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Life Cycle Assessment of a Concrete Masonry House Compared to a Wood Frame House

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KEYWORDS

Block, cement, concrete, concrete masonry unit, CMU, emissions, embodied energy, energy, housing, LCA, LCI, life cycle assessment, life cycle, life cycle characterization, life cycle impact assessment, life cycle inventory, masonry, modeling, residential, wood

ABSTRACT

This report presents the results of an environmental life cycle assessment (LCA) on a house modeled with two types of exterior walls: a wood-framed wall and a concrete masonry unit (CMU) wall. The LCA was carried out according to the guidelines of the ISO 14040 series. The house was also modeled in five cities, representing a range of U.S. climates: Lake Charles, Tucson, St. Louis, Denver, and Minneapolis.

The house is a two-story single-family building with a contemporary design. The house system boundary includes the inputs and outputs of energy and material from construction, occupancy and maintenance. The life of the house is 100 years.

The LCA was conducted by first assembling the relevant LCI data from published reports and commercially available databases. The LCA software tool, SimaPro, was then used to perform a life cycle impact assessment. Impact assessment is not completely scientific; so three different methods were used: Eco-Indicator 99, EDIP/UMIP 96, and EPS 2000. Further, three versions of the Eco-Indicator 99 method were used—each one reflects a different cultural perspective: hierarchic, egalitarian, and individualist.

The data show similar results for the two houses. In most cases the CMU house has lower (better) impact indicators in the colder climates (St. Louis, Denver, and Minneapolis). In the warmer climates, Lake Charles and Tucson, the impact indicators are generally greater (worse) for the CMU house because household energy use is also greater. The exceptions are (i) in the categories “land use” and “minerals” in the Eco-Indicator methods and the categories “severe morbidity,” “species extinction,” and “severe nuisance” in the EPS 2000 method, where indicators for the CMU house are greater, and (ii) “radiation” and “ozone layer” in the Eco-Indicator methods and the categories “ozone depletion” and “ecotoxicity” in the EDIP/UMIP 96 method, where indicators for the wood house are greater.

The most significant environmental impacts are not from construction products but from the production and household-use of electricity and natural gas. Furthermore, the largest impacts are in the form of depletion of fossil fuel reserves (categorized as damage to natural resources) and release to the air of respiratory inorganics (categorized as damage to human health). Among the construction products used in the house, wood products and copper tubing have the largest environmental load, followed by cement-based materials.

REFERENCE

Marceau, Medgar L. and VanGeem, Martha G., “Life Cycle Assessment of a Concrete Masonry House Compared to a Wood Frame House,” R&D Serial No. 2572, Portland Cement Association, Skokie, Illinois, USA, March 2002, 166 pages.

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LIFE CYCLE ASSESSMENT OF A CONCRETE MASONRY HOUSE COMPARED TO A WOOD FRAME HOUSE

by Medgar L. Marceau and Martha G. VanGeem*

INTRODUCTION

The Portland Cement Association (PCA) has developed environmental life cycle inventory data to evaluate the environmental aspects of various concrete products. The objective has been to promote the environmental benefits of building with concrete. The life cycle inventory of three concrete houses has been published by PCA and others.[1, 2, 3, 4] Each house has the same layout but they are modeled with different concrete exterior wall systems: insulating concrete forms, concrete masonry units, and lightweight concrete masonry units. These reports constituted the first phase of a life cycle assessment (LCA). Each report presented a comparison between a concrete house and a similar wood-framed house. The reports described the life cycle inventory of the cement-based materials (concrete, concrete masonry units, mortar, grout, and stucco) and the household occupant energy-use that make up the life cycle of a house. This report is one of three reports that present the results of an assessment of the environmental attributes of concrete construction compared to wood-framed construction.

Life Cycle Assessment

Performing an LCA is one way to assess the impacts a product has on the natural environment. The International Organization for Standardization (ISO) has developed international standards that describe how to conduct an LCA (ISO 14040 series). An LCA is a study of the environmental aspects and potential impacts throughout a product's life—from raw material acquisition through production, use and disposal.[5] The ISO standards describe three phases of an LCA. The first phase is an inventory of the inputs and outputs of a product system. The second phase is the assessment of the potential environmental impacts associated with those inputs and outputs. The third phase is the interpretation of the result of the inventory analysis and impact assessment phases in relation to the objectives of the study.[5] These three phases are commonly referred to as (i) life cycle inventory analysis, (ii) life cycle impact assessment, and (iii) life cycle interpretation. In this report, "LCA" will refer to all three phases. The LCA in this report adheres to the requirements in the ISO 14040 series. However, there are some technical limitations to LCAs: according to ISO 14041,

> *The models used for inventory analysis and to assess environmental impacts are limited by their assumptions, and may not be available for all potential impacts or*

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applications. Results of LCA studies focused on global or regional issues may not be appropriate for local applications, i.e. local conditions might not be adequately represented by regional or global conditions. The accuracy of LCA studies may be limited by accessibility or availability of relevant data, or by data quality, e.g. gaps, types of data, aggregation, average, site-specific. The lack of spatial and temporal dimensions in the inventory data used for impact assessment introduces uncertainly in impact results. This uncertainty varies with the spatial and temporal characteristics of each impact category.[5]

GOAL

The purpose of this project was to determine whether single-family concrete houses have an overall environmental advantage over houses constructed with other materials. To achieve this goal we used life cycle inventory data to conduct a life cycle assessment of two kinds of house: one with a concrete masonry unit (CMU) wall, the other with a wood frame wall. Information on the target audience for this report and other project reports is presented in Appendix A.

SCOPE

The functional unit in an LCA is defined in ISO 14040 as the quantified performance of a product system.[6] In this case, the functional unit is one house. The system boundary is the interface between a product system and the environment.[6] The system boundary of this study is shown in Figure 1. It includes the inputs and outputs of energy and material from construction, occupancy, and maintenance. The system boundary excludes human resources, infrastructure, accidental spills, impacts caused by people, and decomposition of household components after disposal.

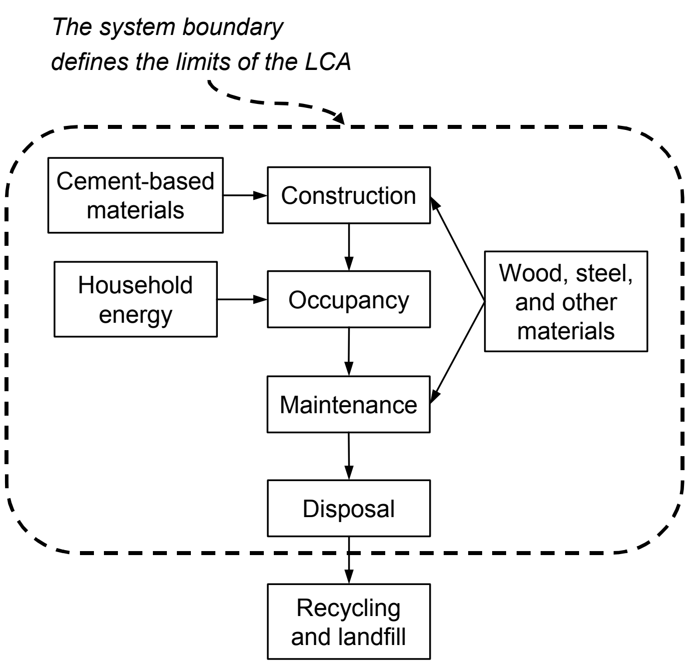

Figure 1. System boundary for house life cycle assessment.

The same layout is assumed for both the wood frame and the CMU houses. The houses are designed to meet the requirements of the 1998 International Energy Conservation Code (IECC)[7] because it is the most widely used energy code in the United States. The long-term energy consumption of a building depends on local climate, so the houses are modeled in a variety of regions. Five cities were chosen that represent the range of climates in the United States: Lake Charles, Tucson, St. Louis, Denver, and Minneapolis.[8] House energy consumption is modeled using Visual DOE 2.6 energy simulation software.[9]

The data and data quality requirements are limited by the available data. In general, recent data from North America, representing average technology, is preferred, however, this is not always available. In general, the LCI data include second order system boundaries, that is, primary flows plus energy and material flows including operations.

HOUSE DESCRIPTION

The houses described in this report were designed by Construction Technology Laboratories, Inc. (CTL) and are based on the designs of typical houses currently built in the United States. Each house is a two-story single-family building with four bedrooms, 2.7-m (9-ft) ceilings, a two-story foyer and family room, and an attached two-car garage. Each house has 228 square meters (2,450 square feet) of living space, which is somewhat larger than the 1998 U.S. average of 203 square meters (2,190 square feet).[10] The size of the houses is based on the average size of insulating concrete form (ICF) houses constructed in the United States.[11] Figures B1 through B8 in Appendix B present the floor plans and elevations.

The houses were modeled in five cities, representing a range of U.S. climates. Tucson was selected because it is a hot dry climate with large daily temperature swings where thermal mass is most effective in increasing thermal comfort and in reducing energy use. Lake Charles, Louisiana, was selected because it is a hot humid climate with small temperature swings where thermal mass works almost as well. St. Louis was selected because it is a moderate climate. Minneapolis was selected because it is a cold climate. Denver was selected because it is a cold climate with large daily temperature swings.

The building envelope in each location was designed to meet the minimum requirements of the 1998 IECC using standard building materials.[7] The IECC minimum requirements for thermal resistance are presented in Table 1 for each of the five cities where the houses are modeled. R-value refers to thermal resistance in $m^2·K/W$ ($hr·ft^2·°F/Btu$) and U-factor refers to thermal transmittance, that is, heat flow per unit area per degree, in $W/m^2·K$ ($Btu/hr·ft^2·°F$). The maximum U-factor is equivalent to the inverse of the minimum R-value. Variations in regional building materials and practices, such as the use of crawl spaces and basements, are not considered in order to simplify the analyses and in order to compare energy use across all cities.

In all cities, the houses are slab-on-grade construction. The slab-on-grade floor consists of carpeted 150-mm (6-in.) thick normal-weight concrete cast on soil. The U-factor of the floor is 1.53 $W/m^2·K$ (0.27 $Btu/hr·ft^2·°F$). Although the IECC requires perimeter insulation for slabs-on-grade in most areas of the United States, commonly used and accepted energy modeling software cannot model perimeter insulation. Therefore, the slab-on-grade is uninsulated. Second story floors are carpeted wood-framed assemblies without insulation.

In all cities except Minneapolis, the exterior walls of the wood frame house consist of medium-colored aluminum siding, 12-mm (½-in.) plywood, R_{SI}-1.9 (R-11) fiberglass batt insulation, and 12-mm (½-in.) painted gypsum board. In Minneapolis, the exterior walls of the

Table 1. International Energy Conservation Code Maximum U-Factors*

Location	Opaque walls**				Roof		Windows***	
	Wood frame		Mass (CMU)					
	$\frac{W}{m^2 \cdot K}$	$\frac{Btu}{hr \cdot ft^2 \cdot °F}$	$\frac{W}{m^2 \cdot K}$	$\frac{Btu}{hr \cdot ft^2 \cdot °F}$	$\frac{W}{m^2 \cdot K}$	$\frac{Btu}{hr \cdot ft^2 \cdot °F}$	$\frac{W}{m^2 \cdot K}$	$\frac{Btu}{hr \cdot ft^2 \cdot °F}$
Lake Charles	0.897	0.158	1.124	0.198	0.233	0.041	2.4	0.47
Tucson	0.886	0.156	1.102	0.194	0.233	0.041	2.4	0.47
St. Louis	0.636	0.112	0.727	0.128	0.182	0.032	1.7	0.30
Denver	0.500	0.088	0.556	0.098	0.148	0.026	1.7	0.30
Minneapolis	0.420	0.074	0.420	0.074	0.148	0.026	1.6	0.28

*The maximum U-factor is equal to the inverse of the minimum R-value.
**Calculated based on the design of the houses and the window U-factors prescribed by the IECC.
***The code also requires that windows have a solar heat gain coefficient (SHGC) less than 0.4 in Lake Charles and Tucson.

wood frame house consist of medium-colored aluminum siding, 12-mm (½-in.) plywood, R_{SI}-2.3 (R-13) fiberglass batt insulation, and 12-mm (½-in.) painted gypsum board. The exterior walls of the CMU house in Lake Charles and Tucson consist of 16-mm ($^5/_8$-in.) light-colored portland cement stucco, 200-mm (8-in.) CMU with partly grouted insulated cells,* wood furring, and 12-mm (½-in.) painted gypsum board. The exterior walls of the CMU house in St. Louis and Denver consist of 16-mm ($^5/_8$-in.) light-colored portland cement stucco, 200-mm (8-in.) CMU with partly grouted uninsulated cells, wood furring with R_{SI}-1.9 (R-11) fiberglass batt insulation, and 12-mm (½-in.) painted gypsum board. In Minneapolis, the exterior walls of the CMU house consist of 16-mm ($^5/_8$-in.) light-colored portland cement stucco, 200-mm (8-in.) CMU with partly grouted uninsulated cells, wood furring with R_{SI}-2.3 (R-13) fiberglass batt insulation, and 12-mm (½-in.) painted gypsum board. In all cities, the nominal weight of the CMU is assumed to be 1,840 kg/m^3 (115 lb/ft^3) with U-factors as presented in ASHRAE Standard 90.1-1999.[12] The wall cross-sections are shown in Figures B7 and B8 in Appendix B.

For both house styles, all exterior garage walls (except the front wall of the garage, which has overhead doors) and the common wall between house and garage are of the same construction as the exterior walls of the house. The front wall of the garage is modeled as a low-mass light-colored wall with a U-factor of 2.8 W/m^2·K (0.50 Btu/hr·ft^2·°F). Interior walls are wood frame construction and uninsulated.

Roofs are wood frame construction with R_{SI}-5.3 or R_{SI}-6.7 (R-30 or R-38) fiberglass batt insulation. They are covered with medium-colored asphalt shingles.

Windows are primarily located on the front and back façades, and the overall window-to-exterior wall ratio is 16%. The windows were chosen to meet the IECC requirements for solar heat gain coefficient (SHGC) and U-factor. They consist of double pane glass with a low-E

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*Partly grouted insulated cells means that some CMU cells are grouted, while others contain insulation. Likewise, partly grouted uninsulated cells means that some CMU cells are grouted, while others are empty (do not contain insulation or grout). Grouted cells typically contain reinforcing steel. *Partly grouted* is assumed to mean cells are grouted 80 cm (32 in.) on center vertically and 120 cm (48 in.) on center horizontally.[12]

coating. To meet the SHGC requirement, windows in Lake Charles and Tucson are tinted and contain air in the space between panes. Windows in St. Louis, Minneapolis, and Denver are not tinted and contain argon gas in the space between panes. It is assumed that interior shades or drapes are closed during periods of high solar heat gains. It is also assumed that the houses are located in new developments without trees or any other form of exterior shading.

Table 2 presents the assembly U-factors used in the analyses. In most cases, using typical building materials results in assemblies that exceed the IECC U-factor requirements.

Table 2. Assembly U-Factors*

<table>
<tr><th rowspan="3">Location</th><th colspan="4">Walls</th><th colspan="2" rowspan="2">Roof**</th><th colspan="2" rowspan="2">Windows</th></tr>
<tr><th colspan="2">Wood frame</th><th colspan="2">Mass (CMU)</th></tr>
<tr><th>$\frac{W}{m^2 \cdot K}$</th><th>$\frac{Btu}{hr \cdot ft^2 \cdot {}^\circ F}$</th><th>$\frac{W}{m^2 \cdot K}$</th><th>$\frac{Btu}{hr \cdot ft^2 \cdot {}^\circ F}$</th><th>$\frac{W}{m^2 \cdot K}$</th><th>$\frac{Btu}{hr \cdot ft^2 \cdot {}^\circ F}$</th><th>$\frac{W}{m^2 \cdot K}$</th><th>$\frac{Btu}{hr \cdot ft^2 \cdot {}^\circ F}$</th></tr>
<tr><td>Lake Charles</td><td rowspan="4">0.47</td><td rowspan="4">0.082</td><td rowspan="2">0.85</td><td rowspan="2">0.150</td><td rowspan="3">0.18</td><td rowspan="3">0.032</td><td rowspan="2">2.4</td><td rowspan="2">0.43</td></tr>
<tr><td>Tucson</td></tr>
<tr><td>St. Louis</td><td rowspan="2">0.44</td><td rowspan="2">0.078</td><td rowspan="3">1.5</td><td rowspan="3">0.27</td></tr>
<tr><td>Denver</td><td rowspan="2">0.15</td><td rowspan="2">0.026</td></tr>
<tr><td>Minneapolis</td><td>0.42</td><td>0.074</td><td>0.41</td><td>0.073</td></tr>
</table>

*The maximum U-factor is equal to the inverse of the minimum R-value.
**R_{SI}-5.3 (R-30) attic insulation is used in Lake Charles, Tucson, and St. Louis. R_{SI}-6.7 (R-38) attic insulation is used in Denver and Minneapolis.

ASSUMPTIONS

In order to create a realistic house model, the following assumptions about occupant behavior and house performance have been made. These assumptions also ensure that comparisons between houses are possible.

Hot water is supplied by a natural gas water heater, which has a peak utilization of 24 liters/minute (2.5 gallons/minute). The hot water load-profile was taken from ASHRAE Standard 90.2.[13] The heating, ventilating, and air-conditioning (HVAC) system consists of a natural gas high-efficiency forced-air system with a high-efficiency central air conditioner. The efficiencies of the HVAC system components are assumed to be identical in all cities.

The HVAC system is controlled by a residential set-back thermostat located in the family room. The cooling set-point temperature is 24°C (75°F) from 6 AM to 10 PM and 26°C (78°F) from 10 PM to 6 AM. The heating set-point temperature is 21°C (70°F) from 6 AM to 10 PM and 18°C (65°F) from 10 PM to 6 AM.

Occupant energy consumption for uses other than heating and cooling is assumed to be 23.36 kWh/day. This value was calculated from ASHRAE Standard 90.2,[13] and it assumes the houses have an electric clothes dryer and an electric stove.

Air infiltration rates are based on ASHRAE Standard 62.[14] The air infiltration rate is 0.35 air changes per hour in the living areas of the house and 2.5 air changes per hour in the unconditioned attached garage. A family of four is assumed to live in each house.

The life of the house is assumed to be 100 years. The maintenance, repair, and replacement schedules for various building components are shown in Table 3.

Table 3. House Component Replacement Schedules

House component	Replacement schedule (years)
Siding, air barrier, and exterior fixtures	33.3
Stucco	50
Latex and silicone caulking	10
Paint, exterior	5
Doors and windows	33.3
Roofing*	20 and 40
Gable and ridge vents	33.3
Bathroom fixtures	25
Bathroom tiles and backer board	25
Paint, interior	10
Carpet and pad	10
Resilient flooring, vinyl sheet	10
Bathroom furniture (toilet, sink, etc.)	25
Garbage disposal	20
Furnace	20
Air conditioner	20
Interior and exterior luminaries	33.3
Water heater	20
Large appliances	15
Manufactured fireplace	50
Kitchen and bathroom casework	25
Kitchen counter tops	25

*A new layer of shingles is added every 20 years, and every 40 years the existing layers of felt and shingles are replaced with a new layer of felt and shingles.

