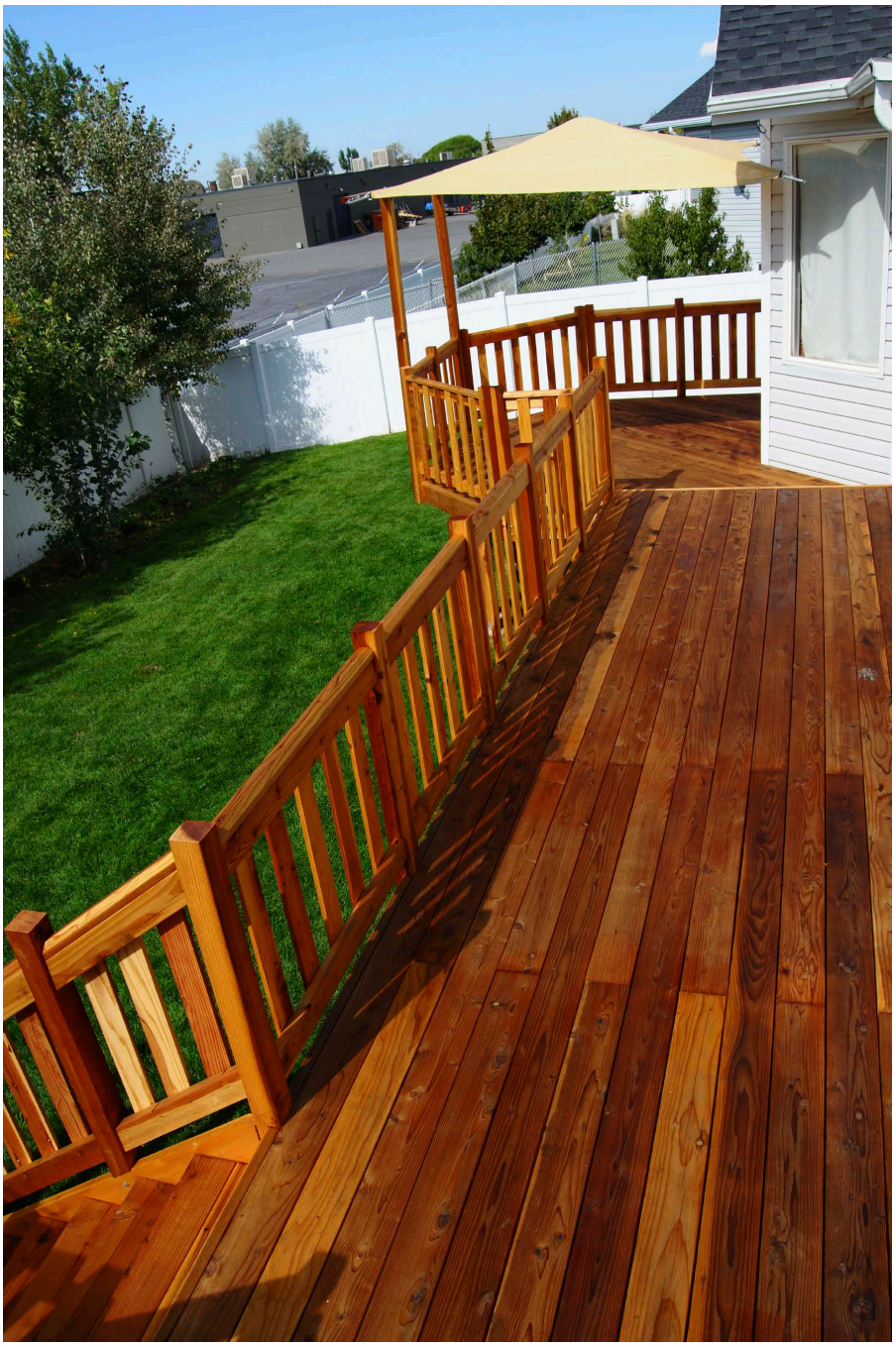
Environmental Product Declaration

Redwood Decking

AMERICAN WOOD COUNCIL
CALIFORNIA REDWOOD ASSOCIATION



The American Wood Council (AWC) and California Redwood Association are pleased to present this Environmental Product Declaration (EPD) for redwood decking. This EPD was developed in compliance with ISO 14025 and ISO 21930, and has been verified under UL Environment's EPD program.

