relevance is minor.
- Energy – if a flow is less than 1% of the cumulative energy of the model flows, it may be excluded, provided its environmental relevance is minor.
- Environmental relevance – if a flow meets the above two criteria, but is determined (via secondary data analysis) to contribute 2% or more to the selected impact categories of the products underlying the EPD, it is included within the system boundary.

Data Quality

Precision and Completeness

Primary data on raw materials, energy, and emissions were provided by hardboard manufacturing facilities based on purchase inputs, production outputs, and reported process emissions. All upstream and downstream secondary data (e.g. forestry operations and fuel production) were drawn from publicly available databases, primarily the United States Life Cycle Inventory (USLCI) database and other public LCI data sources. The LCA practitioners performed quality control on all secondary data sources to ensure completeness.

All inventory flows were modeled and no data were excluded due to application of the EPD cut-off criteria.

Consistency and Reproducibility

To ensure consistency only primary data, as provided by the hardboard manufacturers, were used to model gate-to-gate hardboard manufacturing processes. All other secondary data (upstream and downstream) were consistently applied and adaptations to the databases were documented in the LCA reports.

Reproducibility by third parties is possible using the background LCIs documented in the CORRIM and Athena reports.

Temporal Coverage

Primary data collected from the manufacturing facilities related to the product processes of interest are representative for the year 2012.

Geographic Coverage

The geographical coverage for this EPD is based on North American (NA) system boundaries for all processes and products.

Treatment of Biogenic Carbon

Biogenic carbon dioxide emissions were accounted as global warming neutral in accordance with the PCR. Under this approach, the carbon dioxide emissions from the combustion of internally generated wood fuels are considered equal to the carbon dioxide uptake in the forest during tree growth.

Crediting carbon sequestration against the global warming potential was excluded as the long term carbon storage is dependent on gate-to-grave processes not considered directly in this EPD. The expected carbon sequestration for average end-use and end-of-life treatment is provided in the section on “Additional Information.”

Allocation

According to the PCR (FPInnovations 2015) if one or more co-products are generated during the production process, it is necessary to allocate the inputs and outputs using a standardized approach. The LCA on hardboard follows the allocation rules which states that when the total revenues between the main product and co-products is more than 10%, allocation shall be based on the revenue [economic] allocation. The economic allocation assigned 100 percent of the burden to hardboard. An economic allocation was also applied to upstream wood residue production.

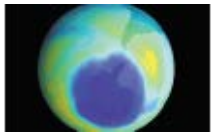
Data Collection and Calculation Methods

Primary data for the LCI were collected through surveys. This study relied almost exclusively on production inputs and emissions data provided by hardboard producers in North America, with some secondary data from the USLCI Database. An economic allocation approach was used which assigned all inputs and outputs for the manufacturing process to hardboard product. Survey data were converted to a unit production basis of 1 cubic meter and a weighted average of input and emissions data were calculated based on production data. Site visits to selected mills were also made for data collection.

Life Cycle Assessment Results

The life cycle impact assessment (LCIA) established links between the life cycle inventory results and the potential environmental impacts. In the LCIA, results are calculated for impact category indicators such as global warming potential and smog potential. These impact category indicator results provide general, but quantifiable, indications of potential environmental impacts. Consistent with the requirements of the PCR, five impact categories are reported in Table 2. The TRACI 2 method was used to characterize the reported environmental impacts.

Table 2: Impact Assessment Categories

Impact Category Indicators	Characterization Model
Global Warming Potential	Calculates global warming potential of all greenhouse gasses that are recognized by the International Panel of Climate Change (IPCC). The characterization model scales substances that include methane and nitrous oxide to the common unit of kg CO_2 equivalents.
Ozone Depletion Potential 	Calculates potential impact of all substances that contribute to stratospheric ozone depletion. The characterization model scales substances that include Chlorofluorocarbons (CFC), Hydrochlorofluorocarbons (HCFC), chlorine, and bromine to the common unit of CFC-11 equivalents.
Acidification Potential	Calculates potential impacts of all substances that contribute to terrestrial acidification. The characterization model scales substances that include sulfur oxides, nitrogen oxides, and ammonia to the common unit of kg SO_2 equivalents.
Smog Potential	Calculates potential impacts of all substances that contribute to photochemical smog. The characterization model scales substances that include nitrogen oxides and volatile organic compounds to the common unit of kg O_3 equivalents.
Eutrophication Potential	Calculates potential impacts of all substances that contribute to eutrophication. The characterization model scales substances that include nitrates and phosphates to the common unit of kg N equivalents.