LIFE CYCLE INVENTORY ANALYSIS

The data used in the LCA comes from a variety of sources. The life cycle inventory data for cement-based materials comes from peer-reviewed published reports and papers published by PCA and others.[2, 4, 15] The household energy models also come from a PCA report.[8] All other data comes from the databases in the commercially available LCA software tool, SimaPro.[16] A brief description of SimaPro and the LCI of each house are listed in Appendices C and D.
Table 4 shows which database is used for each building material. North American data were used whenever available. A brief description of each material is given in Table 5, along with the assumptions that were made. Table 5 indicates that not all data sources are for building materials. In these cases, data for building materials were not available so we used the best available data. The life cycle inventory analysis combines the data from the PCA LCI reports and SimaPro. The LCI of each house is listed in Appendix C (SI units) and D (U.S. customary units). The results do not include waste scenarios or waste treatment.

Unfortunately, not all materials in the houses could be incorporated into the LCA because some materials were not represented in the available databases. However, these materials constitute a minor fraction of the mass of a house, and they represent components that are used in similar amounts in the two houses. The materials excluded are listed in Table 6: notably, gypsum wallboard, floor carpet and under-padding, and roofing materials.

Table 4. Sources of LCI Data

Material and energy	Database name	Source
Aluminum	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.
Cement-based materials	PCA	Reference 15: Nisbet, et al., 2000.
Copper	IDEMAT 2001	Reference 18: PRé Consultants and Delft University of Technology, 2001.
Electrical wire	IDEMAT 2001 and Data Archive	References 18 and 19: PRé Consultants and Delft University of Technology, 2001; and PRé Consultants, 2001.
Expanded polystyrene insulation	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.
Fiberglass insulation	IDEMAT 2001	Reference 18: PRé Consultants and Delft University of Technology, 2001.
Galvanized steel and other sheet metals	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.
Linoleum	IDEMAT 2001	Reference 18: PRé Consultants and Delft University of Technology, 2001.
Paint	ETH-ESU 96	Reference 20: PRé Consultants and ESU-services, 2001.
Plywood and wood sheathing	ETH-ESU 96	Reference 20: PRé Consultants and ESU-services, 2001.
Polyester fabric	IDEMAT 2001	Reference 18: PRé Consultants and Delft University of Technology, 2001.
PVC	IDEMAT 2001	Reference 18: PRé Consultants and Delft University of Technology, 2001.
Steel	IDEMAT 2001	Reference 18: PRé Consultants and Delft University of Technology, 2001.
Tile	IDEMAT 2001	Reference 18: PRé Consultants and Delft University of Technology, 2001.
Windows	ETH 1996 and IDEMAT 2001	References 20 and 18: PRé Consultants and ESU-services, 2001; and PRé Consultants and Delft University of Technology, 2001.
Wood: framing, treated, and miscellaneous	IDEMAT 2001	Reference 18: PRé Consultants and Delft University of Technology, 2001.
Coal	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.
Distillate fuel oil	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.
Electricity	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.
Gasoline	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.
Liquefied petroleum gas	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.
Natural gas	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.
Petroleum coke	Franklin US LCI	Reference 20: PRé Consultants and ESU-services, 2001.
Residual fuel oil	Franklin US LCI	Reference 17: PRé Consultants and Sylvatica, 2001.

Table 5. LCI Data and Assumptions

Material or energy	Description and assumptions
Aluminum	Process copied from Franklin database. The Franklin data is based on the material and energy requirements and process emissions for the production of aluminum cans with no recycled content, using average USA technology from the late 1990's. For this report, it is assumed that the LCI of aluminum siding is similar to the LCI for aluminum cans. Although the energy to form cans is included, the energy to form the siding is not. This assumption does not introduce a large error.
Cement-based materials	All assumptions can be found in Reference 15. For upstream profiles of electricity and fuels, see below. Combustion emissions of fuels are accounted for in the referenced reports.
Copper	Process for producing copper copied from IDEMAT database. The copper LCI is based on open mining (¾) and sulfide ores (0.6% Cu), delivered to Rotterdam, world average data for 2000, 13% old scrap, and 98% recovery. In this report, it is assumed that the energy required to extrude copper to make pipes is similar to the energy required to extrude aluminum.
Electrical wire	Electrical wire LCI is built up from (i) material and energy inputs from IDEMAT database (copper, PVC, and extruding PVC), (ii) furnace gas used for copper beam production, and (iii) electricity used to manufacture a wire from a copper beam. Data taken from Data Archive database.
Expanded polystyrene insulation	Process copied from Franklin database. The data is for the material and energy requirements and process emissions for the production of expanded polystyrene food containers using average USA technology from the late 1990's.
Fiberglass insulation	Process copied from IDEMAT database. The data is for the production of glass fibers based on the average of 6 industries in the Netherlands. However, the LCI does not include the energy to form batt insulation.
Galvanized steel and other sheet metal	Process for producing sheet steel copied from Franklin database. The Franklin data is based on the material and energy requirements and process emissions for the production of steel using basic oxygen furnace with average USA technology from the late 1990's. For this report, it is assumed that the LCI of sheet steels, like sheet metal, galvanized steel, and truss plates, is similar to that for tin-coated steel strips for beverage cans. This is a conservative assumption because more energy is used to make steel for beverage cans because it is rolled much thinner.
Linoleum	Process copied from IDEMAT database. Data for linoleum made from linseed oil, natural resin and tall oil, a waste product of the paper industry.
Paint	Process copied from ETH-ESU database. Data is for total aggregated system inventory.
Plywood and wood sheathing	Process copied from ETH database. Wood board LCI includes total aggregated system inventory.
Polyester fabric	Process copied from IDEMAT database. LCI for dyed, manufactured polyester fabric, average data.
PVC	Processes copied from IDEMAT database. Inputs and outputs associated with the production of general purpose PVC granulate in Europe averaged over all the polymerization processes. Also included is the LCI for the extrusion of PVC pipes, excluding production of resin, including transport to converter and packaging. Data obtained from three suppliers in the Netherlands. Also included is the LCI for injection molding of PVC fittings for drainage pipe systems. Data obtained from two factories in France with a total annual production of 9000 metric tons.

Table 5. LCI Data and Assumptions (continued)

Material or energy	Description and assumptions
Steel	Process for producing non-sheet steels copied from IDEMAT database. The data is based on world average production and delivery in Rotterdam for 1999. These steels are low cost, general-purpose steels that have excellent welding characteristics. They are usually less suitable for machining. For this report, it is assumed that this is the process for making reinforcing steel and steel angles, and all non-sheet steels like anchors, bolts, pipes, etc.
Tile	Process copied from ETH database. Ceramics production based on total aggregated system inventory.
Windows	Window LCI is built up from material and energy inputs from IDEMAT database (pine, PVC, and extruded PVC) and ETH database (glass).
Wood framing, treated wood, and miscellaneous wood	Process copied from IDEMAT database. The LCI is for the production of rough sawn beams imported from North and Central America, and transported to the Netherlands (6,200 km by ship and 250 km by trailer). Furthermore, 72% is imported sawn and 28% is processed in the Netherlands. The LCI for treated wood may be not be conservative because it does not include the production and use of arsenic-, chrome-, or copper-based preservatives.
Coal	Data for the cradle-to-gate resource requirements and emissions for providing coal as a ready input in electric utility boilers using average USA technology from the late 1990's. Combustion emissions are not part of this process.*
Distillate fuel oil (also called diesel fuel)	Data for the cradle-to-gate resource requirements and emissions for the provision of diesel fuel for use in combustion using average USA technology from the late 1990's. Combustion emissions are not part of this process.*
Electricity	Data for the fuel consumption associated with the generation and delivery of an average kilowatt-hour in the USA using average USA technology from the late 1990's. The LCI includes adjustment to account for line losses.
Gasoline	Data for the cradle-to-gate resource requirements and emissions for providing gasoline as a ready input in tractor trailer engines using average USA technology from the late 1990's. Combustion emissions are not part of this process.*
Liquefied petroleum gas (also called light petroleum gas)	Data for the cradle-to-gate resource requirements and emissions for providing liquid propane as a ready input in industrial equipment using average USA technology from the late 1990's. Combustion emissions are not part of this process.*
Natural gas	Data for the cradle-to-gate resource requirements and emissions for providing natural gas as a ready input in industrial boilers using average USA technology from the late 1990's. Combustion emissions are not part of this process.*
Petroleum coke	Process copied from ETH database. The LCI is based on the total aggregated system inventory. It includes building and working materials, construction of the plants, energy requirement, production waste as well as emissions to air and water and land use. Special attention is given to the emissions of hydrocarbons (both to air and water) of coking plants. Energy is delivered by a pure coal coke boiler (not considering other energy carriers such as sewage sludge or blast furnace gas).*
Residual fuel oil	Data for the cradle-to-gate resource requirements and emissions for providing residual fuel oil as a ready input in industrial boilers using average USA technology from the late 1990's. Combustion emissions are not part of this process.*

*Combustion emissions are included in the house LCI.

Table 6. Materials Excluded from the LCA because of Insufficient Data

Material	Wood		CMU	
	Amount		Amount	
	kg	lb	kg	lb
Gypsum wall board	8,900	19,600	8,000	17,800
Floor carpet and under-pad	6,400	14,200	6,400	14,200
Roofing materials	5,800	12,800	5,800	12,800
Shipping weight, various	5,500	12,000	5,500	12,000
Fiber-cement backer board	1,500	3,400	1,500	3,400
Lighting products	580	1,300	580	1,300
Sealant	300	660	300	330
Miscellaneous polymers	20	40	20	40
Total	**29,000**	**64,000**	**28,100**	**61,870**
Total mass of house (average)	**161,000**	**356,000**	**287,000**	**633,000**
Percent of total mass excluded from LCA	**18**		**10**	

Household Occupant Energy-Use

Visual DOE 2.6 energy simulation software is used to model the annual household energy consumption.[9] This software uses the United States Department of Energy DOE 2.1-E hourly simulation tool as the calculation engine. It is used to simulate hourly energy-use and peak demand over a one-year period. Programs that model hourly energy-use are more accurate than other methods, especially for buildings with thermally massive exterior walls, such as CMU systems. Because heating and cooling load vary with solar orientation, the houses are modeled four times: once for each orientation of the façade facing the four cardinal points (north, south, east, and west). Then the total energy consumption for heating, cooling, hot water, and occupant use is averaged to produce an energy consumption that is independent of building orientation. The annual occupant energy-use is presented in Table 7.

The data presented in Table 7 show that, in each of the five climates, the CMU houses have similar occupant energy use as the wood frame houses. These results were expected since the CMU houses and the wood frame houses were designed with standard materials needed to meet IECC requirements. Wood frame walls have R-values that range from approximately 0 to 100% in excess of IECC requirements, while CMU walls have R-values that range from approximately 0 to 50% in excess of IECC requirements.

An important difference between the two houses is that the system capacity for heating, ventilating, and air-conditioning is less for the CMU house than for the wood frame house. Table 8 shows the HVAC system requirements as determined by the energy simulation software. The thermal mass of the CMU house moderates temperature swings and peak loads, and results in lower HVAC system requirements.

Natural gas fired high-efficiency forced-air furnaces are typically available in 20 kBtu/hr capacity increments (equivalent to 5.9 kW) and high-efficiency central air conditioners are typically available in 6 to 12 kBtu/hr (½ to 1 ton) capacity increments (equivalent to 1.8 to

Table 7. Annual Occupant Energy-Use by Location

Location	Variation	Annual operating data				
		Electricity		Natural gas		Total energy, GJ
		GJ	kWh	GJ	therms	
Lake Charles	Wood frame	52.8	14,660	91.5	868	144.3
	CMU	52.2	14,509	94.3	894	146.5
Tucson	Wood frame	60.0	16,659	83.6	793	143.6
	CMU	60.4	16,772	84.5	801	144.9
St. Louis	Wood frame	47.8	13,273	176.3	1,672	224.1
	CMU	46.4	12,902	171.9	1,630	218.3
Denver	Wood frame	40.9	11,368	187.5	1,778	228.5
	CMU	39.2	10,883	177.9	1,687	217.1
Minneapolis	Wood frame	40.9	11,363	241.0	2,285	281.9
	CMU	39.9	11,093	235.4	2,232	275.3

Table 8. Required HVAC System Capacity as Determined by Energy Simulation Software

Location	Variation	System capacity			
		Heating		Cooling	
		kW	kBtu/hr	kW	kBtu/hr
Lake Charles	Wood frame	25	87	13	45
	CMU	23	78	12	41
Tucson	Wood frame	30	102	16	55
	CMU	29	98	16	54
St. Louis	Wood frame	29	99	15	53
	CMU	26	89	14	48
Denver	Wood frame	27	92	14	47
	CMU	23	78	12	39
Minneapolis	Wood frame	25	87	13	45
	CMU	23	79	12	41

3.5 kW). Because HVAC systems are typically oversized (the installed capacity is the required capacity rounded to the next larger available capacity), actual installed system capacity savings will be different.

LIFE CYCLE IMPACT ASSESSMENT

The second phase of a life cycle assessment, after LCI, is life cycle impact assessment. It consists of category definition, classification, and characterization. Category definition consists of identifying which impact categories are relevant for the product being studied. Classification consists of grouping related substances into impact categories. For example, the gases CO_2, methane, and N_2O contribute to climate change; so, they can be grouped together in the impact category, climate change.

According to ISO 14041, the mandatory step in life cycle impact assessment is characterization. In characterization, weighting factors are assigned according to a substance's relative contribution to the impact category. For example, the gases CO_2, methane, and N_2O contribute to climate change. In terms of global warming potential, one pound of methane is 20 times more potent than one pound of CO_2, and one pound of N_2O is 320 times more potent than one pound of CO_2. Therefore, in assessing the potential for global warming, CO_2 is assigned a weighting factor of 1, methane a factor of 20, and N_2O a factor of 320. It is important to remember that there is no scientific basis for comparing across impact categories.[21]

According to ISO 14042, life cycle impact assessment is not intended to identify, measure or predict actual impacts or estimate threshold limits, or measure margins of safety.[21] The methodology is still being developed, and there is no general and widespread practice of life cycle impact assessment at this time or an agreement on specific methodologies.[21] Therefore, several of the available methods were used to measure the life cycle impact assessment. The methods chosen are Eco-Indicator 99 (Dutch/Swiss), EDIP/UMIP 96 (Danish), and EPS 2000 (Swedish). Furthermore, three different weighting sets in Eco-Indicator 99 were used.

The Eco-Indicator 99 method is a damage-oriented approach, which is based on how a panel of experts weighted the different types of damage caused by the impact categories. The three versions of Eco-Indicator 99 reflect the subjective uncertainty inherent in LCA. Each one takes a different perspective on how to consider the potential damage from a particular substance. The egalitarian perspective takes an extremely long-term look at substances if there is any indication that they have some effect. The hierarchic perspective takes a long-term look at all substances if there is consensus regarding their effect. The individualist perspective takes a short-term look (100 years or less) at substances if there is complete proof regarding their effect.

The EDIP/UMIP 96 method is based on normalizing values to person-equivalents in 1990 and weighting factors are equivalent to politically-set target-emissions per person in 2000. The EPS method was designed as a tool for a company's internal product development process, and the weighting factors are based on a willingness to pay to avoid change. A listing of the impact categories in each method is shown in Table 9. A complete description of the category definitions, classification methods, and characterization factors for each of the three methods is too voluminous to be reproduced in this report. Please refer to Appendices E through G for a summary of each method and further references.

Results of the characterization phase for each method are shown in Tables 10 through 14. The data show that in most cases, for a given climate the impact indicators in each category are similar for the wood and CMU houses. In the cold climates (St. Louis, Denver, and Minneapolis), the impact indicators are generally greater (worse) for the wood frame house. In the warm climates (Lake Charles and Tucson), the impact indicators are generally greater for the CMU house because household energy use is also greater. The exceptions are (i) in the categories "land use" and "minerals" in the Eco-Indicator methods and the categories "severe morbidity," "species extinction," and "severe nuisance" in the EPS 2000 method, where indicators for the CMU house are greater, and (ii) "radiation" and "ozone layer" in the Eco-Indicator methods and the categories "ozone depletion" and "ecotoxicity" in the EDIP/UMIP 96 method, where indicators for the wood house are greater.

Other methods of impact assessment, such as damage assessment, normalization, and weighting, are optional. In damage assessment, impact categories that have equivalent units are added. In normalization, the impact assessment values are compared to some reference, such as the average yearly environmental load in a country divided by the number of people in the

Table 9. Impact Categories for Three Life Cycle Impact Assessment Methods

Eco-Indicator 99	EDIP/UMIP 96	EPS 2000
Carcinogens	Global warming potential	Life expectancy
Respiratory organics	Ozone depletion	Severe morbidity and suffering
Respiratory inorganics	Acidification	Morbidity
Climate change	Eutrophication	Severe nuisance
Radiation	Photochemical smog	Nuisance
Ozone layer	Ecotoxicity water, chronic	Crop growth capacity
Ecotoxicity	Ecotoxicity water, acute	Wood growth capacity
Acidification/eutrophication	Ecotoxicity soil, chronic	Fish and meat production
Land use	Human toxicity, air	Soil acidification
Minerals	Human toxicity, water	Production capacity of irrigation water
Fossil fuels	Human toxicity, soil	Production capacity of drinking water
	Bulk waste	Depletion of reserves
	Hazardous waste	Species extinction
	Radioactive waste	
	Slags/ashes	
	Resources (all)	

country. In weighting, the impact assessment values in several or all categories are multiplied by weighting factors and added together to get a single score. However, the weighting factors used are always subjective and reflect societal or personal values. Furthermore, according to ISO 14042, weighting cannot be used to make comparative assertions disclosed to the public.[21] The tables in Appendix H show the normalized and weighted results for each category of each method. In each of the five methods, results are similar for the two houses. The CMU houses in the colder climates (St. Louis, Denver, and Minneapolis) have a lower score (better) than the wood frame house in almost all impact categories. A summary of the normalized and weighted single-score results is shown in Table 15. The data in Table 15 are shown graphically in the figures in Appendix I.

LIFE CYCLE INTERPRETATION

A breakdown of the LCA by major process/product stage shows that most of the environmental load is from the household-use of natural gas and electricity during the life of the houses. For example, Figures 2 and 3 show the breakdown for the CMU houses in Lake Charles and Minneapolis, respectively, using the egalitarian perspective of Eco-Indicator 99. Figures 4 and 5 show that the wood frame houses exhibit similar patterns. The breakdown for all houses in all locations is shown in Figures J-1 through J-10 in Appendix J. The household-use of electricity and natural gas represents 89% to 92% of the environmental load of the CMU houses. The household-use of electricity and natural gas represents 90% to 93% of the environmental load of the wood frame houses. Household-use of energy is less in milder climates (like Lake Charles) than in more severe climates (like Minneapolis), so the houses in milder climates are at the low end of the range, while houses in more severe climates are at the high end of the range. The household-use of electricity (mostly for cooling) contributes the most to the total environmental

Table 10. Characterization of Life Cycle Inventory Data Assuming an Egalitarian Perspective using the Eco-Indicator 99 Method of Characterization (Output from SimaPro)

Impact category	Unit	Wood frame house					CMU house				
		Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Carcinogens	DALY*	0.0627	0.0618	0.0972	0.0998	0.1230	0.0641	0.0627	0.0953	0.0954	0.1200
Respiratory organics	DALY	3.77E-3	3.67E-3	6.14E-3	6.35E-3	7.91E-3	3.85E-3	3.71E-3	5.99E-3	6.04E-3	7.73E-3
Respiratory inorganics	DALY	1.42	1.49	1.80	1.75	2.05	1.45	1.53	1.78	1.70	2.03
Climate change	DALY	0.359	0.380	0.447	0.432	0.501	0.364	0.387	0.439	0.416	0.494
Radiation	DALY	2.54E-5	2.54E-5	2.55E-5	2.55E-5	2.55E-5	2.31E-5	2.31E-5	2.31E-5	2.31E-5	2.32E-5
Ozone layer	DALY	3.59E-5	3.94E-5	3.40E-5	3.07E-5	3.10E-5	3.52E-5	3.91E-5	3.28E-5	2.93E-5	3.00E-5
Ecotoxicity	PAF·m^2·yr**	45,700	48,000	48,200	46,400	49,100	46,000	48,500	47,900	45,700	48,900
Acidification/eutrophication	PDF·m^2·yr***	44,700	47,700	53,700	51,500	59,000	45,200	48,400	52,700	49,500	58,000
Land use	PDF·m^2·yr	65,200	65,200	65,200	65,200	65,200	68,000	68,000	68,000	68,000	68,100
Minerals	MJ surplus	4,950	4,950	4,960	4,970	4,990	5,010	5,010	5,020	5,030	5,050
Fossil fuels	MJ surplus	2.08E+6	2.14E+6	2.86E+6	2.84E+6	3.40E+6	2.10E+6	2.16E+6	2.79E+6	2.71E+6	3.33E+6

*DALY is disability-adjusted life-years. It expresses the number of year-lives lost and the number of year-lives lived with a disability.
**PAF is potentially affected area.
***PDF is potentially disappeared fraction.