The EPD includes Life Cycle Assessment (LCA) results for all processes in the redwood decking life cycle. This cradle-to-grave product system includes forest management, logging, transportation of logs to lumber mills, sawing, kiln-drying, planing, installation, use/maintenance, and landfilling.

The AWC represents wood product manufacturers across North America. The California Redwood Association represents redwood decking manufacturers across California and southern Oregon. Our organizations have undertaken numerous sustainability initiatives on behalf of our membership, and we are pleased to present this document to show how we are doing. The publication of this EPD, which is based on rigorous LCA research, is our effort to back up with science what we know to be true – wood products stand alone as a green building material.

Please follow our sustainability initiatives at: **www.awc.org** and **www.calredwood.org.**

UL CERTIFIED
ENVIRONMENTAL PRODUCT DECLARATION

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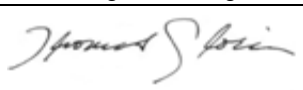
This declaration is an environmental product declaration in accordance with ISO 14025. This EPD does not guarantee that any performance benchmarks, including environmental performance benchmarks, are met. EPDs are intended to compliment Type I environmental performance labels. EPDs provide LCA-based information and additional information on the environmental aspects of products and assist purchasers and users to make informed comparisons between products. EPDs are not comparative assertions. EPDs encourage improvement of environmental performance and provide information for assessing the environmental impacts of products over their life cycle. EPDs not based on an LCA covering all life cycle stages, or based on a different PCR, are examples of declarations that have limited comparability. EPDs from different programs may not be comparable.

UL CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION

PROGRAM OPERATOR	UL Environment
DECLARATION HOLDER	American Wood Council and California Redwood Association
DECLARATION NUMBER	13CA24184.107.1
DECLARED PRODUCT	Redwood Decking
REFERENCE PCR	FP Innovations: 2011. Product Category Rules (PCR) for preparing an Environmental Product Declaration for North American Structural and Architectural Wood Products, Version 1 (UN CPC 31, NAICS 321), November 8, 2011.

DATE OF ISSUE	17 September 2013
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:	FP Innovations PCR confirmed by PCR Review Panel 570 Saint-Jean Blvd. Pointe-Claire, QC Canada H9R 3J9 T 514 630-4100 info@fpinnovations.ca
This declaration was independently verified by Underwriters Laboratories in accordance with ISO 14025 ☐ INTERNAL ☒ EXTERNAL	 Loretta Tam, EPD Program Manager
This life cycle assessment was independently verified by in accordance with ISO 14044 and the reference PCR	 Thomas P. Gloria, Ph. D., Industrial Ecology Consultants

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Description of Industry and Product

Description of Redwood Decking Industry

California redwood (Sequoia sempervirens) decking is produced by members of the California Redwood Association (CRA) whose timberlands are 100% certified as well-managed by the Forest Stewardship Council (FSC). The redwood region consists of 2.2 million acres along California's north coast, stretching from just north of the Oregon border to Santa Cruz County in the south. Within this region are approximately 450,000 acres of federal, state, and municipal parks, as well as other preserves where redwoods, including all remaining stands of old growth, are protected in perpetuity. Valued for its beauty, natural durability, strength and stability, redwood is used extensively for decking, fencing, pergolas, outdoor furniture and other uses where its ability to resist exposure to the elements is renowned. CRA member companies produce redwood decking exclusively in Northern California. Sustainably managed redwood is available for distribution throughout the U.S.

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Description of Redwood Decking Product

The product profile presented in this EPD is for a functional unit of 1 cubic meter of installed redwood decking over a service life of 25 years. One cubic meter of decking is equivalent to 26.2 m^2 of installed product.

Redwood decking is manufactured in a similar fashion to other lumber products. Logs are first milled into 2x6 inch decking boards that are then dried (primarily air-dried) and planed to a finished dimension of 38x140mm. The dried and planed decking boards are then fastened to joists with 62.5 mm galvanized screws (no. 8 or 10). Redwood decking does not require any stains or preservatives and is typically allowed to develop a natural weathered appearance. The deck is assumed to remain in service for 25 years before it is disposed of in a landfill.