Cradle-to-Gate Impact Assessment

Modules included in the EPD are (Table 3): A1- Raw material supply, which includes resource extraction and residue production processes, A2 – Transportation of resource to residue production or residues to hardboard, and A3 – hardboard production. The impact assessment results for hardboard are shown in Table 4. This LCIA does not make value judgments about the impact indicators, meaning that no single indicator is given more or less value than any of the others. All are presented as equals. Each impact indicator summarizes a different group of environmental emissions based on their pathway to potential impact using reference units that are common to the group but not comparable between the groups. For this reason the indicators should not be combined or added.

Table 3. Life cycle stages included in the LCA.

Product stage			Construction process Stage		Use stage							End of life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse- Recovery- Recycling- potential
A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**B6**	**B7**	**C1**	**C2**	**C3**	**C4**	**D**
X	X	X	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND	MND

X = modules included in the study
MND = Module not declared

The results presented below indicate the potential impacts caused by the cradle-to-gate production of hardboard. Ozone depletion was below 10^{-5} kg CFC eq. for forestry operations, residue production, and hardboard production and is thus not reported in the results. Water consumption was a total from the LCI as required by the PCR and includes all water withdrawals without netting out non-consumptive use. As a result, the total water consumption is a conservative value which may overstate the use.

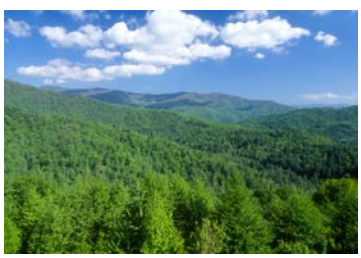


Table 4: Cradle-to-Gate Impact Assessment Results - 1 m^3 North American Hardboard/EWST					
Impact category indicator	**Unit**	**Total**	**Forestry operations**	**Wood residue production**	**Hardboard Production**
Global warming potential	kg CO_2 eq.	658.48	17.43	29.43	611.62
Acidification potential	kg SO2 eq.	6.39	0.24	0.25	5.91
Eutrophication potential	kg N eq.	0.58	0.01	0.01	0.56
Ozone depletion potential	kg CFC-11 eq.	0.000	0.0000	0.0000	0.0000
Smog potential	kg O_3 eq.	90.02	7.60	3.81	78.61
Energy consumption					
Total primary energy consumption	MJ	29,834	258	556	29,020
Non-renewable, fossil	MJ	10,724	255	426	10,043
Non-renewable, nuclear	MJ	2,145	3	85	2,057
Renewable, biomass	MJ	185	0	9	176
Renewable, other	MJ	16,780	0	36	16,744
Material resources consumption					
Non-renewable materials	kg	5.04	0	0.07	4.97
Renewable materials	kg	609.68	0	29.88	579.80
Fresh water	L	10,054	0.00	15	10,039
Non-hazardous waste generated					
Solid waste	kg	126.17	0.31	5.05	120.84

Impact Assessment Results by Life Stage

Figures 2 shows the hardboard manufacturing life cycle stage that consumes 98% of fossil fuels and 100% of biomass energy thus is the primary driver of impacts in the cumulative cradle-to-grave product system (Figure 3).