Table 11. Characterization of Life Cycle Inventory Data Assuming a Hierarchic Perspective using the Eco-Indicator 99 Method of Characterization (Output from SimaPro)

Impact category	Unit	Wood frame house					CMU house				
		Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Carcinogens	DALY*	0.0627	0.0618	0.0972	0.0998	0.1230	0.0641	0.0627	0.0953	0.0954	0.1200
Respiratory organics	DALY	3.77E-3	3.67E-3	6.14E-3	6.35E-3	7.91E-3	3.85E-3	3.71E-3	5.99E-3	6.04E-3	7.73E-3
Respiratory inorganics	DALY	1.41	1.49	1.79	1.75	2.04	1.45	1.53	1.78	1.70	2.03
Climate change	DALY	0.359	0.380	0.447	0.432	0.501	0.364	0.387	0.439	0.416	0.494
Radiation	DALY	2.54E-5	2.54E-5	2.55E-5	2.55E-5	2.55E-5	2.31E-5	2.31E-5	2.31E-5	2.31E-5	2.32E-5
Ozone layer	DALY	3.59E-5	3.94E-5	3.40E-5	3.07E-5	3.10E-5	3.52E-5	3.91E-5	3.28E-5	2.93E-5	3.00E-5
Ecotoxicity	PAF·m^2·yr**	45,700	48,000	48,200	46,400	49,100	46,000	48,500	47,900	45,700	48,900
Acidification/eutrophication	PDF·m^2·yr***	44,700	47,700	53,700	51,500	59,000	45,200	48,400	52,700	49,500	58,000
Land use	PDF·m^2·yr	65,200	65,200	65,200	65,200	65,200	68,000	68,000	68,000	68,000	68,100
Minerals	MJ surplus	4,950	4,950	4,960	4,970	4,990	5,010	5,010	5,020	5,030	5,050
Fossil fuels	MJ surplus	2.36E+6	2.31E+6	3.77E+6	3.88E+6	4.81E+6	2.40E+6	2.33E+6	3.68E+6	3.69E+6	4.71E+6

*DALY is disability-adjusted life-years. It expresses the number of year-lives lost and the number of year-lives lived with a disability.
**PAF is potentially affected area.
***PDF is potentially disappeared fraction.

Table 12. Characterization of Life Cycle Inventory Data Assuming an Individualist Perspective using the Eco-Indicator 99 Method of Characterization (Output from SimaPro)

Impact category	Unit	Wood frame house					CMU house				
		Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Carcinogens	DALY*	0.0297	0.0290	0.0478	0.0494	0.0613	0.0304	0.0294	0.0468	0.0472	0.0601
Respiratory organics	DALY	3.50E-3	3.42E-3	5.71E-3	5.90E-3	7.36E-3	3.58E-3	3.45E-3	5.57E-3	5.62E-3	7.19E-3
Respiratory inorganics	DALY	0.704	0.730	0.949	0.939	1.120	0.728	0.755	0.943	0.914	1.110
Climate change	DALY	0.343	0.363	0.426	0.413	0.479	0.348	0.370	0.420	0.398	0.472
Radiation	DALY	1.11E-5	1.11E-5	1.11E-5	1.11E-5	1.11E-5	1.01E-5	1.01E-5	1.01E-5	1.01E-5	1.01E-5
Ozone layer	DALY	2.91E-5	3.19E-5	2.75E-5	2.48E-5	2.51E-5	2.85E-5	3.17E-5	2.66E-5	2.37E-5	2.43E-5
Ecotoxicity	$PAF \cdot m^2 \cdot yr$**	7,630	7,780	9,800	9,790	11,300	7,740	7,880	9,680	9,500	11,200
Acidification/eutrophication	$PDF \cdot m^2 \cdot yr$***	44,700	47,700	53,700	51,500	59,000	45,200	48,400	52,700	49,500	58,000
Land use	$PDF \cdot m^2 \cdot yr$	65,200	65,200	65,200	65,200	65,200	68,000	68,000	68,000	68,000	68,100
Minerals	MJ surplus	4,950	4,950	4,960	4,970	4,990	5,010	5,010	5,020	5,030	5,050

*DALY is disability-adjusted life-years. It expresses the number of year-lives lost and the number of year-lives lived with a disability.
**PAF is potentially affected area.
***PDF is potentially disappeared fraction.

Table 13. Characterization of Life Cycle Inventory Data using the EDIP/UMIP 96 Method of Characterization (Output from SimaPro)

Impact category	Unit	Wood frame house					CMU house				
		Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Global warming (GWP 100)	g CO_2	1.74E+9	1.84E+9	2.17E+9	2.10E+9	2.43E+9	1.76E+9	1.87E+9	2.13E+9	2.02E+9	2.40E+9
Ozone depletion	g CFC-11	34.2	37.5	32.4	29.2	29.5	33.5	37.3	31.2	27.9	28.6
Acidification	g SO_2	1.97E+7	2.04E+7	2.63E+7	2.59E+7	3.07E+7	1.99E+7	2.07E+7	2.57E+7	2.47E+7	3.01E+7
Eutrophication	g NO_3	6.67E+6	7.27E+6	7.26E+6	6.76E+6	7.45E+6	6.73E+6	7.40E+6	7.16E+6	6.55E+6	7.36E+6
Photochemical smog	g ethene	8.43E+4	8.53E+4	1.21E+5	1.22E+5	1.48E+5	8.59E+4	8.66E+4	1.19E+5	1.17E+5	1.45E+5
Ecotoxicity water, chronic	g/m^3	1.70E+8	1.72E+8	2.30E+8	2.31E+8	2.73E+8	1.60E+8	1.61E+8	2.13E+8	2.10E+8	2.56E+8
Ecotoxicity water, acute	g/m^3	1.54E+7	1.55E+7	2.12E+7	2.14E+7	2.55E+7	1.43E+7	1.44E+7	1.96E+7	1.94E+7	2.38E+7
Ecotoxicity soil, chronic	g/m^3	5.65E+5	5.71E+5	5.69E+5	5.64E+5	5.70E+5	5.57E+5	5.63E+5	5.59E+5	5.54E+5	5.60E+5
Human toxicity, air	g/m^3	2.88E+11	3.02E+11	3.10E+11	2.99E+11	3.21E+11	2.90E+11	3.05E+11	3.07E+11	2.93E+11	3.18E+11
Human toxicity, water	g/m^3	5.31E+7	5.62E+7	5.88E+7	5.63E+7	6.16E+7	5.24E+7	5.58E+7	5.69E+7	5.37E+7	5.98E+7
Human toxicity, soil	g/m^3	1.56E+5	1.65E+5	1.69E+5	1.62E+5	1.75E+5	1.56E+5	1.66E+5	1.66E+5	1.56E+5	1.72E+5
Bulk waste	kg	2.27E+5	2.49E+5	2.31E+5	2.10E+5	2.24E+5	2.25E+5	2.50E+5	2.25E+5	2.01E+5	2.18E+5
Hazardous waste	kg	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
Radioactive waste*	kg	x	x	x	x	x	x	x	x	x	x
Slags/ashes	kg	11.4	11.4	11.4	11.4	11.4	11.2	11.2	11.2	11.2	11.2
Resources (all)	kg	33.1	33.2	43.3	43.8	50.7	33.6	33.6	42.7	42.5	50.0

*An x means there are no data.

Table 14. Characterization of Life Cycle Inventory Data using the EPS 2000 Method of Characterization (Output from SimaPro)

Impact category	Unit	Wood frame house					CMU house				
		Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Life expectancy	Person-year	1.34	1.35	1.95	1.98	2.40	1.40	1.41	1.95	1.93	2.40
Severe morbidity	Person-year	0.101	0.085	0.223	0.244	0.319	0.113	0.093	0.225	0.239	0.319
Morbidity	Person-year	0.589	0.572	0.959	0.993	1.240	0.615	0.592	0.950	0.960	1.220
Severe nuisance	Person-year	0.151	0.153	0.151	0.151	0.152	0.154	0.156	0.154	0.153	0.155
Nuisance	Person-year	117	121	159	157	187	118	123	155	150	183
Crop growth capacity	kg	3.74E+3	4.02E+3	4.32E+3	4.10E+3	4.63E+3	3.80E+3	4.11E+3	4.27E+3	3.98E+3	4.58E+3
Wood growth capacity	kg	-3.45E+4	-3.42E+4	-5.34E+4	-5.47E+4	-6.73E+4	-3.61E+4	-3.55E+4	-5.31E+4	-5.32E+4	-6.68E+4
Fish and meat production	kg	-148	-162	-155	-142	-154	-149	-165	-153	-139	-153
Soil acidification	H+ eq.	3.07E+4	3.19E+4	4.10E+4	4.04E+4	4.79E+4	3.10E+4	3.23E+4	4.01E+4	3.86E+4	4.70E+4
Prod. cap. of irrigation water*	kg	x	x	x	x	x	x	x	x	x	x
Prod. cap. of drinking water	kg	x	x	x	x	x	x	x	x	x	x
Depletion of reserves	ELU/kg**	4.19E+5	4.12E+5	6.39E+5	6.57E+5	8.02E+5	4.27E+5	4.16E+5	6.26E+5	6.29E+5	7.87E+5
Species extinction	[-]	3.45E-8	3.40E-8	3.86E-8	3.93E-8	4.18E-8	3.63E-8	3.57E-8	4.01E-8	4.06E-8	4.32E-8

*An x means there are no data.
**ELU is environmental load unit.

Table 15. Single Score Summary (Output from SimaPro)

House style	Location	Method				
		Eco-indicator 99			EDIP/UMIP 96	EPS 2000
		Egalitarian	Hierarchic	Individualist		
Wood frame house	Lake Charles	117,000	113,000	84,700	514,000	565,000
	Tucson	121,000	115,000	87,800	540,000	557,000
	St. Louis	154,000	160,000	108,000	655,000	857,000
	Denver	152,000	162,000	107,000	639,000	879,000
	Minneapolis	179,000	194,000	124,000	747,000	1,070,000
CMU house	Lake Charles	119,000	115,000	86,900	520,000	580,000
	Tucson	123,000	117,000	90,200	548,000	568,000
	St. Louis	151,000	158,000	108,000	642,000	844,000
	Denver	146,000	155,000	104,000	613,000	846,000
	Minneapolis	176,000	191,000	124,000	733,000	1,060,000

*No units: data have been normalized and weighted.

load in cooling-dominant climates like Lake Charles. Household natural gas use (mostly for heating) contributes the most to the total environmental load in heating-dominant climate like Minneapolis. In all locations, cement-based materials represent a small fraction of the total environmental load. Furthermore, Figures 2 through 5 also show that the most significant impact categories are fossil fuel depletion and respiratory inorganics. The other methods of life cycle impact assessment produce similar results.

A breakdown of the environmental load of buildings materials shows that most of the environmental load from construction materials is due to wood and copper tubing, followed by cement-based materials. For example, Figures 6 and 7 show a breakdown of the environmental load of buildings materials for each of the houses in Minneapolis using the egalitarian perspective of the Eco-Indicator 99 Method. Furthermore, the impact categories that contribute the most to the environmental load are land use and fossil fuel depletion, primarily from wood and copper tubing. Figures K-1 through K-10 in Appendix K show the breakdown of environmental load for all locations.

Complete disposal scenarios have not been included in this LCA. Including complete disposal scenarios (notably decomposition of wood-based products in landfill) will not significantly alter the results of this LCA.

CONCLUSIONS

This report presented the results of an LCA of a house modeled with two types of exterior walls: a wood-framed wall and a CMU wall. The LCA was carried out according to the ISO 14040 series guidelines. The house was modeled in five cities, representing a range of U.S. climates: Lake Charles, Tucson, St. Louis, Denver, and Minneapolis.

Each house is a two-story single-family building with a contemporary design. The house system boundary includes the inputs and outputs of energy and material from construction, occupancy and maintenance. The system boundary excludes human resources, infrastructure,

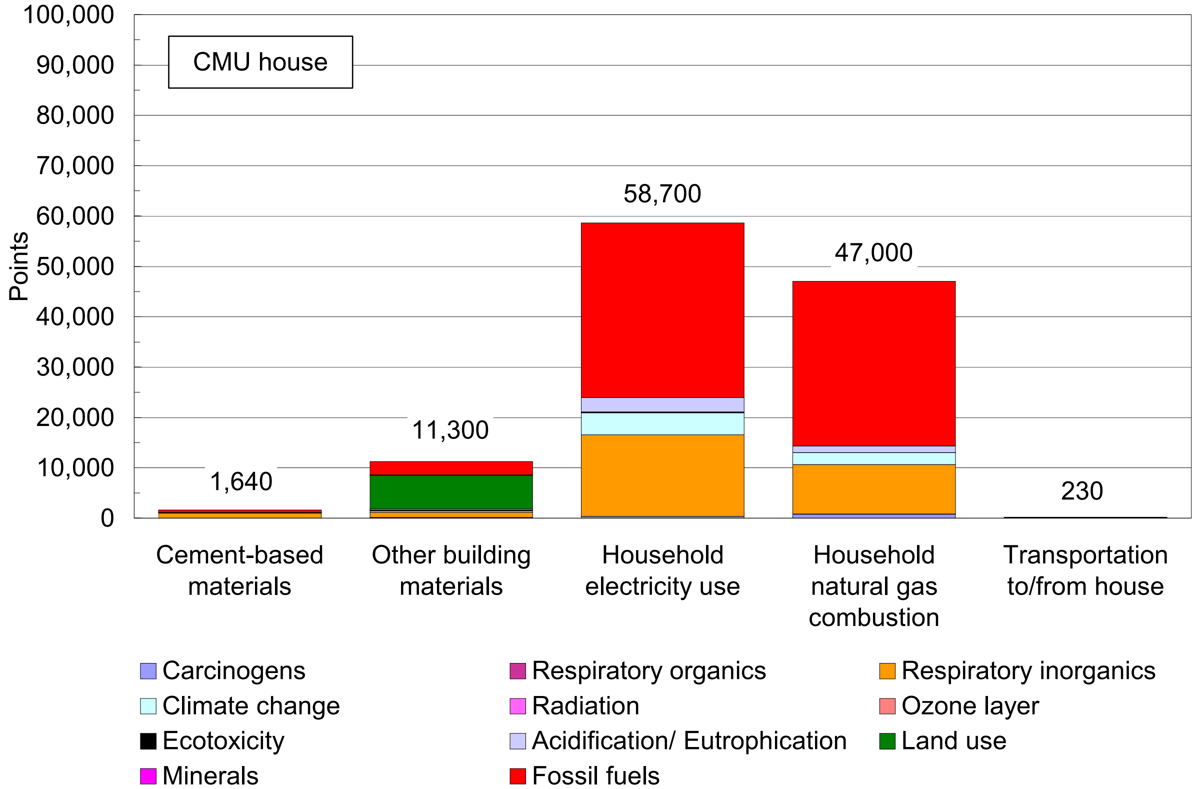

Figure 2. Single-score life cycle inventory assessment of CMU house in Lake Charles showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

accidental spills, impacts caused by people, and decomposition of household components after disposal. The life of the houses is 100 years.

The LCA was conducted by first assembling the relevant LCI data from published reports and commercially available databases. The LCA software tool, SimaPro, was used to perform a life cycle impact assessment. Impact assessment is not completely scientific; so three different models were used. The methods chosen are Eco-Indicator 99 (Dutch/Swiss), EDIP/UMIP 96 (Danish), and EPS 2000 (Swedish). Furthermore, three different weighting sets in Eco-Indicator 99 were used.

The data show similar results for the houses for all five methods. In most cases the CMU house has lower (better) impact indicators in the colder climates (St. Louis, Denver, and Minneapolis). In the warmer climates, Lake Charles and Tucson, the impact indicators are generally greater for the CMU house because household energy use is also greater. The exceptions are (i) in the categories "land use" and "minerals" in the Eco-Indicator method and the categories "severe morbidity," "species extinction," and "severe nuisance" in the EPS 2000 method, where indicators for the CMU house are greater, and (ii) "radiation" and "ozone layer" in the Eco-Indicator method and the categories "ozone depletion" and "ecotoxicity" in the EDIP/UMIP 96 method, where indicators for the wood house are greater.

The most significant environmental impacts are not from the construction materials but from the production and use of electricity and natural gas in the houses by the occupants.

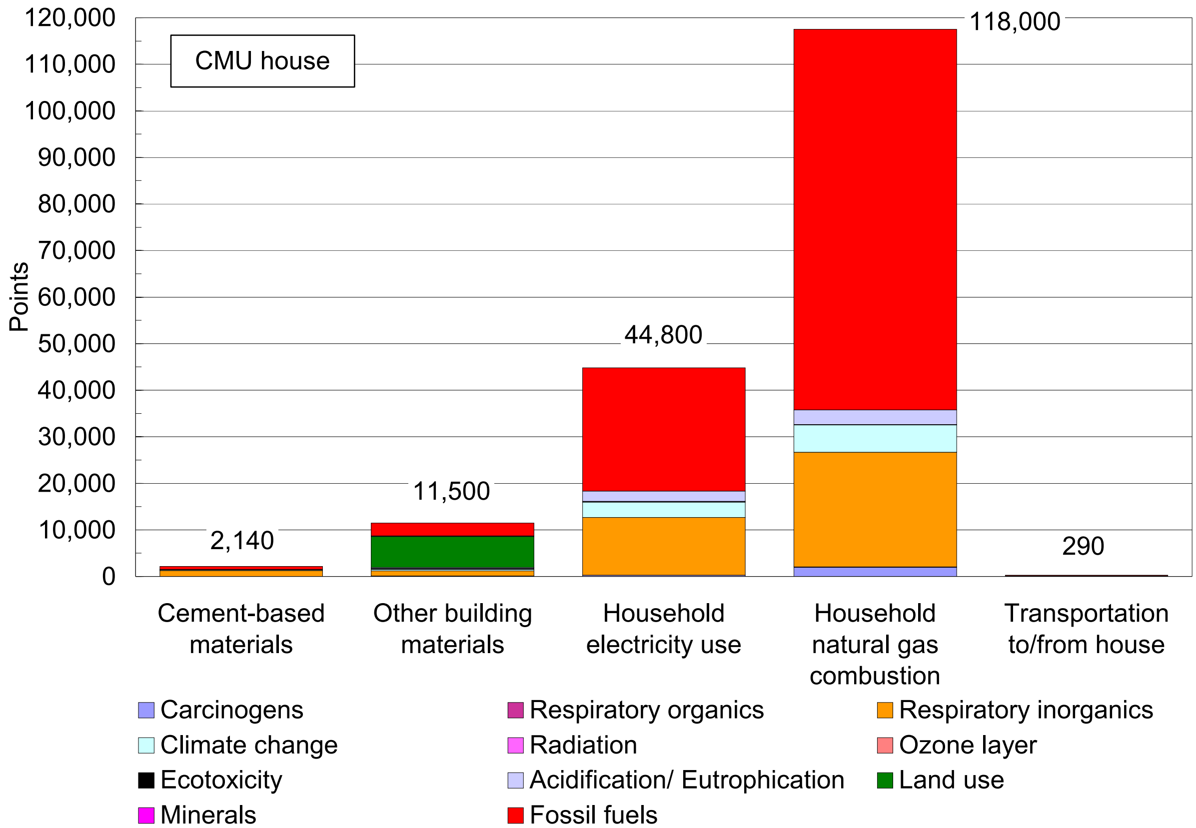

Figure 3. Single-score life cycle inventory assessment of CMU house in Minneapolis showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

Furthermore, the largest impacts from these uses are in the form of depletion of fossil fuel reserves (categorized as damage to natural resources) and release to the air of respiratory inorganics (categorized as damage to human health).