One cubic meter of installed redwood decking weighs 382.6 kg, excluding the variable moisture content. The product composition for the mass of the wood component and the steel fasteners is as follows:

- Wood: 380.0 oven dry kg (99.3%)
- Fasteners: 2.6 kg (0.7%)

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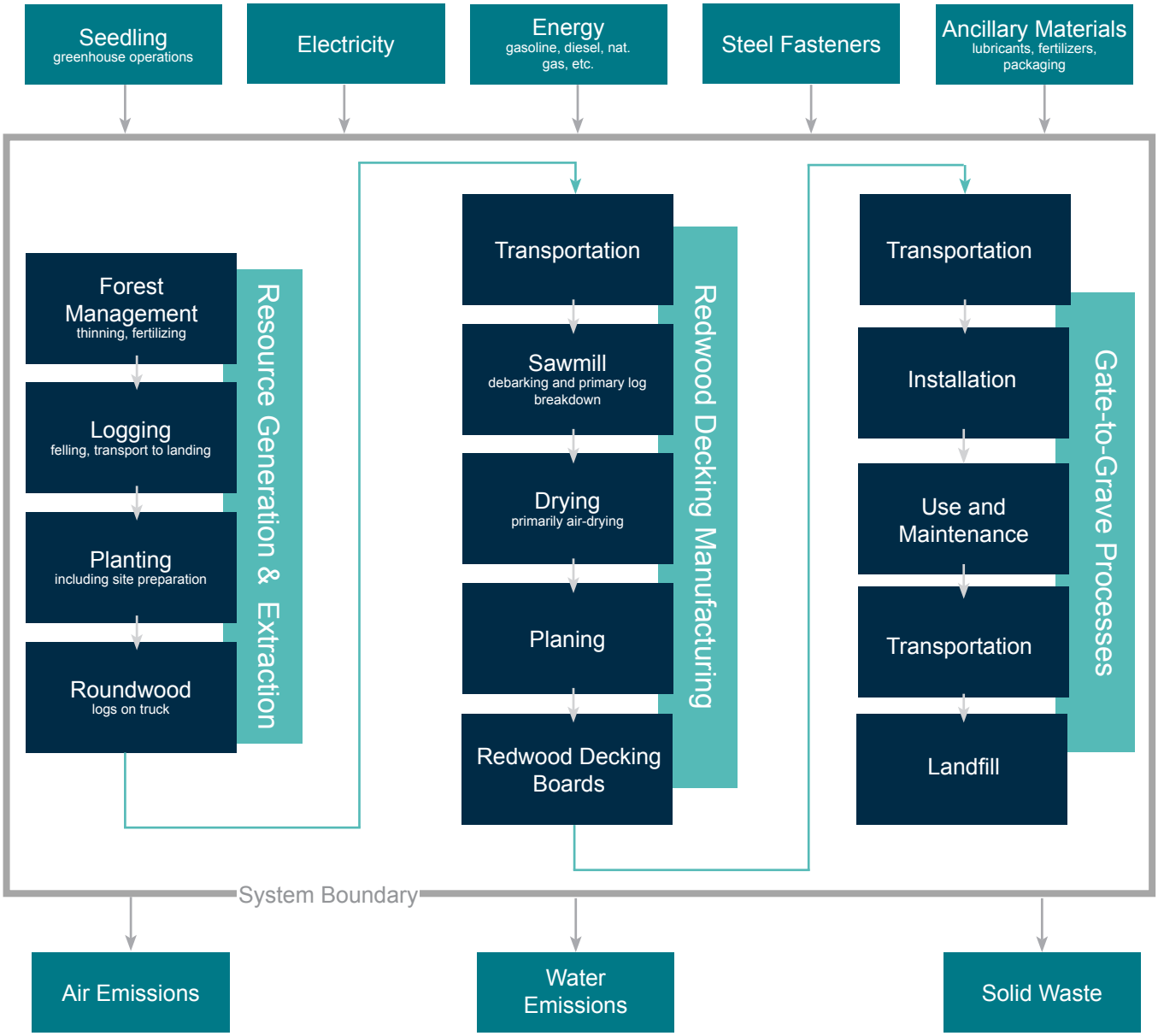
Cradle-to-Grave Life Cycle of Redwood Decking

Figure 1: Cradle-to-Grave Product System for Redwood Decking



Business-to-Consumer EPD and Cradle-to-Grave LCA

Business-to-consumer EPDs are those that focus on the entire life cycle of a product, which is typically referred to as cradle-to-grave, that includes manufacture, use, and end-of life treatment. This EPD includes the cradle-to-grave processes as shown in Figure 1 on the previous page.