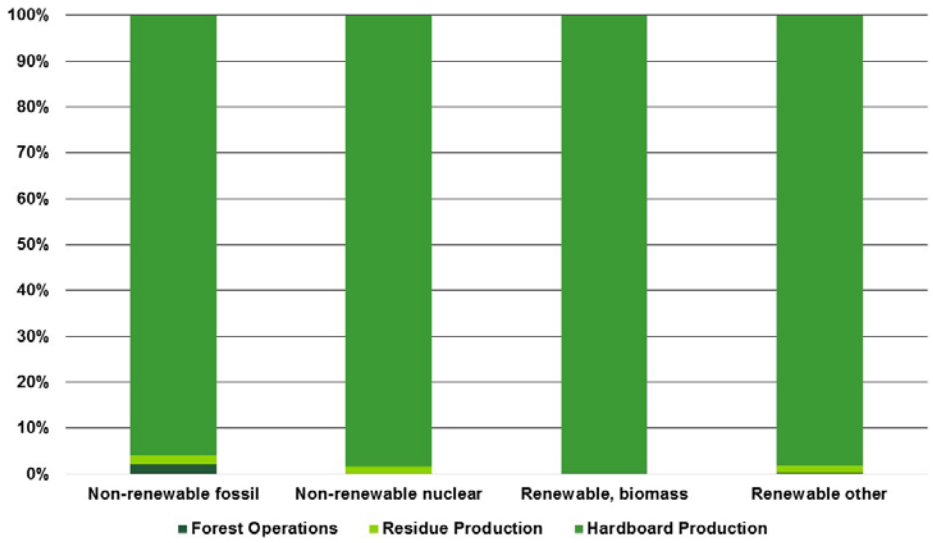


Figure 2: Cradle-to-Gate Primary Energy Consumption

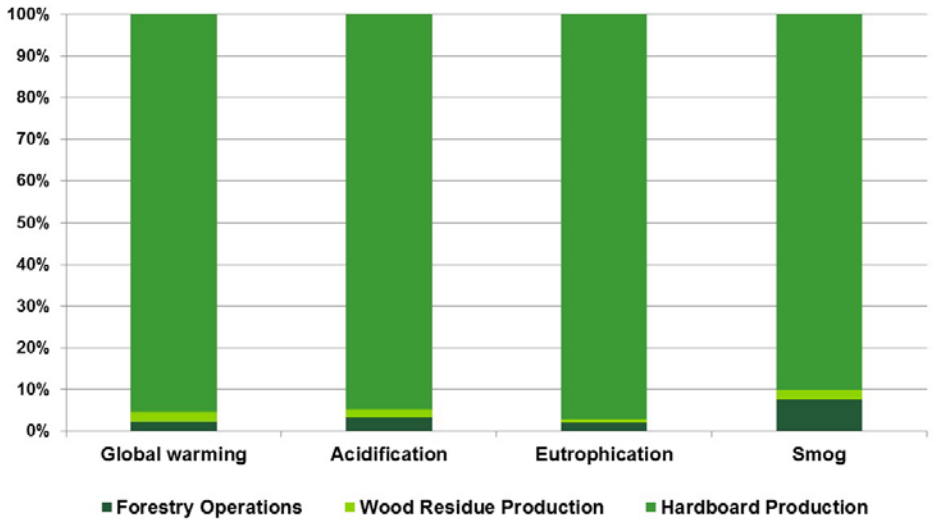


Figure 3: Cradle-to-Gate Impact Assessment Results

Primary Energy Consumption by Resource

Figures 4 through 7 show the primary energy consumption by type for the total cradle-to-gate, forestry operations, residue production, and hardboard production life stages respectively. Wood contributes the most to cradle-to-gate energy consumption at 56% followed by coal at 15% (Figure 4).

The forestry operations portion of the life cycle relies heavily on oil-based energy consumed mainly in the form of diesel used by heavy equipment during planting, management, and harvesting of the resource. Oil accounts for 91 percent of primary energy resources consumed in forestry operations, followed by natural gas and coal making up most of the rest at 4 and 3 percent, respectiviely (Figure 5).

All of the biomass energy is consumed during hardboard production (Figures 2 and 7). Wood residues for hardboard production are purchased green, therefore all energy for removing water from the residues is allocated to hardboard production. While biomass fuel is used during hardboard production, fossil fuels still represent 36 percent of the fuel demand during this life cycle stage (Figure 7). The cradle-to-gate renewable biomass energy use in the life cycle of hardboarded reduces the energy consumption derived from fossil fuel sources by 57 percent which results in a lower overall carbon footprint.