When considering only the construction materials, most of the environmental load is from wood and copper tubing, with total cement-based materials third.

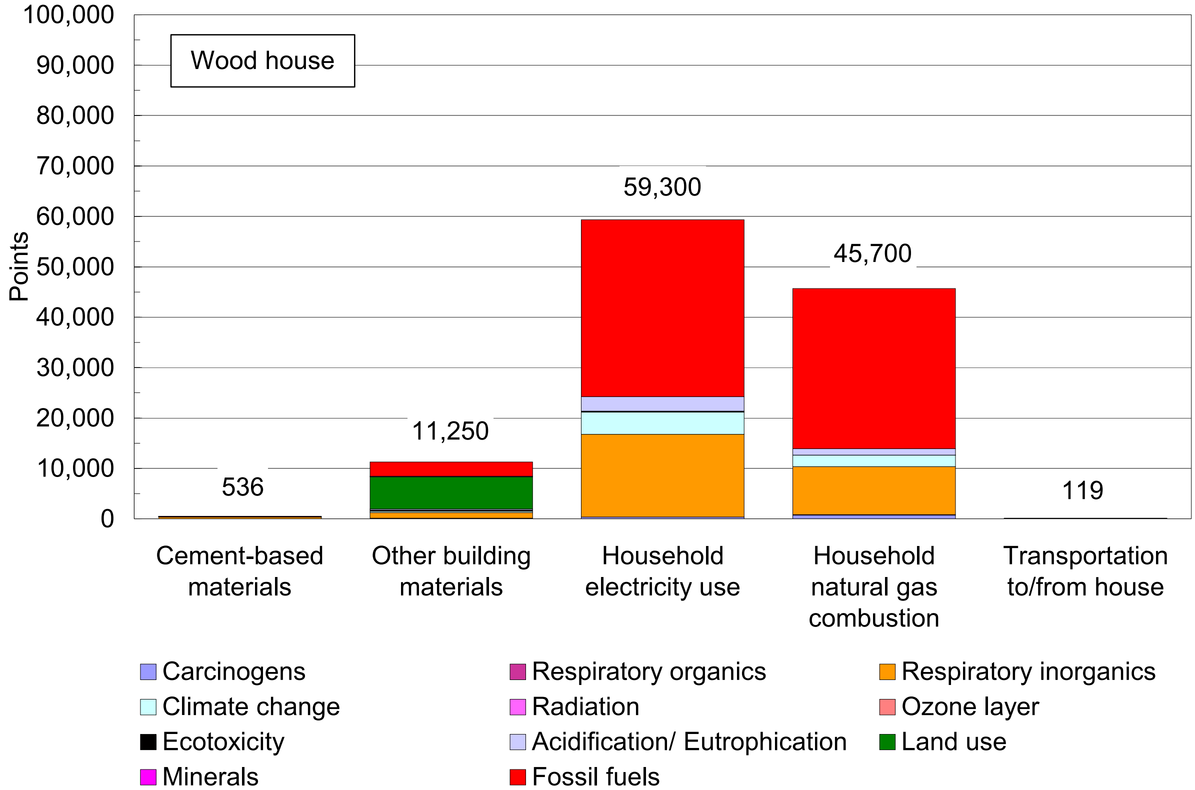

Figure 4. Single-score life cycle inventory assessment of wood frame house in Lake Charles showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

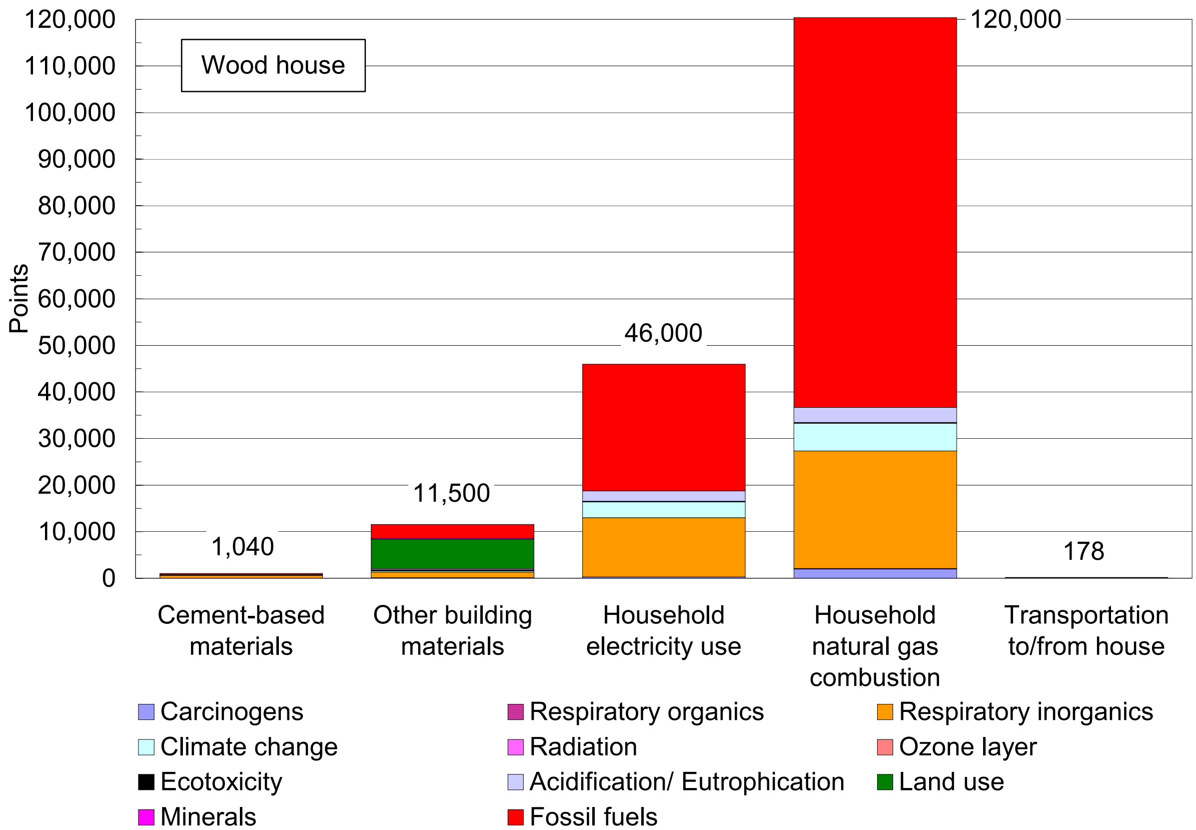

Figure 5. Single-score life cycle inventory assessment of wood frame house in Minneapolis showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

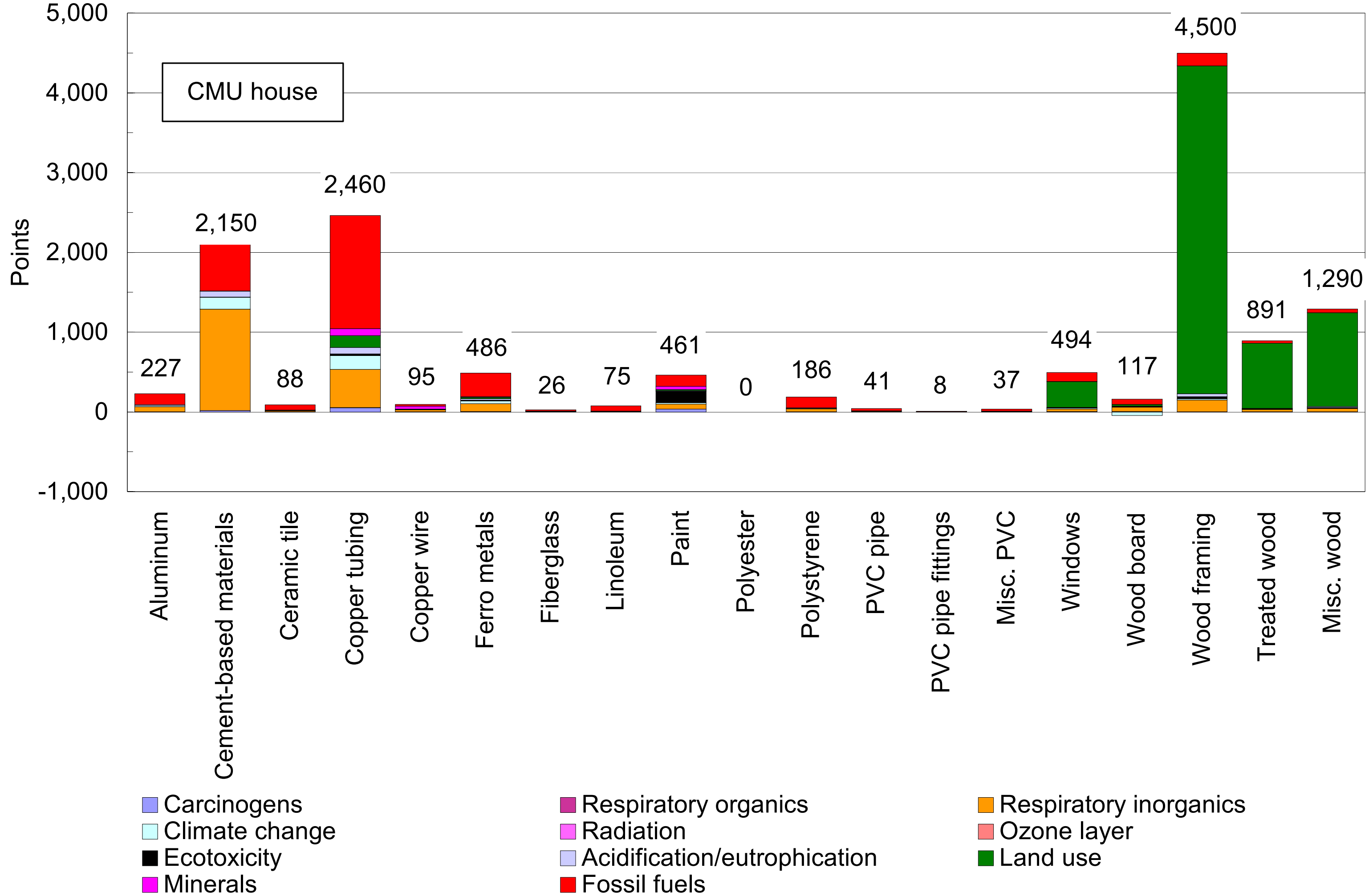

Figure 6. Single-score life cycle inventory assessment for construction materials in the CMU house in Minneapolis (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

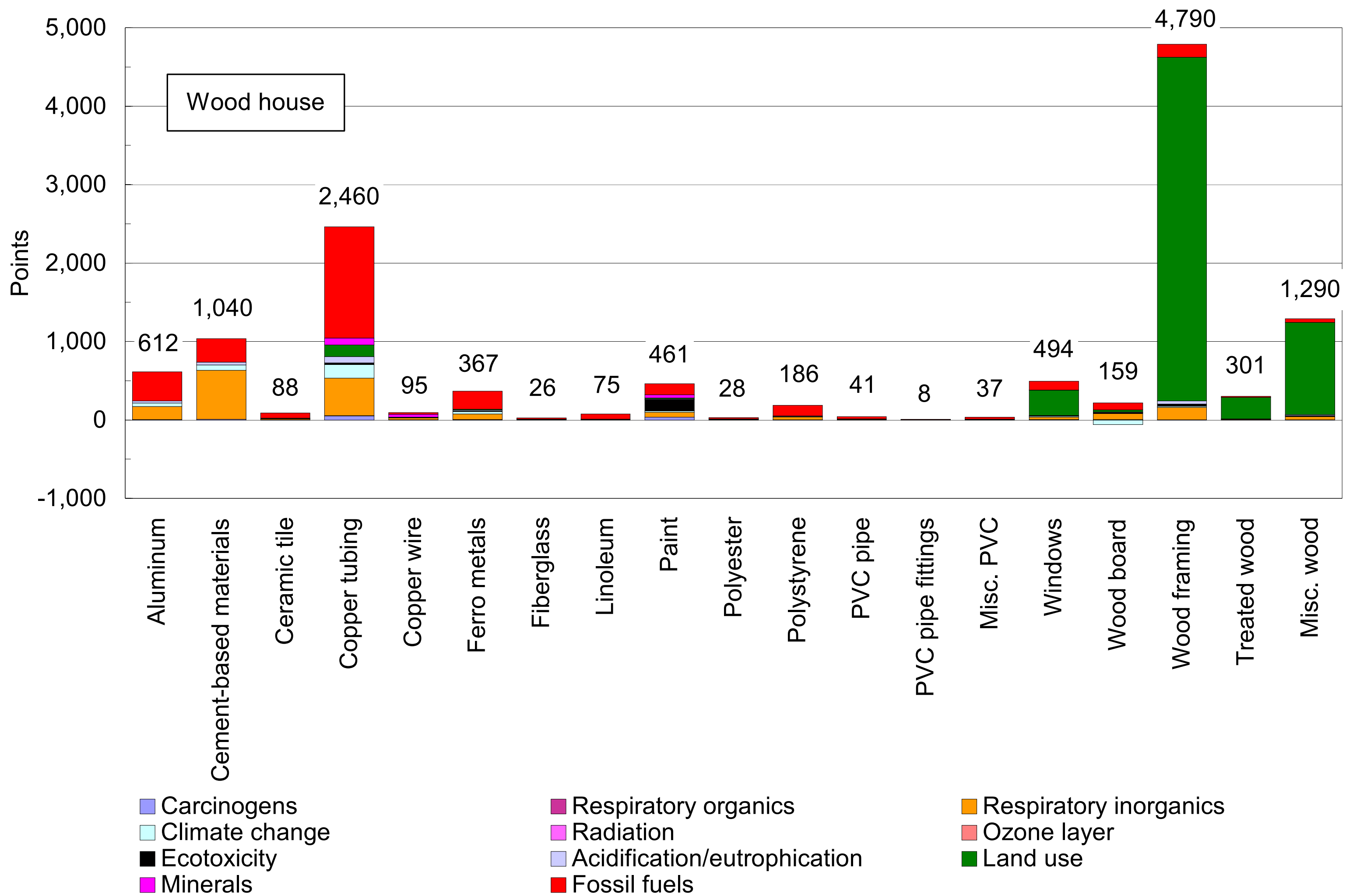

Figure 7. Single-score life cycle inventory assessment for construction materials in the wood frame house in Minneapolis (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

ACKNOWLEDGEMENTS

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APPENDIX A – TARGET AUDIENCES AND INFORMATION TO BE COMMUNICATED

This report is one of many for the Environmental Life Cycle Assessment (LCA) of Portland Cement Concrete project sponsored by the Portland Cement Association.
The objectives of publishing reports and disseminating information are to:

- Determine the environmental life cycle benefits associated with the use of these products.
- Produce comparisons of concrete and other building materials.
- Provide information about these benefits to manufacturers and users of these products.
- Provide life cycle inventory (LCI) and LCA information to practitioners and others, such as data base providers in need of accurate data on cement and concrete.

The contents of the reports will provide information for the following audiences:

- Members of the Portland Cement Association (PCA) and other organizations that promote the use of cement and concrete, generally called "allied industries."
- Members of the Environmental Council of Concrete Organizations (ECCO).
- LCA practitioners and database developers.
- Engineers, architects, and designers.
- Public agencies (Departments of Transportation [DOTs], Energy Star, Environmentally Preferable Purchasing Program).
- General public.

The report formats are not particularly suited for all audiences. The reports are intended to document the particular partial LCI, LCI, or LCA. They provide data in a transparent, traceable format for documentation purposes. The intent is that abbreviated papers, brochures, data packages, presentations, or press releases can be developed from the project reports. The materials presenting the results of this project will be matched, in form and format, to the needs of the target audience. The materials have been categorized as follows:

- General Information:
  - Purpose of life cycle assessments (LCAs) and how they are done.
  - Limited life cycle results of portland cement concrete products from production through use to demolition and recycling.
- Summary Results:
  - Presentation of selected life cycle inventory (LCI) data in the form of summary information, bar charts or other diagrams; for example PowerPoint™ presentations.
  - Published papers or articles.
- Detailed Results:
  - LCI results for databases or LCA models, such as BEES or Athena.
  - Description of the LCI methodology used in the project and specific assumptions, information sources/references, and detailed results.

APPENDIX B – HOUSE PLANS AND WALL CROSS-SECTIONS

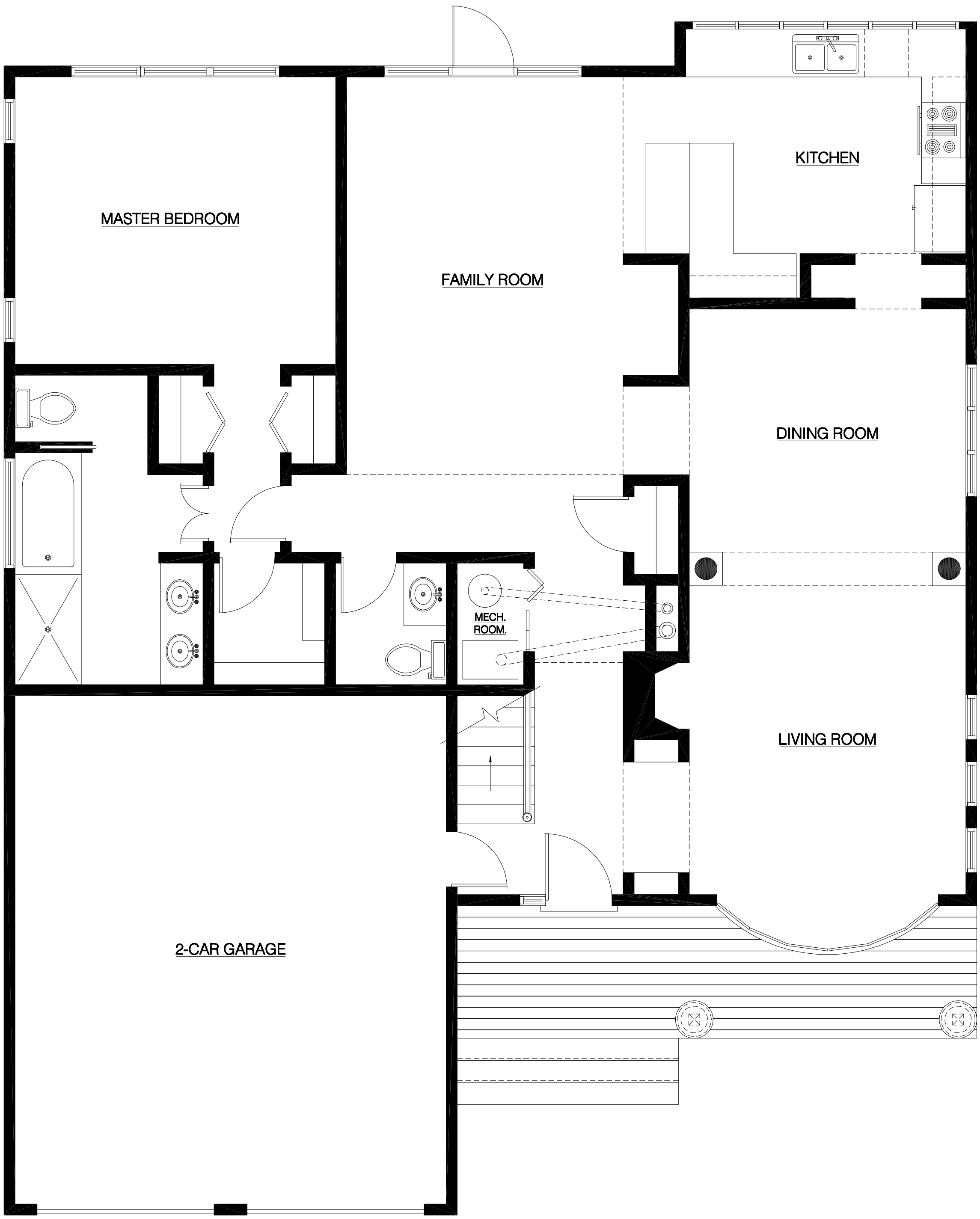

Figure B-1. Floor plan of the lower level.