Because the delivery of the product to the consumer, its use, and eventual end-of-life processing are included in the life cycle, the carbon sequestered in the product may be included in the carbon footprint. The carbon sequestration may be included because the eventual fate of the biogenic carbon is tracked as it is emitted from the landfill process.

Forest Operations

The assessment of the life cycle impacts of a wood product begins with its origin in natural or managed forests and the energy use and emissions caused by its extraction. Forest management and the reforestation that occurs after extraction are also included. The PCR requires that the product system include all forest management activities that may include site preparation, thinning, and fertilization. The forest operations portion of the resource extraction/generation phase also includes the production and planting of seedlings that occur after logging.

Redwood Decking Production

The redwood decking production phase begins with the transportation of logs to sawmills, where they are sawed, dried (primarily air-dried, with a small percentage also kiln-dried), and then planed into finished 2x6 inch decking boards (38 x 140mm actual dimensions).

Gate-to-Grave Processes

The dried and planed decking is then transported to consumers who are primarily located within the western U.S. market. These consumers install the decking boards onto wood joists with galvanized deck screws. The decking remains in service for 25 years and undergoes periodic cleaning. At the end of the service life, the decking is removed and transported to a landfill for disposal.

Energy and material resources are consumed and emissions are produced throughout the cradle-to-grave product system. This business-to-consumer EPD captures the impacts of all of these flows.

Methodology of Underlying LCA

Functional Unit

The functional unit in this EPD is 1 cubic meter (m^3) of installed redwood decking over a service life of 25 years. This is equivalent to 423.6 board feet (0.4236 mbfm) or 26.2 m^2 coverage. The average density of North American redwood decking is 380.0 oven dry kg/m^3.

System Boundaries

The product system considered in this EPD is depicted in Figure 1. The system boundary begins with the forest management and resource extraction and ends with the end-of-life landfilling of all materials. The forest resources system boundary includes cultivating and planting the seedlings, site preparation, thinning, fertilization, and final harvest. Redwood decking manufacturing includes the transportation of logs to sawmills, sawing, drying (primarily air-drying), and planing. The gate-to-grave portion of the life cycle includes transportation of redwood decking to consumers, on-site installation using galvanized screws, use and maintenance over 25 years, and its eventual disposal in landfills. The system boundaries also include the substitution impacts of captured landfill gas that is utilized as a heat fuel.

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 system model, it may be excluded, provided its environmental relevance is minor.
- Environmental relevance – if a flow meets the above two criteria, but is determined by secondary data analysis to contribute 2% or more to the selected impact categories of the products underlying the EPD (based on a sensitivity analysis), it is included within the system boundary.

The steel fasteners were excluded from the system boundary because they represent less than 1% of the total functional unit mass. Sensitivity analysis reveals the fasteners contribute less than 2% in every impact category.

Data Quality

Precision and Completeness

Primary data on raw materials, energy, and emissions were provided by logging operations and redwood decking manufacturing facilities, based on input purchases, production output, and reported process emissions. All upstream and downstream secondary data was drawn from publicly available databases, primarily the United States Life Cycle Inventory (USLCI) database. The LCA practitioners performed quality control on all secondary data sources to ensure completeness.

Consistency and Reproducibility

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

Reproducibility by third parties is possible using the background LCIs documented in the CORRIM LCA report.

Temporal Coverage

Primary data collected from the manufacturing facilities related to the product processes of interest are representative for the years 2010-2011.

Geographical Coverage

Redwood decking production is exclusive to California. The electricity grid that powers the manufacturing processes is specific to the western United States. The product is purchased, used, and disposed of within the region and thus the geographical coverage of this EPD is the western United States.

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.

Carbon sequestration was calculated based on a detailed mass-balance of the biogenic redwood manufacturing and end-of-life processes. The partial decomposition of wood in the landfill was modeled based on average landfill emissions statistics. The carbon sequestration calculation is described in detail in the CORRIM LCA report.

Allocation

Allocation followed the requirements of the PCR by only attributing impacts to the primary product. The PCR describes allocation as follows:

- Allocation of multi-output processes shall be based on mass. However, if economic value difference is at least ten times greater between products from a multi-output process, a suitable revenue-based allocation principle shall be applied and these deviations shall be substantiated and readily available for review.

The redwood decking co-products are valueless relative to the primary product, and thus no allocation is required.