Figure 4 Cradle-to-Gate Energy Use

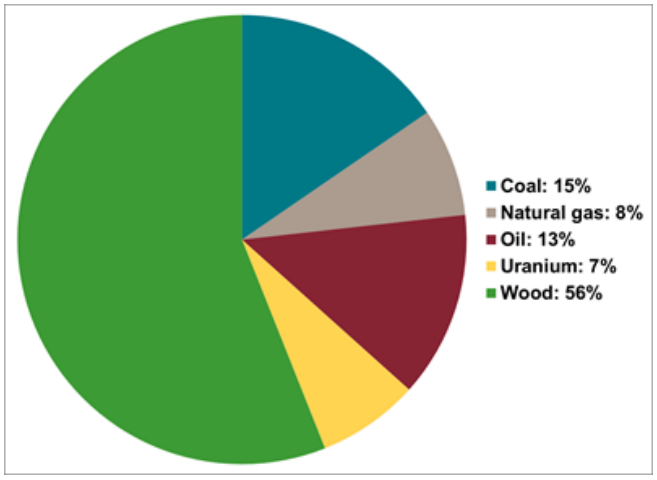


Figure 5 Forestry Operations Energy Use

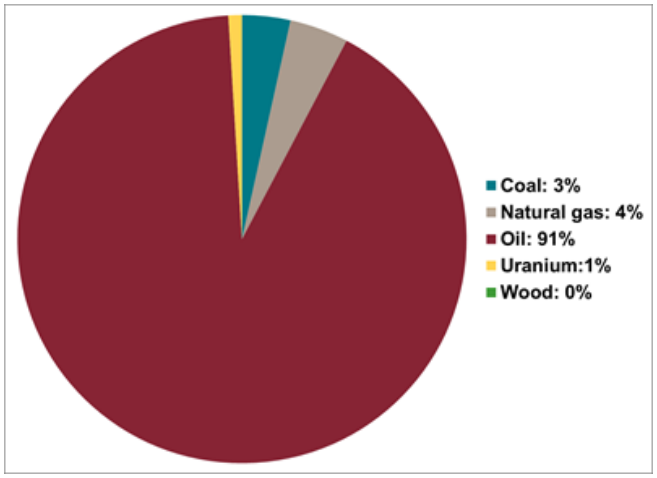


Figure 6 Residue Production Energy Use

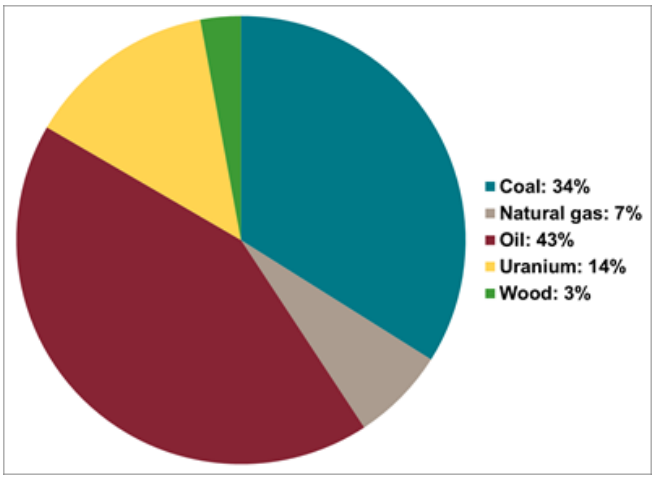
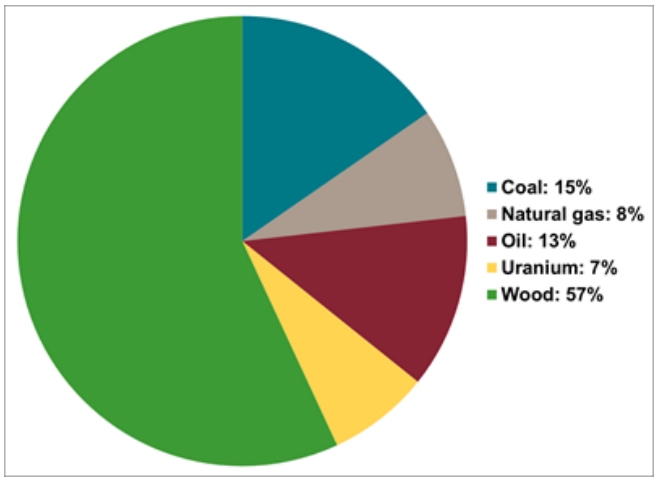


Figure 7 Hardboard Production Energy Use



Additional Information

Range of Applications

A variety of wood sources are appropriate for hardboard. Because only the wood fiber is utilized in the production of hardboards, wood with defects, recovered wood from construction waste, manufacturing waste, small diameter timber, forest residues, as well as exotic and invasive species could all be used. Hardboard has long been used in furniture manufacturing but has many uses in the construction industry. Hardboards many uses include residential and commercial construction (exterior siding and trim), flooring, wall paneling, moulded door skins, furniture components, home appliances, automobile, and perforated boards.

The carbon sequestration calculation is based on the expected service life for hardboard. To complete this calculation, the various end used for hardboard were estimated based on the classification for “non-structural panels” as provided in the FPInnovations B-to-B carbon sequestration tool.

Carbon Sequestration

This PCR requires that carbon sequestration may only be credited to the product if the end-of-life fate of that carbon is considered in the LCA study. FPInnovations (FPI) has recently published a carbon sequestration calculation tool that estimates the emissions from typical end-of-life treatment of wood products that includes recycling, combustion, and landfilling. The carbon sequestration in the product at the manufacturing gate serves as the basis for such an analysis and is as follows (all conversion factors and assumptions are documented in the carbon tool):

1 m^3 Hardboard = 722 oven dry kg = 361 kg Carbon = 1324 kg CO_2 eq.

This initial carbon sequestration may then be considered against its emission as the hardboard product reaches the end of its service life in various applications. The FPI carbon tool is used to estimate the biogenic carbon balance at year 100, including service life estimations for various applications and the average landfill decay rate. The carbon tool gives the following results for nonstructural panels:

Carbon sequestered in product at manufacturing gate:
1324 kg CO_2 eq. = - 1324 CO_2 eq emission

Methane emitted from fugitive landfill gas:
6.16 kg CH_4 = 154 kg CO_2 eq emission

Carbon dioxide emitted from fugitive landfill gas and the combustion of waste and captured landfill gas:
437.34 kg CO_2 eq emission

Carbon sequestration at year 100, net of biogenic carbon emissions:
732.32 kg CO_2 eq emission = - 732.32 kg CO_2 eq emission

References

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