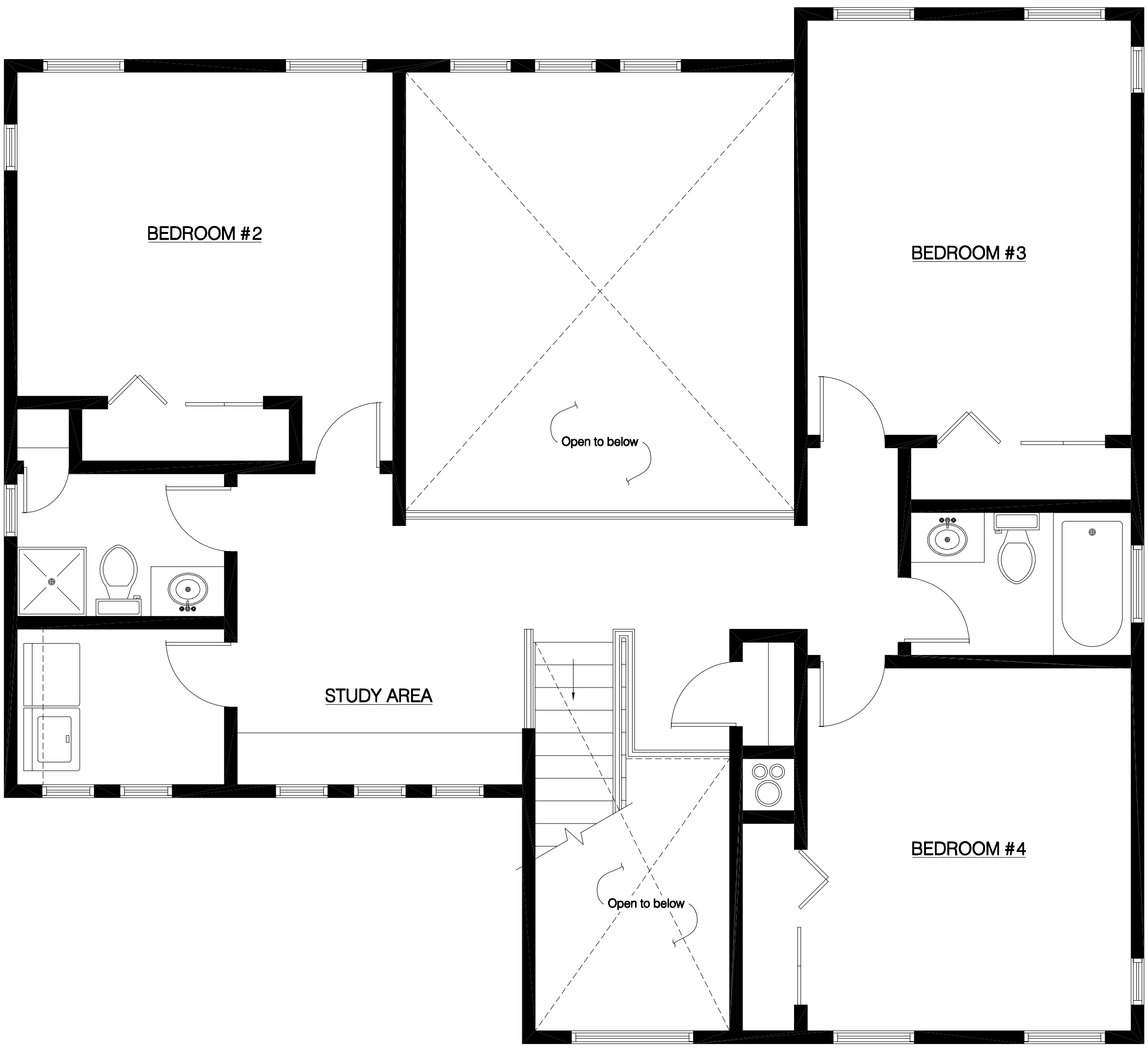

Figure B-2. Floor plan of the upper level.

Figure B-3. Front elevation.

Figure B-4. Rear elevation.

Figure B-5. Right elevation.

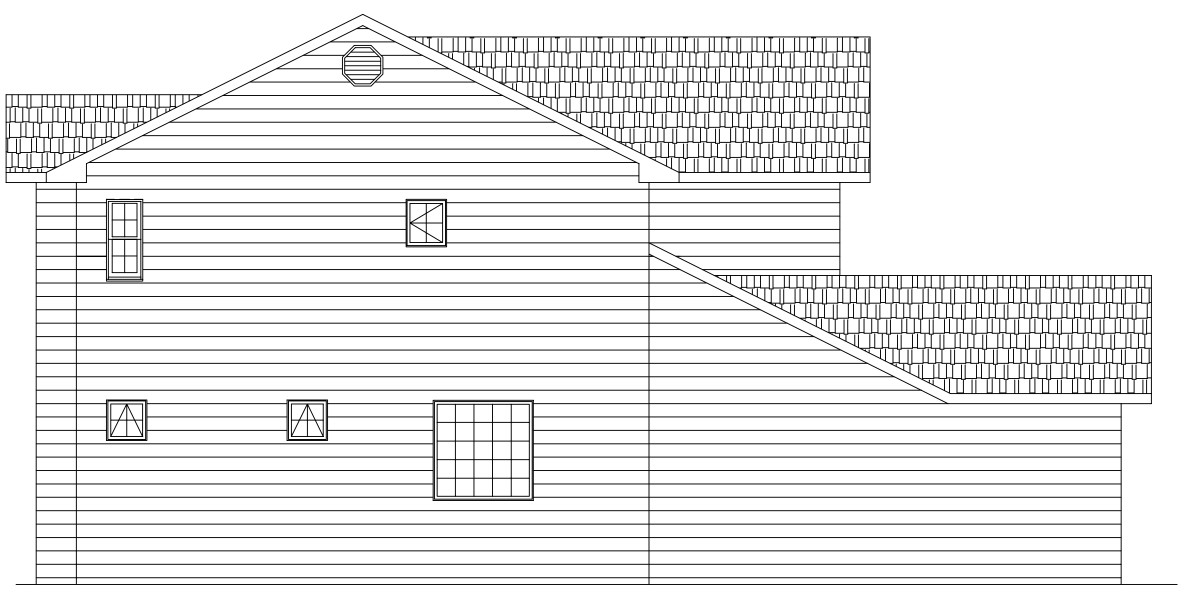

Figure B-6. Left elevation.

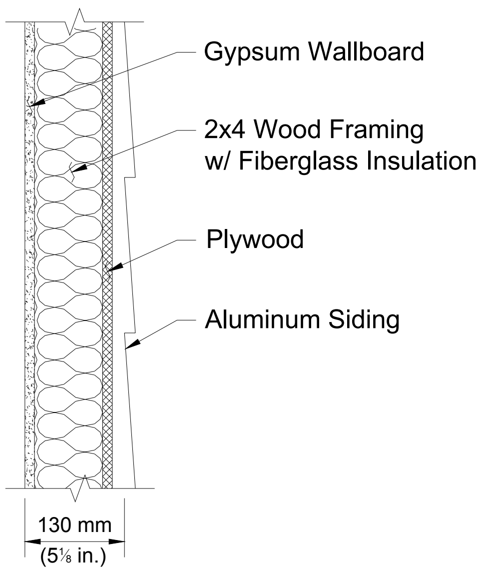

Figure B-7. Wood frame wall cross-section.

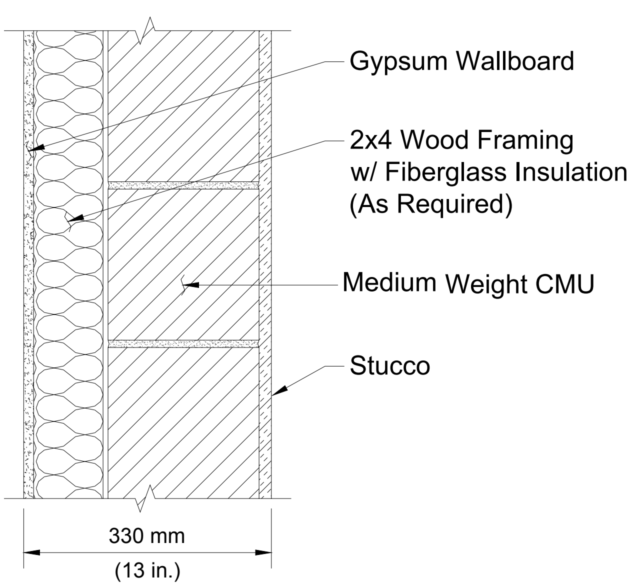

Figure B-8. CMU wall cross-section.

APPENDIX C – LCI DATA FOR WOOD HOUSES AND CMU HOUSES – SI UNITS

SIMAPRO: A LIFE CYCLE ASSESSMENT TOOL

The Dutch company PRé Consultants is a leader in developing tools for life cycle assessment. They created and continue to develop SimaPro, the most widely used life cycle assessment tool (www.pre.nl/simapro). SimaPro can be used to perform detailed and robust life cycle assessments of materials, components, buildings, and processes. It contains a large database of products and processes and seven comprehensive, widely-accepted impact assessment methods.

The user can either build up a product or process from scratch using the databases supplied with SimaPro, or the LCI of an existing product or process can be augmented with upstream and downstream profiles for other processes to determine a life cycle assessment. The impact assessment methods can be utilized to determine the impacts of materials, energy use, and pollutants. For example, upstream profiles can be the energy sources or extraction of raw materials. Downstream profiles can be other manufacturing steps used to make a final product.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
air	Raw	kg	170	170	170	170	170
barrage water	Raw	ton	96.9	96.9	96.9	96.9	96.9
baryte	Raw	kg	12.2	12.2	12.2	12.2	12.2
bauxite	Raw	kg	222	222	222	222	222
bentonite	Raw	kg	9.29	9.29	9.3	9.3	9.31
chromium (in ore)	Raw	kg	73	73	73	73	73
clay	Raw	kg	907	977	1.19E3	1.4E3	1.75E3
clay minerals	Raw	g	6.96	6.96	6.96	6.96	6.96
coal	Raw	kg	397	434	545	655	840
coal ETH	Raw	ton	6.49	6.52	6.6	6.69	6.83
coal FAL	Raw	ton	397	449	362	312	314
cobalt (in ore)	Raw	µg	541	541	542	542	543
copper (in ore)	Raw	kg	98.3	98.3	98.3	98.3	98.3
crude oil	Raw	kg	3.48	4.07	5.81	7.56	10.5
crude oil (feedstock) FAL	Raw	kg	0	29.2	117	205	351
crude oil ETH	Raw	ton	2.17	2.17	2.17	2.17	2.17
crude oil FAL	Raw	ton	19.7	21.7	21	19.4	21.3
crude oil IDEMAT	Raw	ton	9.46	9.47	9.49	9.51	9.54
dolomite	Raw	kg	21.7	21.7	21.7	25.1	25.1
energy (undef.)	Raw	GJ	31.8	31.8	31.9	31.9	32
energy from hydro power	Raw	GJ	633	709	581	508	509
energy from uranium	Raw	MJ	8.74	10.2	14.6	19	26.3
feldspar	Raw	kg	21.7	21.7	21.7	25.1	25.1
fluorspar	Raw	g	1.55	1.55	1.55	1.55	1.55
gas from oil production	Raw	m3	57.3	57.3	57.3	57.3	57.3
gravel	Raw	ton	34.8	37.4	45.5	53.5	66.8

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
gypsum	Raw	kg	678	731	890	1.05E3	1.31E3
iron (in ore)	Raw	kg	486	548	733	919	1.23E3
iron (ore)	Raw	ton	2.68	2.68	2.7	2.73	2.76
K	Raw	kg	39.7	39.7	39.7	39.7	39.7
lead (in ore)	Raw	kg	143	143	143	143	143
lignite	Raw	ton	1.27	1.27	1.27	1.27	1.27
lignite ETH	Raw	ton	1.46	1.46	1.46	1.46	1.46
limestone	Raw	ton	39.2	43.5	42.2	43.1	49.4
manganese (in ore)	Raw	kg	2.65	3.08	4.36	5.63	7.76
manganese (ore)	Raw	g	1.12	1.12	1.12	1.12	1.12
marl	Raw	ton	7.6	7.84	8.53	9.22	10.4
methane (kg)	Raw	kg	31.2	31.2	31.2	31.2	31.3
methane (kg) ETH	Raw	kg	14.5	14.7	15.5	16.2	17.4
molybdene (in ore)	Raw	mg	1.15	1.15	1.15	1.15	1.15
NaCl	Raw	kg	605	605	605	605	605
NaOH	Raw	kg	65.2	65.2	65.2	75.2	75.2
natural gas	Raw	ton	3.73	3.73	3.74	3.75	3.76
natural gas (feedstock) FAL	Raw	kg	0	7.59	30.4	53.1	91.1
natural gas ETH	Raw	m3	1.69E3	1.69E3	1.69E3	1.69E3	1.7E3
natural gas FAL	Raw	ton	292	282	493	512	643
nickel (in ore)	Raw	g	315	315	315	316	316
nitrogen	Raw	kg	13.1	13.1	13.1	13.1	13.1
oxygen	Raw	kg	218	218	218	218	218
palladium (in ore)	Raw	mg	1.93	1.93	1.93	1.93	1.93
petroleum gas ETH	Raw	m3	67.5	67.5	67.6	67.6	67.6
phosphate (ore)	Raw	mg	671	671	671	671	671

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
platinum (in ore)	Raw	mg	2.18	2.18	2.18	2.18	2.18
potential energy water ETH	Raw	GJ	8.94	8.94	8.95	8.95	8.96
reservoir content ETH	Raw	m3y	192	192	192	192	192
rhenium (in ore)	Raw	mg	1.82	1.82	1.82	1.82	1.82
rhodium (in ore)	Raw	mg	2.05	2.05	2.05	2.05	2.05
rock salt	Raw	kg	659	659	659	659	659
sand	Raw	ton	28.5	30.4	36.4	42.4	52.3
scrap, external	Raw	kg	849	849	849	849	849
shale	Raw	kg	721	777	945	1.11E3	1.39E3
silicon (in SiO2)	Raw	kg	1.26	1.47	2.1	2.74	3.79
silver	Raw	g	3.47	3.47	3.47	3.47	3.48
silver (in ore)	Raw	g	3.1	3.1	3.1	3.1	3.1
sulphur	Raw	kg	11.6	11.6	11.6	11.6	11.6
tin (in ore)	Raw	g	3.65	3.65	3.65	3.66	3.66
turbine water ETH	Raw	m3	4.6E4	4.6E4	4.60E4	4.61E4	4.61E4
uranium (in ore)	Raw	g	400	400	400	400	400
uranium (in ore) ETH	Raw	g	99.3	99.3	99.4	99.4	99.6
uranium (ore)	Raw	kg	7.04	7.04	7.04	7.04	7.04
uranium FAL	Raw	kg	1.55	1.76	1.42	1.22	1.23
water	Raw	ton	987	988	992	996	1E3
wood	Raw	ton	22.7	22.7	22.7	22.7	22.7
wood (dry matter) ETH	Raw	ton	12.8	12.8	12.8	12.8	12.8
wood/wood wastes FAL	Raw	kg	343	370	402	381	433
zeolite	Raw	g	80.9	80.9	80.9	80.9	80.9
zinc (in ore)	Raw	g	7.19	7.19	7.2	7.2	7.21
1,2-dichloroethane	Air	mg	59.6	59.6	59.7	59.7	59.8

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
acetaldehyde	Air	g	15.1	15.1	15.1	15.1	15.1
acetic acid	Air	g	50.7	50.7	50.8	50.8	50.8
acetone	Air	g	12.1	12.1	12.1	12.1	12.1
acrolein	Air	g	13.5	15.3	12.3	10.6	10.6
Al	Air	g	358	358	360	361	363
aldehydes	Air	kg	4.55	4.8	5.64	5.54	6.44
alkanes	Air	g	158	158	158	158	158
alkenes	Air	g	168	168	168	169	169
ammonia	Air	kg	4.35	4.82	4.06	3.62	3.64
As	Air	g	91.6	97.8	87.9	82.1	82.6
B	Air	g	79.5	79.5	79.6	79.7	79.8
Ba	Air	g	4.67	4.67	4.69	4.7	4.72
Be	Air	g	5.59	6.33	5.13	4.43	4.46
benzaldehyde	Air	μg	612	612	612	613	613
benzene	Air	g	183	186	182	180	181
benzo(a)pyrene	Air	mg	117	130	168	206	270
Br	Air	g	16.4	16.4	16.4	16.4	16.5
butane	Air	g	195	195	195	195	196
butene	Air	g	5.92	5.92	5.92	5.92	5.92
Ca	Air	g	131	131	132	132	132
Cd	Air	g	12.9	14.2	13.1	12	12.7
CFC-11	Air	mg	31.3	31.3	31.3	31.3	31.3
CFC-114	Air	mg	828	828	829	830	830
CFC-116	Air	g	2.44	2.44	2.44	2.44	2.45
CFC-12	Air	mg	6.72	6.73	6.73	6.73	6.74
CFC-13	Air	mg	4.22	4.22	4.22	4.22	4.23