System Expansion

The redwood decking life cycle ends with the disposal of the material in a landfill. The same decomposition equations that were used to calculate long-term carbon sequestration were also used to estimate the generation of landfill gas and the portion of this gas that is captured. Typical landfills flare a portion of the landfill gas while the majority is combusted with energy recovery.

The amount of heat generated in the energy recovery process was considered as an additional functional output of the product system. In the CORRIM LCA, the equivalent higher heating value of natural gas was assumed to be displaced as a direct result of the redwood decking life cycle. This displacement was modeled by crediting the redwood decking product system with the fossil energy resource use and emissions that would have otherwise been caused by combusting the equivalent amount of natural gas. This credit is shown in the cradle-to-grave results under the “Landfill” life stage.

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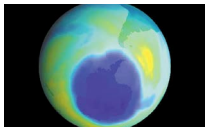
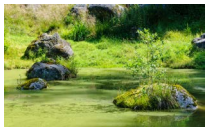
Life Cycle Assessment Results

The life cycle impact assessment (LCIA) establishes links between the life cycle inventory results and 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. The various impact category indicators and means of characterizing the impacts are summarized in the table below. Environmental impacts are determined using the TRACI 2.1 method. These five impact categories are reported consistently as required by the PCR.

Table 1: Impact Assessment Categories

Impact Category Indicators	Characterization Model
Global Warming Potential 	Calculates global warming potential of all greenhouse gasses that are recognized by the 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 CFCs, HCFCs, chlorine, and bromine to the common unit of kg CFC-11 equivalents.
Acidification Potential 	Calculates potential impacts of all substances that contribute to terrestrial acidification potential. 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 potential. 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 potential. The characterization model scales substances that include nitrates and phosphates to the common unit of kg N equivalents.

Life Cycle Impact Assessment Results

The cradle-to-grave impact assessment results are shown in Table 2. 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. Additionally, each impact indicator value is stated in units that are not comparable to others.

The results presented in Table 2 indicate the potential impacts caused by the cradle-to-grave life cycle of redwood decking. Water consumption includes all water withdrawals without netting out non-consumptive use. As a result, the water consumption value overstates actual consumption and is thus conservative.

The cradle-to-gate portion of the life cycle includes an initial credit equal to the carbon dioxide equivalent of the carbon that is sequestered in the product at the manufacturing gate. This initial credit causes the net life cycle global warming potential of redwood decking to be significantly negative, -460 kg CO_2 eq.

Table 2: Cradle-to-Grave Impact Assessment Results - 1m^3 Redwood Decking

Impact category indicator	**Unit**	**Total**	**Cradle-to-gate**	**Delivery to customer**	**Use phase**	**Landfill**
Global warming potential	kg CO_2 eq.	-460	-648	41	0.08	147
Acidification potential	kg SO_2 eq.	0.59	0.92	0.21	0.00	-0.54
Eutrophication potential	kg N eq.	6.09e-02	4.83e-02	1.38e-02	5.58e-04	-1.73e-03
Ozone depletion potential	kg CFC-11 eq.	3.83e-06	3.82e-06	1.57e-09	5.63e-09	1.02e-09
Smog potential	kg O_3 eq.	26.8	19.3	6.8	0.0	0.7
Total primary energy consumption	**Unit**	**Total**	**Cradle-to-gate**	**Delivery to customer**	**Use phase**	**Landfill**
Non-renewable, fossil	MJ	780	1424	559	2	-1195
Non-renewable, nuclear	MJ	109	107	5	0	-3
Renewable, biomass	MJ	265	265	0	0	0
Renewable, other	MJ	98	96	0	0	0
Material resources consumption	**Unit**	**Total**	**Cradle-to-gate**	**Delivery to customer**	**Use phase**	**Landfill**
Non-renewable materials	kg	2	2	0	0	0
Renewable materials	kg	383	383	0	0	0
Fresh water	L	646	395	0	251	0
Non-hazardous waste generated	**Unit**	**Total**	**Cradle-to-gate**	**Delivery to customer**	**Use phase**	**Landfill**
Solid waste	kg	0.629	0.629	0.000	0.000	0.000

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Cradle-to-Grave Results

The forest carbon uptake drives the cradle-to-grave global warming potential results. The energy substitution caused by landfill gas utilization is also shown to significantly reduce cradle-to-grave acidification and fossil energy use. The cradle-to-gate portion of the life cycle drives impacts in all impact and energy consumption categories.