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
CFC-14	Air	g	21.9	21.9	21.9	21.9	21.9
Cl2	Air	kg	0.336	0.385	0.529	0.679	0.921
CO	Air	ton	1.81	1.8	2.75	2.82	3.44
CO2	Air	ton	509	470	940	999	1.27E3
CO2 (fossil)	Air	ton	1.11E3	1.25E3	1.07E3	944	981
CO2 (non-fossil)	Air	kg	462	501	530	498	561
coal dust	Air	mg	259	259	259	259	259
cobalt	Air	g	20.9	23.1	20.3	18.2	18.8
Cr	Air	g	86.8	97	80.6	71	71.6
Cu	Air	g	10.4	10.5	10.8	11.1	11.6
CxHy	Air	kg	58.2	58.3	58.6	58.8	59.2
CxHy aromatic	Air	g	1.77	1.77	1.77	1.77	1.77
CxHy chloro	Air	g	5.98	5.98	5.98	6.89	6.89
cyanides	Air	mg	45.1	46.3	49.9	53.5	59.5
dichloroethane	Air	mg	197	197	197	197	197
dichloromethane	Air	g	57.1	64.8	52.2	44.9	45.1
dioxin (TEQ)	Air	µg	119	135	139	150	183
dust	Air	kg	36.7	34.2	63.9	67.5	84.6
dust (coarse)	Air	kg	21.4	21.4	21.4	21.5	21.5
dust (coarse) process	Air	kg	4	4.02	4.08	4.15	4.26
dust (PM10)	Air	kg	33.2	35.8	43.5	51.3	64.2
dust (PM10) mobile	Air	g	164	164	164	164	165
dust (PM10) stationary	Air	kg	8.71	8.71	8.72	8.72	8.72
dust (SPM)	Air	kg	5.29	5.35	5.54	5.76	6.07
ethane	Air	g	362	363	364	365	367
ethanol	Air	g	24.2	24.2	24.2	24.3	24.3

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
ethene	Air	g	105	106	108	110	113
ethylbenzene	Air	g	64.4	64.4	64.4	64.5	64.5
ethyne	Air	g	1.53	1.55	1.61	1.68	1.79
F2	Air	g	11.6	12.2	13.9	16.5	19.3
Fe	Air	g	182	182	183	183	184
fluoranthene	Air	g	0.216	0.252	0.36	0.469	0.649
fluoride	Air	g	2.43	2.43	2.43	2.43	2.43
formaldehyde	Air	g	185	191	181	176	177
H2	Air	g	225	225	225	225	225
H2S	Air	g	81.2	88.2	109	130	165
HALON-1301	Air	mg	665	665	665	665	665
HCFC-21	Air	mg	638	638	639	639	640
HCFC-22	Air	mg	7.45	7.45	7.46	7.46	7.47
HCl	Air	kg	71.4	80.6	65.5	56.9	57.1
He	Air	g	68	68	68	68	68.1
heptane	Air	g	37.8	37.8	37.8	37.9	37.9
hexachlorobenzene	Air	µg	12.4	12.4	12.4	12.4	12.5
hexane	Air	g	79.8	79.8	79.9	79.9	79.9
HF	Air	kg	12.5	13.7	11.7	10.5	10.5
HFC-134a	Air	pg	-0.0303	-0.0303	-0.0303	-0.0302	-0.0302
Hg	Air	g	26.9	30.4	24.8	21.6	21.8
I	Air	g	6.06	6.06	6.07	6.07	6.08
K	Air	g	54.8	54.8	55	55.2	55.5
kerosene	Air	g	343	389	313	269	270
La	Air	mg	136	136	137	137	138
metals	Air	g	266	282	293	280	305

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
methane	Air	ton	3.84	4.02	4.99	4.88	5.75
methanol	Air	g	24.9	24.9	24.9	24.9	24.9
Mg	Air	g	118	118	118	118	119
Mn	Air	g	165	185	152	133	134
Mo	Air	mg	986	986	987	987	988
MTBE	Air	mg	83.8	83.8	83.8	83.8	83.8
n-nitrodimethylamine	Air	g	2.84	3.23	2.6	2.23	2.25
N2	Air	g	405	405	405	405	405
N2O	Air	kg	27.5	27.9	34.6	34.6	39.6
Na	Air	g	66.7	66.7	66.8	66.9	67
naphthalene	Air	g	7.17	7.26	7.22	7.15	7.23
Ni	Air	g	218	239	216	196	205
NO2	Air	kg	1.5	1.58	1.83	2.08	2.49
non methane VOC	Air	ton	2.83	2.75	4.66	4.82	6.03
NOx	Air	ton	4.84	5.28	5.27	4.9	5.4
NOx (as NO2)	Air	kg	26.4	26.4	26.5	26.5	26.6
organic substances	Air	kg	15.9	16.5	20	20.9	24.6
P	Air	g	2.95	2.95	2.95	2.95	2.96
P-tot	Air	g	1.41	1.41	1.42	1.43	1.43
PAH’s	Air	g	3.42	3.42	3.42	3.42	3.43
particulates (PM10)	Air	kg	204	231	185	160	161
particulates (unspecified)	Air	kg	1.06E3	1.19E3	981	855	865
Pb	Air	g	517	524	518	515	520
pentachlorobenzene	Air	µg	33.3	33.3	33.3	33.3	33.3
pentachlorophenol	Air	µg	5.37	5.37	5.37	5.38	5.38
pentane	Air	g	364	364	365	365	365

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
phenol	Air	g	43.2	47.7	41.9	38.5	39.8
phosphate	Air	g	1.18	1.18	1.18	1.18	1.18
propane	Air	g	254	254	255	255	256
propene	Air	g	14.5	14.5	14.6	14.8	15
propionic acid	Air	mg	315	316	317	320	322
Pt	Air	µg	675	675	675	676	676
Sb	Air	g	6.41	7.18	6.18	5.47	5.68
Sc	Air	mg	54.7	54.8	55	55.2	55.5
Se	Air	g	98.1	111	90.1	78.1	78.6
silicates	Air	g	697	697	699	701	703
Sn	Air	mg	117	117	117	117	117
SO2	Air	kg	376	378	385	390	400
soot	Air	kg	1.97	1.97	1.98	2	2.02
SOx	Air	ton	15.8	16.2	22	21.9	26.4
SOx (as SO2)	Air	kg	44.7	44.7	44.8	44.8	44.9
Sr	Air	g	5.55	5.56	5.57	5.58	5.6
tetrachloroethene	Air	g	12.8	14.6	11.7	10.1	10.1
tetrachloromethane	Air	g	21.2	24	19.7	17.1	17.3
Th	Air	mg	258	258	258	259	259
Ti	Air	g	16.5	16.5	16.5	16.6	16.6
Tl	Air	mg	21.5	21.5	21.6	21.6	21.7
toluene	Air	g	222	222	222	223	223
trichloroethene	Air	g	12.7	14.4	11.6	9.99	10
trichloromethane	Air	mg	5.2	5.2	5.2	5.2	5.2
U	Air	mg	133	134	134	134	134
V	Air	g	126	126	126	126	126

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
vinyl chloride	Air	mg	66.1	66.1	66.2	66.2	66.2
VOC	Air	kg	22.4	20.6	42.3	45.1	57.9
water	Air	ton	20.2	20.2	20.2	20.2	20.2
xylene	Air	g	144	144	144	144	144
Zn	Air	g	225	225	226	228	229
Zr	Air	mg	13.3	14	16	18	21.3
1,1,1-trichloroethane	Water	µg	162	162	162	162	162
acenaphthylene	Water	mg	857	857	857	857	858
Acid as H+	Water	g	114	114	114	114	114
acids (unspecified)	Water	g	3.54	4.81	8.63	12.4	18.8
Ag	Water	mg	71.1	71.2	71.2	71.2	71.3
Al	Water	kg	10.5	10.6	10.7	10.9	11.1
alkanes	Water	g	14.4	14.4	14.4	14.4	14.4
alkenes	Water	g	1.31	1.31	1.31	1.31	1.32
AOX	Water	mg	394	394	394	394	395
As	Water	g	21.3	21.4	21.7	22	22.4
B	Water	kg	36.4	41.2	33.3	28.7	28.9
Ba	Water	kg	1.1	1.11	1.12	1.13	1.15
baryte	Water	kg	2.48	2.48	2.48	2.48	2.48
Be	Water	mg	8.84	8.84	8.85	8.85	8.86
benzene	Water	g	14.6	14.6	14.6	14.6	14.6
BOD	Water	kg	16	15.6	25.4	26.2	32.4
calcium compounds	Water	kg	8.36	8.36	8.37	8.38	8.39
calcium ions	Water	kg	237	237	237	237	237
Cd	Water	kg	0.706	0.681	1.19	1.24	1.55
chlorinated solvents (unspec.)	Water	mg	7.29	7.3	7.34	7.38	7.44

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
chlorobenzenes	Water	µg	4.06	4.06	4.06	4.06	4.06
chromate	Water	g	9.68	10.8	9.66	8.64	9.15
Cl-	Water	kg	1.26E3	1.24E3	1.75	1.79E3	2.11E3
Co	Water	g	20.7	20.8	21.1	21.3	21.8
COD	Water	kg	142	142	205	208	251
Cr	Water	kg	0.813	0.789	1.3	1.35	1.67
Cr (VI)	Water	mg	24.8	24.8	24.8	24.8	24.8
crude oil	Water	g	278	278	278	279	280
Cs	Water	mg	109	109	109	109	109
Cu	Water	g	54	54.3	55	55.7	56.9
CxHy	Water	kg	1.63	1.63	1.63	1.63	1.63
CxHy aromatic	Water	g	67.5	67.5	67.5	67.6	67.6
CxHy chloro	Water	mg	24.6	24.6	24.6	24.7	24.7
cyanide	Water	g	6.11	6.11	6.98	7.15	7.79
detergent/oil	Water	g	38.7	38.7	38.7	38.7	38.7
di(2-ethylhexyl)phthalate	Water	µg	10.2	10.2	10.2	10.2	10.2
dibutyl p-phthalate	Water	µg	86.7	86.7	86.7	86.7	86.8
dichloroethane	Water	mg	131	131	131	131	131
dichloromethane	Water	mg	663	663	663	664	664
dimethyl p-phthalate	Water	µg	546	546	547	547	547
dissolved organics	Water	kg	1.27	1.27	1.27	1.27	1.27
dissolved solids	Water	ton	15.4	14.8	25.9	26.9	33.7
dissolved substances	Water	kg	4.45	4.47	4.52	4.58	4.67
DOC	Water	g	22.9	22.9	22.9	22.9	22.9
ethyl benzene	Water	g	2.61	2.61	2.61	2.61	2.61
F2	Water	g	8.53	8.53	8.53	9.84	9.84

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
fats/oils	Water	kg	1.09	1.09	1.09	1.09	1.09
fatty acids as C	Water	g	255	255	255	256	256
Fe	Water	kg	59.3	66.5	54.7	48	48.3
fluoride ions	Water	kg	8.23	8.42	8.11	7.94	7.94
formaldehyde	Water	g	7.22	7.22	7.22	7.22	7.22
glutaraldehyde	Water	mg	306	306	306	306	306
H2	Water	g	262	262	263	263	264
H2S	Water	g	0.706	0.74	0.841	0.942	1.11
H2SO4	Water	kg	9.09	10.3	8.32	7.18	7.23
herbicides	Water	µg	1.48	1.48	1.48	1.48	1.48
hexachloroethane	Water	µg	2.25	2.25	2.25	2.25	2.25
Hg	Water	mg	114	112	154	158	185
HOCL	Water	g	69.6	69.6	69.7	69.7	69.8
I	Water	g	10.8	10.8	10.8	10.8	10.8
inorganic general	Water	kg	267	267	267	267	267
K	Water	kg	3.78	3.79	3.84	3.88	3.95
Kjeldahl-N	Water	g	108	127	181	235	326
metallic ions	Water	kg	0.977	1.02	1	0.975	1.02
Mg	Water	kg	8.91	8.95	9.06	9.17	9.35
Mn	Water	kg	31.3	35.4	28.6	24.7	24.8
Mo	Water	g	34.3	34.4	34.7	35.1	35.6
MTBE	Water	mg	9.77	9.77	9.77	9.77	9.77
N-tot	Water	g	266	266	266	267	267
N organically bound	Water	g	10.9	10.9	10.9	10.9	10.9
Na	Water	kg	135	135	135	135	136
NH3	Water	g	722	802	684	610	622

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
NH3 (as N)	Water	g	408	408	409	410	411
NH4+	Water	g	3.09	3.09	3.09	3.09	3.09
Ni	Water	g	54	54.3	55	55.7	56.8
nitrate	Water	g	433	450	422	406	407
nitrite	Water	g	3.93	3.93	3.93	3.94	3.95
nitrogen	Water	g	7.54	7.54	7.54	7.54	7.54
non methane VOC	Water	g	0	2.99	12	20.9	35.9
OCl-	Water	g	15.9	15.9	15.9	15.9	15.9
oil	Water	kg	275	265	462	480	602
other organics	Water	kg	51.2	50.6	81.1	83	103
P-compounds	Water	mg	46.5	46.9	48.2	49.4	51.5
P-tot	Water	mg	13.2	13.2	13.2	13.2	13.2
P2O5	Water	g	13.4	13.4	13.4	13.4	13.4
PAH’s	Water	g	2.59	2.59	2.6	2.6	2.6
Pb	Water	g	63.9	64.2	64.9	65.6	66.9
pesticides	Water	ng	751	751	751	751	751
phenol	Water	g	14.6	14.7	14.7	14.6	14.7
phenols	Water	g	7	7	7	7.01	7.01
phosphate	Water	kg	10.6	11.2	10.3	9.69	9.73
Ru	Water	mg	497	498	498	498	498
S	Water	g	1.82	1.82	1.82	1.83	1.83
salt	Water	g	389	389	390	390	391
salts	Water	kg	4.99	5	5.03	5.06	5.12
Sb	Water	mg	158	158	158	158	158
Se	Water	g	52.9	53.1	53.8	54.5	55.6
Si	Water	g	1.51	1.51	1.51	1.51	1.51

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Sn	Water	mg	125	125	125	125	125
SO3	Water	g	11.3	11.3	11.3	11.3	11.3
Sr	Water	g	780	781	782	784	787
sulphate	Water	kg	753	757	1.12E3	1.13E3	1.38E3
sulphates	Water	kg	64.6	64.6	64.7	64.7	64.8
sulphide	Water	g	1.63	2.23	4.02	5.81	8.8
suspended solids	Water	kg	711	799	669	586	599
suspended substances	Water	kg	4.64	4.64	4.64	4.64	4.65
tetrachloroethene	Water	µg	267	267	267	267	267
tetrachloromethane	Water	µg	407	407	407	407	407
Ti	Water	g	622	625	633	641	655
TOC	Water	kg	2.56	2.56	2.56	2.57	2.57
toluene	Water	g	12.7	12.7	12.7	12.7	12.7
tributyltin	Water	mg	398	398	399	399	399
trichloroethene	Water	mg	22	22	22	22	22
trichloromethane	Water	mg	62.5	62.5	62.5	62.5	62.5
triethylene glycol	Water	g	22.9	22.9	22.9	22.9	22.9
undissolved substances	Water	kg	58.7	58.7	58.7	58.7	58.7
V	Water	g	55.8	56	56.7	57.4	58.5
vinyl chloride	Water	µg	75.7	75.7	75.8	75.8	75.8
VOC as C	Water	g	17.3	17.3	17.3	17.3	17.3
W	Water	mg	199	199	199	199	199
xylene	Water	g	10.5	10.5	10.5	10.5	10.5
Zn	Water	g	354	346	523	540	651
aluminium	Solid	kg	0	0	0	0	0
chemical waste	Solid	g	380	380	380	380	380

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
chemical waste (inert)	Solid	kg	9.11	9.11	9.11	9.11	9.11
chemical waste (regulated)	Solid	kg	3.89	3.89	3.89	3.89	3.89
dust – not specified	Solid	g	120	140	200	260	361
final waste (inert)	Solid	ton	1.96	1.96	1.96	1.96	1.96
high active nuclear waste	Solid	cm3	68	68	68	68	68
incinerator waste	Solid	g	24	24	24	24	24
industrial waste	Solid	kg	3.59	3.59	3.59	3.59	3.59
inorganic general	Solid	ton	12.7	12.7	12.7	12.7	12.7
low, med. act. nucl. waste	Solid	l	4.64	4.64	4.64	4.64	4.65
mineral waste	Solid	kg	56.4	56.4	56.4	56.4	56.5
oil	Solid	kg	15.5	15.6	15.8	16	16.4
plastic production waste	Solid	g	340	340	340	340	340
produc. waste (not inert)	Solid	kg	121	121	121	121	121
slag	Solid	kg	9.5	9.5	9.51	9.51	9.52
slags/ash	Solid	kg	1.87	1.87	1.87	1.87	1.87
solid waste	Solid	ton	212	235	216	196	209
unspecified	Solid	g	6.96	6.96	6.96	6.96	6.96
wood (sawdust)	Solid	ton	1.51	1.51	1.51	1.51	1.51
Al (ind.)	Soil	g	87.2	87.2	87.2	87.2	87.2
As (ind.)	Soil	mg	34.9	34.9	34.9	34.9	34.9
C (ind.)	Soil	g	268	268	268	268	268
Ca (ind.)	Soil	g	349	349	349	349	349
Cd (ind.)	Soil	mg	1.43	1.44	1.45	1.45	1.47
Co (ind.)	Soil	mg	1.34	1.34	1.35	1.35	1.35
Cr (ind.)	Soil	mg	436	436	436	436	436
Cu (ind.)	Soil	mg	6.72	6.72	6.72	6.72	6.73

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Fe (ind.)	Soil	g	175	175	175	175	175
Hg (ind.)	Soil	µg	218	220	225	231	240
Mn (ind.)	Soil	g	3.49	3.49	3.49	3.49	3.49
N	Soil	mg	86.4	88.3	94.1	100	110
Ni (ind.)	Soil	mg	10.1	10.1	10.1	10.1	10.1
oil (ind.)	Soil	g	309	309	309	309	310
oil biodegradable	Soil	g	167	167	167	167	167
P-tot	Soil	g	4.61	4.62	4.65	4.68	4.74
Pb (ind.)	Soil	mg	30.7	30.7	30.7	30.7	30.8
S (ind.)	Soil	g	52.4	52.4	52.4	52.4	52.4
Zn (ind.)	Soil	g	1.37	1.37	1.37	1.38	1.38
Ag110m to air	Non mat.	mBq	39.8	39.8	39.8	39.8	39.9
Ag110m to water	Non mat.	Bq	272	272	272	272	272
alpha radiation (unspecified) to water	Non mat.	mBq	32	32	32	32.1	32.1
Am241 to air	Non mat.	mBq	765	765	766	766	767
Am241 to water	Non mat.	Bq	101	101	101	101	101
Ar41 to air	Non mat.	kBq	86.2	86.2	86.2	86.3	86.4
Ba140 to air	Non mat.	mBq	181	181	181	182	182
Ba140 to water	Non mat.	mBq	932	932	933	933	934
beta radiation (unspecified) to air	Non mat.	mBq	8.41	8.41	8.42	8.42	8.43
C14 to air	Non mat.	kBq	62.6	62.6	62.6	62.7	62.7
C14 to water	Non mat.	kBq	5.08	5.08	5.09	5.09	5.1
Cd109 to water	Non mat.	mBq	5.41	5.41	5.41	5.41	5.41
Ce141 to air	Non mat.	mBq	3.72	3.72	3.72	3.73	3.73
Ce141 to water	Non mat.	mBq	140	140	140	140	140
Ce144 to air	Non mat.	Bq	8.14	8.14	8.15	8.15	8.16

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Ce144 to water	Non mat.	kBq	2.3	2.3	2.31	2.31	2.31
Cm (alpha) to air	Non mat.	Bq	1.21	1.21	1.21	1.22	1.22
Cm (alpha) to water	Non mat.	Bq	134	134	134	134	134
Cm242 to air	Non mat.	µBq	3.89	3.89	3.89	3.9	3.9
Cm244 to air	Non mat.	µBq	35.3	35.3	35.4	35.4	35.4
Co57 to air	Non mat.	µBq	67.8	67.8	67.9	67.9	68
Co57 to water	Non mat.	mBq	960	960	960	961	961
Co58 to air	Non mat.	Bq	1.13	1.13	1.13	1.13	1.13
Co58 to water	Non mat.	Bq	586	586	586	586	587
Co60 to air	Non mat.	Bq	1.71	1.71	1.71	1.71	1.72
Co60 to water	Non mat.	kBq	22.5	22.5	22.6	22.6	22.6
Conv. to continuous urban land	Non mat.	m2	1.72	1.73	1.76	1.79	1.84
Conv. to industrial area	Non mat.	m2	1.19	1.19	1.19	1.19	1.19
Cr51 to air	Non mat.	mBq	143	143	143	143	143
Cr51 to water	Non mat.	Bq	20.6	20.6	20.6	20.6	20.6
Cs134 to air	Non mat.	Bq	29	29	29	29.1	29.1
Cs134 to water	Non mat.	kBq	5.14	5.14	5.15	5.15	5.16
Cs136 to water	Non mat.	mBq	5.02	5.02	5.02	5.02	5.03
Cs137 to air	Non mat.	Bq	56	56.1	56.1	56.1	56.2
Cs137 to water	Non mat.	kBq	47.5	47.5	47.5	47.6	47.6
Fe59 to air	Non mat.	mBq	1.54	1.54	1.54	1.54	1.54
Fe59 to water	Non mat.	mBq	16.5	16.5	16.5	16.5	16.6
Fission and activation products (RA) to water	Non mat.	Bq	291	291	291	291	291
H3 to air	Non mat.	kBq	620	620	621	621	622
H3 to water	Non mat.	kBq	1.51E5	1.51E5	1.51E5	1.51E5	1.51E5
heat losses to air	Non mat.	GJ	217	219	224	230	240

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
heat losses to soil	Non mat.	MJ	91.9	92	92	92.1	92.1
heat losses to water	Non mat.	GJ	-12.3	-12.3	-12.2	-12.2	-12.2
I129 to air	Non mat.	Bq	218	218	219	219	219
I129 to water	Non mat.	kBq	14.5	14.5	14.6	14.6	14.6
I131 to air	Non mat.	Bq	31.3	31.3	31.3	31.4	31.4
I131 to water	Non mat.	Bq	11.2	11.2	11.2	11.2	11.2
I133 to air	Non mat.	Bq	13.2	13.2	13.2	13.2	13.2
I133 to water	Non mat.	Bq	4.28	4.28	4.28	4.28	4.29
I135 to air	Non mat.	Bq	19.7	19.7	19.7	19.7	19.7
K40 to air	Non mat.	Bq	143	143	143	143	144
K40 to water	Non mat.	Bq	387	387	387	388	388
Kr85 to air	Non mat.	kBq	3.76E6	3.76E6	3.77E6	3.77E6	3.77E6
Kr85m to air	Non mat.	kBq	6.79	6.79	6.79	6.8	6.8
Kr87 to air	Non mat.	kBq	2.67	2.67	2.67	2.67	2.67
Kr88 to air	Non mat.	kBq	172	172	172	173	173
Kr89 to air	Non mat.	kBq	2.14	2.14	2.14	2.14	2.15
La140 to air	Non mat.	mBq	102	102	103	103	103
La140 to water	Non mat.	mBq	194	194	194	194	194
land use (sea floor) II-III	Non mat.	m2a	108	108	108	108	108
land use (sea floor) II-IV	Non mat.	m2a	11.1	11.1	11.1	11.1	11.1
land use II-III	Non mat.	m2a	390	390	391	391	392
land use II-IV	Non mat.	m2a	215	215	215	215	215
land use III-IV	Non mat.	m2a	24.6	24.6	24.7	24.7	24.8
land use IV-IV	Non mat.	m2a	0.243	0.243	0.243	0.243	0.244
Mn54 to air	Non mat.	mBq	40.6	40.6	40.7	40.7	40.7
Mn54 to water	Non mat.	kBq	3.42	3.43	3.43	3.43	3.43

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Mo99 to water	Non mat.	mBq	65.4	65.4	65.5	65.5	65.5
Na24 to water	Non mat.	Bq	28.8	28.8	28.8	28.8	28.8
Nb95 to air	Non mat.	mBq	7.23	7.23	7.23	7.24	7.25
Nb95 to water	Non mat.	mBq	531	531	531	531	532
Np237 to air	Non mat.	µBq	40	40	40.1	40.1	40.1
Np237 to water	Non mat.	Bq	6.44	6.44	6.44	6.45	6.45
Occup. as contin. urban land	Non mat.	m2a	14	14.8	17.2	19.6	23.6
Occup. as convent. arable land	Non mat.	m2a	1.26E3	1.26E3	1.27E3	1.27E3	1.27E3
Occup. as forest land	Non mat.	cm2a	476	476	476	477	477
Occup. as industrial area	Non mat.	m2a	925	930	942	955	976
Occup. as rail/road area	Non mat.	m2a	7.43E4	7.43E4	7.43E4	7.43E4	7.43E4
Pa234m to air	Non mat.	Bq	24.2	24.2	24.3	24.3	24.3
Pa234m to water	Non mat.	Bq	449	449	450	450	450
Pb210 to air	Non mat.	Bq	775	775	776	776	777
Pb210 to water	Non mat.	Bq	308	308	308	308	309
Pm147 to air	Non mat.	Bq	20.6	20.6	20.7	20.7	20.7
Po210 to air	Non mat.	kBq	1.19	1.19	1.19	1.19	1.19
Po210 to water	Non mat.	Bq	308	308	308	308	309
Pu alpha to air	Non mat.	Bq	2.43	2.43	2.43	2.43	2.43
Pu alpha to water	Non mat.	Bq	400	400	401	401	401
Pu238 to air	Non mat.	µBq	87.7	87.7	87.7	87.8	87.9
Pu241 beta	Non mat.	kBq	9.95	9.95	9.96	9.96	9.97
Pu241 Beta to air	Non mat.	Bq	66.8	66.8	66.8	66.9	66.9
Ra224 to water	Non mat.	kBq	2.47	2.47	2.47	2.48	2.48
Ra226 to air	Non mat.	Bq	890	891	891	892	893
Ra226 to water	Non mat.	kBq	1.86E3	1.86E3	1.86E3	1.86E3	1.86E3

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Ra228 to air	Non mat.	Bq	70.4	70.4	70.5	70.5	70.6
Ra228 to water	Non mat.	kBq	4.94	4.94	4.94	4.94	4.95
radio active noble gases to air	Non mat.	kBq	9.87	9.88	9.88	9.88	9.89
radioactive substance to air	Non mat.	kBq	5.37E7	5.63E7	5.21E7	4.97E7	4.98E7
radioactive substance to water	Non mat.	kBq	3.2E5	3.2E5	3.20E5	3.2E5	3.2E5
radionuclides (mixed) to water	Non mat.	mBq	227	227	227	227	228
Rn220 to air	Non mat.	kBq	5.82	5.82	5.83	5.83	5.84
Rn222 (long term) to air	Non mat.	kBq	5.4E6	5.4E6	5.41E6	5.41E6	5.42E6
Rn222 to air	Non mat.	kBq	5.86E4	5.86E4	5.86E4	5.86E4	5.87E4
Ru103 to air	Non mat.	µBq	441	441	441	442	442
Ru103 to water	Non mat.	mBq	314	314	314	314	314
Ru106 to air	Non mat.	Bq	243	243	243	243	243
Ru106 to water	Non mat.	kBq	24.3	24.3	24.3	24.3	24.3
Sb122 to water	Non mat.	mBq	932	932	933	933	934
Sb124 to air	Non mat.	mBq	11	11	11.1	11.1	11.1
Sb124 to water	Non mat.	Bq	76.1	76.2	76.2	76.2	76.3
Sb125 to air	Non mat.	mBq	2	2	2	2	2
Sb125 to water	Non mat.	Bq	7.62	7.62	7.63	7.63	7.63
Sr89 to air	Non mat.	mBq	71.1	71.1	71.2	71.2	71.3
Sr89 to water	Non mat.	Bq	2.11	2.11	2.11	2.11	2.12
Sr90 to air	Non mat.	Bq	40	40	40.1	40.1	40.1
Sr90 to water	Non mat.	kBq	4.85	4.85	4.86	4.86	4.87
Tc99 to air	Non mat.	mBq	1.7	1.7	1.7	1.7	1.7
Tc99 to water	Non mat.	kBq	2.55	2.55	2.55	2.55	2.55
Tc99m to water	Non mat.	mBq	441	442	442	442	442
Te123m to air	Non mat.	mBq	177	177	177	177	177

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Te123m to water	Non mat.	mBq	39.5	39.5	39.5	39.5	39.5
Te132 to water	Non mat.	mBq	16.2	16.2	16.2	16.2	16.2
Th228 to air	Non mat.	Bq	59.6	59.6	59.7	59.7	59.8
Th228 to water	Non mat.	kBq	9.9	9.9	9.9	9.9	9.91
Th230 to air	Non mat.	Bq	270	270	270	271	271
Th230 to water	Non mat.	kBq	70.2	70.2	70.3	70.3	70.4
Th232 to air	Non mat.	Bq	37.8	37.8	37.9	37.9	38
Th232 to water	Non mat.	Bq	72.1	72.1	72.2	72.2	72.3
Th234 to air	Non mat.	Bq	24.2	24.2	24.3	24.3	24.3
Th234 to water	Non mat.	Bq	453	453	453	454	454
U alpha to air	Non mat.	Bq	868	868	869	870	871
U alpha to water	Non mat.	kBq	29.3	29.3	29.4	29.4	29.4
U234 to air	Non mat.	Bq	291	291	291	291	292
U234 to water	Non mat.	Bq	600	600	601	601	602
U235 to air	Non mat.	Bq	14.1	14.1	14.1	14.1	14.1
U235 to water	Non mat.	Bq	896	896	896	897	898
U238 to air	Non mat.	Bq	395	395	396	396	396
U238 to water	Non mat.	kBq	1.53	1.53	1.53	1.53	1.53
waste heat to air	Non mat.	MJ	-4.16E4	-4.16E4	-4.13E4	-4.11E4	-4.07E4
waste heat to soil	Non mat.	MJ	376	376	376	376	377
waste heat to water	Non mat.	GJ	6.82	6.82	6.82	6.82	6.82
Xe131m to air	Non mat.	kBq	12.3	12.3	12.3	12.3	12.3
Xe133 to air	Non mat.	kBq	2.68E3	2.68E3	2.69E3	2.69E3	2.69E3
Xe133m to air	Non mat.	kBq	1.31	1.31	1.31	1.31	1.31
Xe135 to air	Non mat.	kBq	496	496	497	497	498
Xe135m to air	Non mat.	kBq	67.3	67.3	67.3	67.3	67.4

*An x means there are no data.

Table C-1. LCI Output from SimaPro for Wood Houses – SI Units (Continued)*

Substance	Compartment	Unit	Wood frame house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Xe137 to air	Non mat.	kBq	1.56	1.56	1.56	1.56	1.56
Xe138 to air	Non mat.	kBq	18.4	18.4	18.4	18.4	18.4
Y90 to water	Non mat.	mBq	108	108	108	108	108
Zn65 to air	Non mat.	mBq	186	186	186	186	186
Zn65 to water	Non mat.	Bq	60.9	60.9	60.9	60.9	61
Zr95 to air	Non mat.	mBq	2.58	2.58	2.58	2.58	2.58
Zr95 to water	Non mat.	Bq	207	207	207	207	207

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
air	Raw	kg	170	170	170	170	170
barrage water	Raw	ton	95.6	95.6	95.6	95.6	95.6
baryte	Raw	kg	11.8	11.8	11.8	11.8	11.8
bauxite	Raw	kg	222	222	222	222	222
bentonite	Raw	kg	9.13	9.13	9.14	9.15	9.16
chromium (in ore)	Raw	kg	73	73	73	73	73
clay	Raw	kg	2.95E3	3.02E3	3.23E3	3.44E3	3.79E3
clay minerals	Raw	g	6.96	6.96	6.96	6.96	6.96
coal	Raw	kg	1.08E3	1.12E3	1.23E3	1.34E3	1.52E3
coal ETH	Raw	ton	7.27	7.3	7.39	7.47	7.61
coal FAL	Raw	ton	394	454	353	300	308
cobalt (in ore)	Raw	µg	486	486	487	487	488
copper (in ore)	Raw	kg	98.1	98.1	98.1	98.1	98.1
crude oil	Raw	kg	14.3	14.9	16.6	18.4	21.3
crude oil (feedstock) FAL	Raw	kg	117	147	117	205	351
crude oil ETH	Raw	ton	2.09	2.09	2.09	2.09	2.09
crude oil FAL	Raw	ton	20.2	22.3	21	19.2	21.3
crude oil IDEMAT	Raw	ton	9.54	9.55	9.58	9.6	9.63
dolomite	Raw	kg	13	13	21.7	25.1	25.1
energy (undef.)	Raw	GJ	31.9	31.9	32	32	32.1
energy from hydro power	Raw	GJ	608	695	547	471	479
energy from uranium	Raw	MJ	35.9	37.3	41.7	46.1	53.4
feldspar	Raw	kg	13	13	21.7	25.1	25.1
fluorspar	Raw	g	1.55	1.55	1.55	1.55	1.55
gas from oil production	Raw	m3	57.3	57.3	57.4	57.4	57.4
gravel	Raw	ton	51.2	53.9	61.9	69.9	83.3

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
gypsum	Raw	kg	2.22E3	2.27E3	2.43E3	2.59E3	2.85E3
iron (in ore)	Raw	kg	1.63E3	1.69E3	1.88E3	2.06E3	2.37E3
iron (ore)	Raw	ton	2.9	2.9	2.92	2.95	2.98
K	Raw	kg	39.7	39.7	39.7	39.7	39.7
lead (in ore)	Raw	kg	143	143	143	143	143
lignite	Raw	ton	1.27	1.27	1.27	1.27	1.27
lignite ETH	Raw	ton	1.34	1.34	1.34	1.34	1.34
limestone	Raw	ton	75.2	79.9	77.9	78.5	85.2
manganese (in ore)	Raw	kg	10.6	11	12.3	13.5	15.7
manganese (ore)	Raw	g	x	x	x	x	x
marl	Raw	ton	14.3	14.6	15.3	16	17.1
methane (kg)	Raw	kg	31.3	31.3	31.4	31.4	31.5
methane (kg) ETH	Raw	kg	21.5	21.8	22.5	23.2	24.4
molybdene (in ore)	Raw	mg	1.04	1.04	1.05	1.05	1.05
NaCl	Raw	kg	541	541	541	541	541
NaOH	Raw	kg	39.1	39.1	65.2	75.2	75.2
natural gas	Raw	ton	3.7	3.7	3.73	3.75	3.75
natural gas (feedstock) FAL	Raw	kg	30.5	38.1	30.4	53.1	91.1
natural gas ETH	Raw	m3	1.63E3	1.63E3	1.63E3	1.63E3	1.64E3
natural gas FAL	Raw	ton	298	284	480	486	627
nickel (in ore)	Raw	g	308	308	308	308	309
nitrogen	Raw	kg	13.1	13.1	13.1	13.1	13.1
oxygen	Raw	kg	219	219	219	219	219
palladium (in ore)	Raw	mg	1.62	1.62	1.62	1.62	1.62
petroleum gas ETH	Raw	m3	62.1	62.1	62.1	62.2	62.2
phosphate (ore)	Raw	mg	x	x	x	x	x

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
platinum (in ore)	Raw	mg	1.83	1.83	1.83	1.83	1.83
potential energy water ETH	Raw	GJ	8.19	8.19	8.2	8.2	8.21
reservoir content ETH	Raw	m3y	175	175	175	175	176
rhenium (in ore)	Raw	mg	1.55	1.55	1.55	1.55	1.55
rhodium (in ore)	Raw	mg	1.72	1.72	1.73	1.73	1.73
rock salt	Raw	kg	659	659	659	659	659
sand	Raw	ton	110	111	118	124	133
scrap, external	Raw	kg	853	853	853	853	853
shale	Raw	kg	2.36E3	2.42E3	2.58E3	2.75E3	3.03E3
silicon (in SiO2)	Raw	kg	5.17	5.39	6.02	6.65	7.7
silver	Raw	g	3.48	3.48	3.48	3.48	3.48
silver (in ore)	Raw	g	2.85	2.85	2.85	2.85	2.86
sulphur	Raw	kg	11.6	11.6	11.6	11.6	11.6
tin (in ore)	Raw	g	3.52	3.52	3.52	3.52	3.52
turbine water ETH	Raw	m3	4.23E4	4.23E4	4.23E4	4.23E4	4.24E4
uranium (in ore)	Raw	g	401	401	401	401	401
uranium (in ore) ETH	Raw	g	90.4	90.4	90.5	90.5	90.7
uranium (ore)	Raw	kg	7.03	7.03	7.03	7.03	7.03
uranium FAL	Raw	kg	1.54	1.78	1.38	1.17	1.2
water	Raw	ton	1.01E3	1.01E3	1.01E3	1.02E3	1.02E3
wood	Raw	ton	23.7	23.7	23.7	23.7	23.7
wood (dry matter) ETH	Raw	ton	9.36	9.36	9.36	9.36	9.36
wood/wood wastes FAL	Raw	kg	344	374	392	364	423
zeolite	Raw	g	81	81	81	81	81
zinc (in ore)	Raw	g	6.68	6.68	6.69	6.7	6.71
1,2-dichloroethane	Air	mg	59.9	59.9	60	60	60.1

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
acetaldehyde	Air	g	14.1	14.1	14.1	14.1	14.1
acetic acid	Air	g	50	50	50.1	50.1	50.2
acetone	Air	g	11.9	11.9	11.9	11.9	11.9
acrolein	Air	g	13.3	15.4	11.9	10.1	10.4
Al	Air	g	363	363	365	366	368
aldehydes	Air	kg	4.86	5.13	5.79	5.6	6.59
alkanes	Air	g	143	144	144	144	144
alkenes	Air	g	131	131	131	131	131
ammonia	Air	kg	4.18	4.72	3.84	3.36	3.44
As	Air	g	91.2	98.2	86.8	80.5	81.7
B	Air	g	75.2	75.2	75.3	75.4	75.5
Ba	Air	g	4.68	4.68	4.7	4.71	4.73
Be	Air	g	5.53	6.37	4.98	4.24	4.36
benzaldehyde	Air	µg	589	589	590	591	591
benzene	Air	g	168	171	167	165	166
benzo(a)pyrene	Air	mg	356	369	407	446	510
Br	Air	g	16	16	16	16	16.1
butane	Air	g	188	188	188	189	189
butene	Air	g	5.48	5.48	5.49	5.49	5.49
Ca	Air	g	125	125	126	126	126
Cd	Air	g	13.1	14.6	13	11.8	12.7
CFC-11	Air	mg	28.5	28.5	28.5	28.5	28.6
CFC-114	Air	mg	754	754	755	755	756
CFC-116	Air	g	2.44	2.44	2.44	2.44	2.44
CFC-12	Air	mg	6.13	6.13	6.13	6.14	6.15
CFC-13	Air	mg	3.84	3.84	3.85	3.85	3.85