Figure 2: Cradle-to-Grave Impact Assessment Results

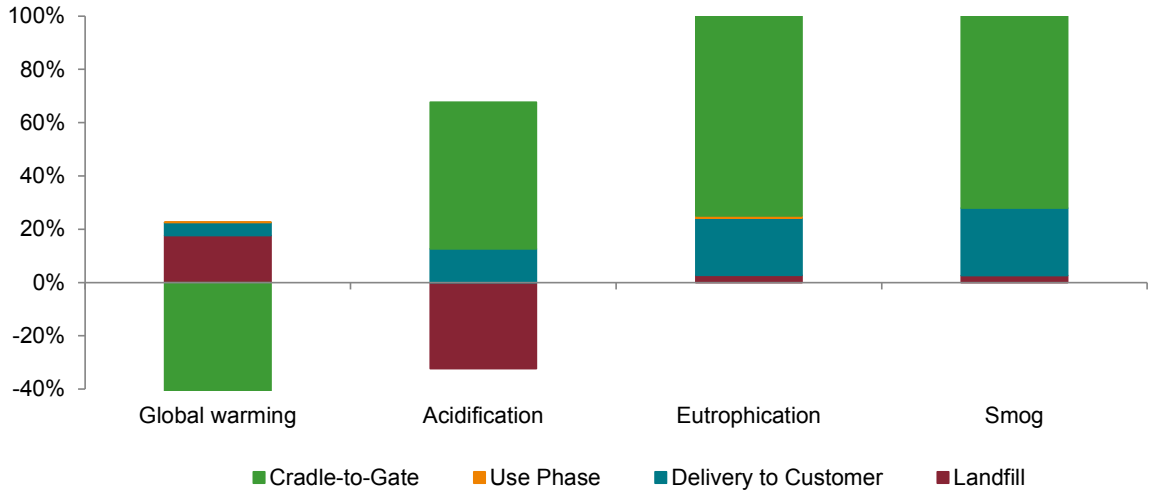


Figure 3: Cradle-to-Grave Primary Energy Consumption

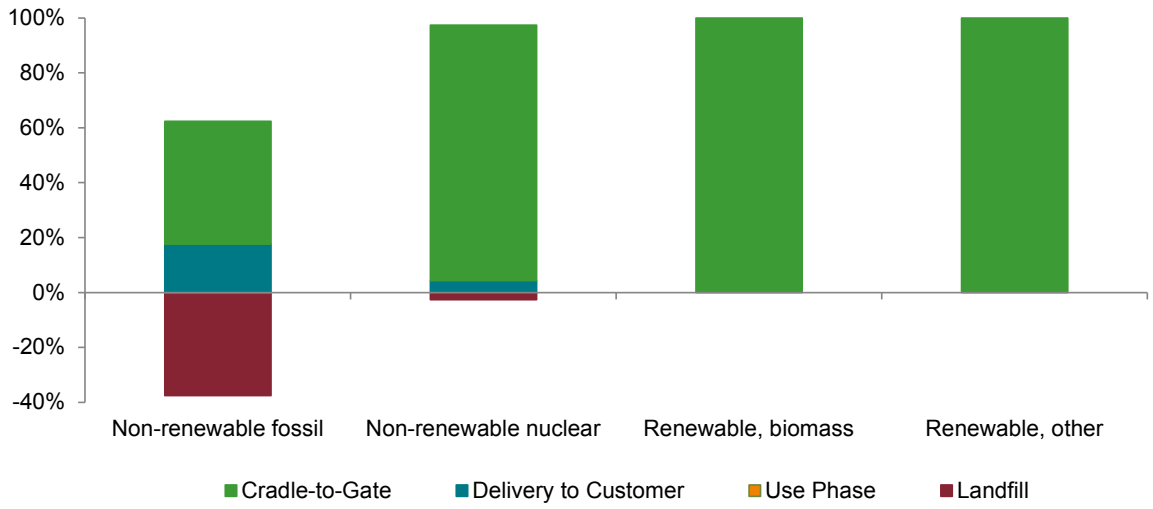


Figure 4: Cradle-to-Grave Energy Use

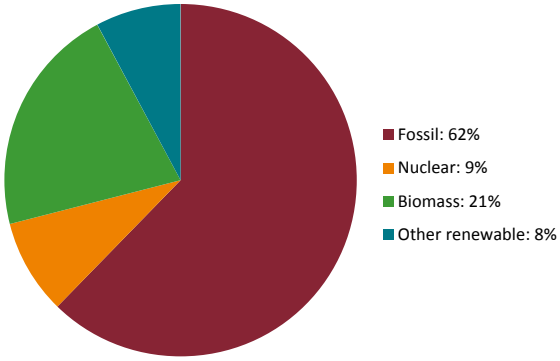


Figure 5: Cradle-to-Gate Energy Use

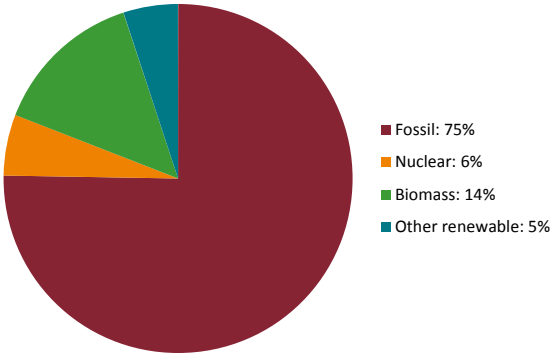


Figure 6: Forestry Operations Energy Use

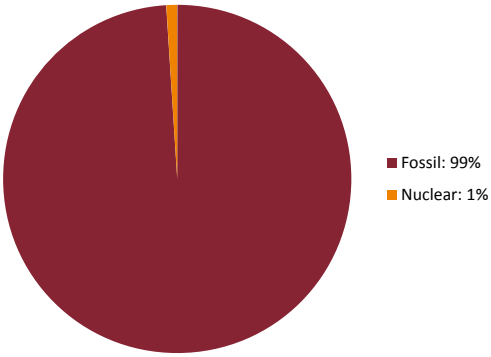
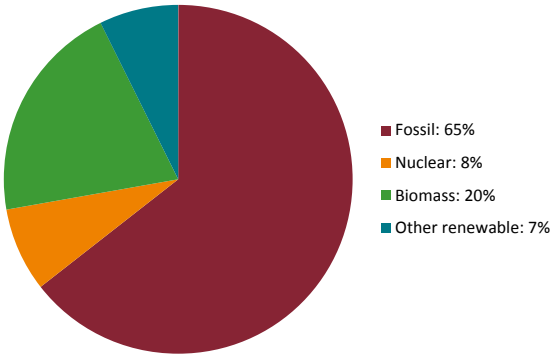


Figure 7: Decking Production Energy Use



Primary Energy Consumption by Resource

The four pie charts show the consumption of various energy resources in the cradle-to-grave life cycle. Figure 4 shows that fossil energy drives energy consumption in the cradle-to-grave life cycle. Figure 5 shows that fossil energy also drives energy consumption in the cradle-to-gate portion of the life cycle. Figures 6 and 7 similarly show consumption of energy in forestry operations and decking production, both of which are primarily fueled by fossil energy. Renewable energy, including biomass and hydropower, accounts for 27% of the energy use in decking production, 19% of cradle-to-gate energy use, and 29% of cradle-to-grave energy use.

It should be noted that fossil energy would have accounted for an even greater share of energy resource consumption had the landfill gas recovery not caused the natural gas substitution noted previously.

References

CORRIM:2013. Life-Cycle Assessment of Redwood Decking in the United States with a Comparison to Three Other Decking Materials.

FPInnovations: 2011. Product Category Rules (PCR) for preparing an Environmental Product Declaration (EPD) for North American Structural and Architectural Wood Products, Version 1 (UN CPC 31, NAICS 321), November 8, 2011. http://www.forintek.ca/public/pdf/Public_Information/EPD%20Program/PCR%20November%208%20 2011%20Final.pdf

ISO 14040:2006. Environmental Management – Life Cycle Assessment – Principles and Framework.

ISO 14044:2006. Environmental Management – Life Cycle Assessment – Requirements and guidelines.

ISO 21930:2007 – Building and Construction Assets – Sustainability in building construction – Environmental declaration of building products.

TRACI: Tool for the Reduction and Assessment of Chemical and other environmental Impacts: http://www.epa.gov/ORD/NRMRL/std/sab/traci/

USLCI Database: http://www.nrel.gov/lci