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
CFC-14	Air	g	21.9	21.9	21.9	21.9	21.9
Cl2	Air	kg	1.21	1.26	1.42	1.57	1.81
CO	Air	ton	1.85	1.83	2.69	2.7	3.38
CO2	Air	ton	545	496	940	972	1.27E3
CO2 (fossil)	Air	ton	1.1E3	1.25E3	1.04E3	902	956
CO2 (non-fossil)	Air	kg	463	505	516	476	549
coal dust	Air	mg	259	259	259	259	259
cobalt	Air	g	20.7	23.1	19.7	17.5	18.4
Cr	Air	g	84.1	95.7	76.7	66.5	68.2
Cu	Air	g	11.8	11.9	12.2	12.5	13
CxHy	Air	kg	58.6	58.7	58.9	59.2	59.6
CxHy aromatic	Air	g	1.68	1.68	1.68	1.68	1.68
CxHy chloro	Air	g	3.58	3.58	5.98	6.89	6.89
cyanides	Air	mg	80.8	82	85.6	89.2	95.3
dichloroethane	Air	mg	163	163	163	163	163
dichloromethane	Air	g	56.5	65.1	50.6	42.9	44
dioxin (TEQ)	Air	µg	241	259	260	270	305
dust	Air	kg	37.6	34.5	62.5	64.4	82.8
dust (coarse)	Air	kg	21.5	21.5	21.5	21.6	21.6
dust (coarse) process	Air	kg	4.45	4.47	4.54	4.6	4.71
dust (PM10)	Air	kg	98	101	108	116	129
dust (PM10) mobile	Air	g	151	151	151	151	151
dust (PM10) stationary	Air	kg	7.11	7.11	7.11	7.11	7.11
dust (SPM)	Air	kg	5.82	5.89	6.17	6.39	6.7
ethane	Air	g	356	357	358	359	361
ethanol	Air	g	23.9	23.9	23.9	23.9	23.9

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
ethene	Air	g	114	114	116	118	122
ethylbenzene	Air	g	64.7	64.7	64.7	64.8	64.8
ethyne	Air	g	2.21	2.23	2.3	2.36	2.47
F2	Air	g	17.5	18.1	22.2	24.8	27.7
Fe	Air	g	182	182	182	183	184
fluoranthene	Air	g	0.887	0.923	1.03	1.14	1.32
fluoride	Air	g	2.43	2.43	2.43	2.43	2.43
formaldehyde	Air	g	175	181	170	165	166
H2	Air	g	224	224	224	224	224
H2S	Air	g	218	225	246	267	302
HALON-1301	Air	mg	634	634	635	635	635
HCFC-21	Air	mg	559	559	560	560	561
HCFC-22	Air	mg	6.78	6.78	6.79	6.79	6.8
HCl	Air	kg	70.5	80.9	63.6	54.4	55.6
He	Air	g	62.5	62.5	62.6	62.6	62.6
heptane	Air	g	36.4	36.4	36.5	36.5	36.5
hexachlorobenzene	Air	µg	10.1	10.1	10.1	10.1	10.1
hexane	Air	g	76.8	76.8	76.9	76.9	76.9
HF	Air	kg	11.2	12.6	10.2	8.96	9.13
HFC-134a	Air	pg	-0.03	-0.03	-0.0299	-0.0299	-0.0298
Hg	Air	g	26.7	30.6	24.2	20.7	21.3
I	Air	g	5.87	5.87	5.88	5.88	5.89
K	Air	g	54.6	54.7	54.9	55.1	55.4
kerosene	Air	g	340	392	304	258	264
La	Air	mg	138	138	139	139	140
metals	Air	g	268	285	288	272	301

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
methane	Air	ton	3.87	4.06	4.87	4.66	5.63
methanol	Air	g	24.5	24.5	24.5	24.6	24.6
Mg	Air	g	119	119	119	120	120
Mn	Air	g	161	184	146	126	129
Mo	Air	mg	966	966	966	967	968
MTBE	Air	mg	63	63	63	63	63
n-nitrodimethylamine	Air	g	2.81	3.24	2.52	2.14	2.19
N2	Air	g	386	386	386	386	387
N2O	Air	kg	27.6	28	34	33.4	38.9
Na	Air	g	65.9	65.9	66	66.1	66.2
naphthalene	Air	g	7.38	7.47	7.41	7.32	7.42
Ni	Air	g	215	240	210	188	200
NO2	Air	kg	2.5	2.58	2.82	3.07	3.48
non methane VOC	Air	ton	2.89	2.78	4.54	4.58	5.89
NOx	Air	ton	4.89	5.38	5.2	4.75	5.34
NOx (as NO2)	Air	kg	23.9	23.9	24	24	24.1
organic substances	Air	kg	22.5	23.1	26.2	26.9	30.7
P	Air	g	2.96	2.96	2.97	2.97	2.97
P-tot	Air	g	1.36	1.37	1.37	1.38	1.39
PAH's	Air	g	3.39	3.39	3.39	3.39	3.39
particulates (PM10)	Air	kg	203	234	181	154	158
particulates (unspecified)	Air	kg	1.03E3	1.18E3	938	804	829
Pb	Air	g	527	534	528	524	530
pentachlorobenzene	Air	µg	27	27	27	27	27
pentachlorophenol	Air	µg	4.36	4.36	4.36	4.36	4.36
pentane	Air	g	360	360	361	361	361

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
phenol	Air	g	40.6	45.7	40.6	36.7	38.6
phosphate	Air	g	1.18	1.18	1.18	1.18	1.18
propane	Air	g	248	249	249	250	251
propene	Air	g	14.7	14.7	14.8	15	15.2
propionic acid	Air	mg	312	313	317	319	321
Pt	Air	µg	580	580	580	580	581
Sb	Air	g	6.35	7.21	6	5.22	5.53
Sc	Air	mg	55.7	55.8	56	56.2	56.6
Se	Air	g	97	111	87.5	74.6	76.6
silicates	Air	g	688	689	691	693	695
Sn	Air	mg	116	116	116	116	117
SO2	Air	kg	408	409	417	422	431
soot	Air	kg	2.1	2.1	2.12	2.13	2.15
SOx	Air	ton	15.9	16.3	21.5	20.9	25.8
SOx (as SO2)	Air	kg	41.9	41.9	41.9	42	42
Sr	Air	g	5.57	5.58	5.59	5.61	5.63
tetrachloroethene	Air	g	12.7	14.6	11.4	9.64	9.88
tetrachloromethane	Air	g	21	24.1	19.1	16.3	16.9
Th	Air	mg	259	259	259	260	260
Ti	Air	g	16.5	16.5	16.6	16.6	16.7
Tl	Air	mg	21.4	21.4	21.4	21.5	21.6
toluene	Air	g	218	218	219	219	220
trichloroethene	Air	g	12.6	14.5	11.3	9.55	9.78
trichloromethane	Air	mg	4.32	4.32	4.32	4.32	4.32
U	Air	mg	133	133	133	133	134
V	Air	g	124	124	124	124	124

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
vinyl chloride	Air	mg	60.8	60.8	60.9	60.9	61
VOC	Air	kg	24.9	22.7	43.2	44.8	58.5
water	Air	ton	21	21	21	21	21
xylene	Air	g	133	133	133	133	134
Zn	Air	g	230	230	233	234	235
Zr	Air	mg	34.4	35.1	37.1	39.1	42.4
1,1,1-trichloroethane	Water	µg	138	138	138	138	138
acenaphthylene	Water	mg	788	789	789	789	789
Acid as H+	Water	g	38.5	38.5	38.5	38.5	38.5
acids (unspecified)	Water	g	13.2	14.5	13.9	17.7	24.1
Ag	Water	mg	68.6	68.6	68.7	68.7	68.8
Al	Water	kg	11.8	11.8	12	12.1	12.4
alkanes	Water	g	13.8	13.8	13.9	13.9	13.9
alkenes	Water	g	1.27	1.27	1.27	1.27	1.27
AOX	Water	mg	379	379	379	379	379
As	Water	g	23.8	23.9	24.2	24.5	25
B	Water	kg	35.9	41.4	32.3	27.5	28.2
Ba	Water	kg	1.19	1.2	1.21	1.22	1.24
baryte	Water	kg	2.39	2.39	2.39	2.39	2.4
Be	Water	mg	8.55	8.55	8.55	8.56	8.56
benzene	Water	g	14	14	14	14	14
BOD	Water	kg	15.6	15	24	24.3	31
calcium compounds	Water	kg	8.4	8.4	8.41	8.42	8.43
calcium ions	Water	kg	237	237	237	238	238
Cd	Water	kg	0.72	0.687	1.16	1.17	1.52
chlorinated solvents (unspec.)	Water	mg	6.93	6.94	6.98	7.01	7.08

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
chlorobenzenes	Water	µg	3.06	3.06	3.06	3.06	3.06
chromate	Water	g	9.61	10.9	9.38	8.25	8.92
Cl-	Water	kg	1.28E3	1.25E3	1.72E3	1.74E3	2.08E3
Co	Water	g	23.2	23.3	23.6	23.9	24.3
COD	Water	kg	133	133	190	188	235
Cr	Water	kg	0.84	0.808	1.28	1.3	1.64
Cr (VI)	Water	mg	24.6	24.6	24.6	24.6	24.7
crude oil	Water	g	283	283	284	284	285
Cs	Water	mg	105	105	105	105	105
Cu	Water	g	60.5	60.7	61.5	62.2	63.4
CxHy	Water	kg	1.62	1.62	1.63	1.63	1.63
CxHy aromatic	Water	g	65.1	65.1	65.2	65.2	65.2
CxHy chloro	Water	mg	24.7	24.7	24.8	24.8	24.8
cyanide	Water	g	7	6.98	7.79	7.92	8.6
detergent/oil	Water	g	38.3	38.3	38.3	38.3	38.3
di(2-ethylhexyl)phthalate	Water	µg	8.49	8.49	8.49	8.5	8.5
dibutyl p-phthalate	Water	µg	79.8	79.8	79.8	79.8	79.9
dichloroethane	Water	mg	114	114	114	114	114
dichloromethane	Water	mg	621	621	622	622	622
dimethyl p-phthalate	Water	µg	503	503	503	503	503
dissolved organics	Water	kg	1.24	1.24	1.24	1.24	1.24
dissolved solids	Water	ton	15.7	15	25.2	25.5	32.9
dissolved substances	Water	kg	4.94	4.96	5.01	5.07	5.16
DOC	Water	g	21.8	21.8	21.8	21.8	21.9
ethyl benzene	Water	g	2.51	2.51	2.51	2.52	2.52
F2	Water	g	5.12	5.12	8.53	9.84	9.84

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
fats/oils	Water	kg	0.976	0.976	0.976	0.976	0.977
fatty acids as C	Water	g	235	235	235	235	235
Fe	Water	kg	59.2	67.3	53.7	46.6	47.7
fluoride ions	Water	kg	8.05	8.26	7.91	7.73	7.75
formaldehyde	Water	g	5.29	5.29	5.29	5.29	5.29
glutaraldehyde	Water	mg	295	295	295	296	296
H2	Water	g	266	266	266	267	268
H2S	Water	g	1.76	1.8	1.9	2	2.17
H2SO4	Water	kg	8.98	10.4	8.08	6.86	7.04
herbicides	Water	µg	x	x	x	x	x
hexachloroethane	Water	µg	1.87	1.87	1.87	1.87	1.87
Hg	Water	mg	122	120	158	160	189
HOCL	Water	g	68.5	68.5	68.5	68.6	68.6
I	Water	g	10.4	10.4	10.4	10.5	10.5
inorganic general	Water	kg	267	267	267	267	267
K	Water	kg	4.14	4.15	4.19	4.24	4.31
Kjeldahl-N	Water	g	445	463	517	572	662
metallic ions	Water	kg	0.689	0.734	0.704	0.67	0.718
Mg	Water	kg	9.9	9.94	10.1	10.2	10.4
Mn	Water	kg	31.1	35.8	28	23.8	24.4
Mo	Water	g	37.2	37.3	37.7	38	38.6
MTBE	Water	mg	7.29	7.29	7.29	7.29	7.29
N-tot	Water	g	259	259	259	259	259
N organically bound	Water	g	9.83	9.83	9.83	9.84	9.84
Na	Water	kg	135	135	135	135	135
NH3	Water	g	659	749	610	530	552

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
NH3 (as N)	Water	g	401	401	402	403	404
NH4+	Water	g	3.09	3.09	3.09	3.09	3.09
Ni	Water	g	60.3	60.6	61.3	62	63.1
nitrate	Water	g	427	447	414	398	401
nitrite	Water	g	3.6	3.6	3.61	3.61	3.62
nitrogen	Water	g	7.54	7.54	7.54	7.54	7.54
non methane VOC	Water	g	12	15	12	20.9	35.9
OCl-	Water	g	14.6	14.6	14.6	14.6	14.6
oil	Water	kg	279	266	449	454	586
other organics	Water	kg	52	51	79	78.9	100
P-compounds	Water	mg	56.7	57.1	58.4	59.6	61.7
P-tot	Water	mg	13.2	13.2	13.2	13.2	13.2
P2O5	Water	g	13.1	13.1	13.1	13.1	13.1
PAH's	Water	g	2.55	2.55	2.55	2.55	2.55
Pb	Water	g	70.2	70.5	71.2	72	73.2
pesticides	Water	ng	x	x	x	x	x
phenol	Water	g	14.2	14.4	14.3	14.2	14.3
phenols	Water	g	6.45	6.46	6.46	6.46	6.47
phosphate	Water	kg	10.3	11	9.88	9.28	9.39
Ru	Water	mg	458	458	458	458	458
S	Water	g	1.83	1.83	1.83	1.83	1.83
salt	Water	g	392	392	393	393	394
salts	Water	kg	4.87	4.88	4.91	4.94	4.99
Sb	Water	mg	156	156	156	157	157
Se	Water	g	59.1	59.3	60.1	60.8	61.9
Si	Water	g	1.42	1.42	1.42	1.42	1.42

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Sn	Water	mg	124	124	124	124	124
SO3	Water	g	9.56	9.57	9.57	9.58	9.58
Sr	Water	g	771	772	774	776	779
sulphate	Water	kg	767	767	1.09E3	1.08E3	1.36E3
sulphates	Water	kg	64.8	64.8	64.9	64.9	65
sulphide	Water	g	3.9	4.49	3.89	5.68	8.67
suspended solids	Water	kg	694	794	640	551	575
suspended substances	Water	kg	4.65	4.65	4.66	4.67	4.67
tetrachloroethene	Water	µg	221	222	222	222	222
tetrachloromethane	Water	µg	338	338	338	338	338
Ti	Water	g	697	700	709	717	731
TOC	Water	kg	2.41	2.42	2.42	2.42	2.43
toluene	Water	g	12.2	12.2	12.2	12.2	12.2
tributyltin	Water	mg	393	393	393	394	394
trichloroethene	Water	mg	19.1	19.1	19.2	19.2	19.2
trichloromethane	Water	mg	51.8	51.8	51.8	51.8	51.9
triethylene glycol	Water	g	21.8	21.8	21.8	21.8	21.9
undissolved substances	Water	kg	58.4	58.4	58.4	58.4	58.4
V	Water	g	62	62.2	62.9	63.6	64.8
vinyl chloride	Water	µg	62.9	62.9	62.9	63	63
VOC as C	Water	g	15.9	15.9	15.9	15.9	15.9
W	Water	mg	192	192	193	193	193
xylene	Water	g	10.1	10.1	10.1	10.1	10.1
Zn	Water	g	373	362	526	532	652
aluminium	Solid	kg	0	0	0	0	0
chemical waste	Solid	g	380	380	380	380	380

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
chemical waste (inert)	Solid	kg	9.07	9.07	9.07	9.07	9.07
chemical waste (regulated)	Solid	kg	3.89	3.89	3.89	3.89	3.89
dust - not specified	Solid	g	493	513	573	633	733
final waste (inert)	Solid	ton	1.96	1.97	1.97	1.97	1.97
high active nuclear waste	Solid	cm3	68	68	68	68	68
incinerator waste	Solid	g	24	24	24	24	24
industrial waste	Solid	kg	3.51	3.51	3.51	3.51	3.51
inorganic general	Solid	ton	12.7	12.7	12.7	12.7	12.7
low, med. act. nucl. waste	Solid	l	4.65	4.65	4.65	4.65	4.65
mineral waste	Solid	kg	55.9	55.9	55.9	55.9	56
oil	Solid	kg	17.3	17.4	17.6	17.8	18.2
plastic production waste	Solid	g	340	340	340	340	340
produc. waste (not inert)	Solid	kg	121	121	121	122	122
slag	Solid	kg	9.56	9.56	9.57	9.57	9.58
slags/ash	Solid	kg	1.66	1.66	1.66	1.66	1.66
solid waste	Solid	ton	210	236	210	187	204
unspecified	Solid	g	6.96	6.96	6.96	6.96	6.96
wood (sawdust)	Solid	ton	1.58	1.58	1.58	1.58	1.58
Al (ind.)	Soil	g	81.2	81.2	81.2	81.2	81.3
As (ind.)	Soil	mg	32.5	32.5	32.5	32.5	32.5
C (ind.)	Soil	g	249	250	250	250	250
Ca (ind.)	Soil	g	325	325	325	325	325
Cd (ind.)	Soil	mg	1.41	1.41	1.42	1.43	1.44
Co (ind.)	Soil	mg	1.24	1.24	1.24	1.24	1.24
Cr (ind.)	Soil	mg	406	406	406	406	406
Cu (ind.)	Soil	mg	6.18	6.18	6.18	6.19	6.19

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Fe (ind.)	Soil	g	163	163	163	163	163
Hg (ind.)	Soil	µg	261	263	268	274	283
Mn (ind.)	Soil	g	3.25	3.25	3.25	3.25	3.25
N	Soil	mg	143	145	151	157	167
Ni (ind.)	Soil	mg	9.27	9.27	9.27	9.27	9.28
oil (ind.)	Soil	g	235	235	235	235	235
oil biodegradable	Soil	g	122	122	122	122	122
P-tot	Soil	g	4.64	4.65	4.68	4.71	4.77
Pb (ind.)	Soil	mg	28.3	28.3	28.3	28.4	28.4
S (ind.)	Soil	g	48.8	48.8	48.8	48.8	48.8
Zn (ind.)	Soil	g	1.28	1.28	1.28	1.28	1.28
Ag110m to air	Non mat.	mBq	36.4	36.4	36.4	36.5	36.5
Ag110m to water	Non mat.	Bq	249	249	249	249	250
alpha radiation (unspecified) to water	Non mat.	mBq	29.3	29.3	29.4	29.4	29.4
Am241 to air	Non mat.	mBq	696	696	697	698	698
Am241 to water	Non mat.	Bq	91.5	91.5	91.6	91.7	91.8
Ar41 to air	Non mat.	kBq	79	79	79	79.1	79.2
Ba140 to air	Non mat.	mBq	161	161	161	162	162
Ba140 to water	Non mat.	mBq	772	772	773	773	774
beta radiation (unspecified) to air	Non mat.	mBq	7.08	7.08	7.08	7.09	7.09
C14 to air	Non mat.	kBq	56.7	56.7	56.8	56.8	56.9
C14 to water	Non mat.	kBq	4.62	4.63	4.63	4.63	4.64
Cd109 to water	Non mat.	mBq	4.48	4.48	4.48	4.48	4.49
Ce141 to air	Non mat.	mBq	3.4	3.4	3.4	3.41	3.41
Ce141 to water	Non mat.	mBq	116	116	116	116	116
Ce144 to air	Non mat.	Bq	7.41	7.41	7.41	7.42	7.43

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Ce144 to water	Non mat.	kBq	2.1	2.1	2.1	2.1	2.1
Cm (alpha) to air	Non mat.	Bq	1.1	1.1	1.11	1.11	1.11
Cm (alpha) to water	Non mat.	Bq	122	122	122	122	122
Cm242 to air	Non mat.	µBq	3.56	3.57	3.57	3.57	3.58
Cm244 to air	Non mat.	µBq	32.4	32.4	32.4	32.4	32.5
Co57 to air	Non mat.	µBq	62.1	62.2	62.2	62.3	62.3
Co57 to water	Non mat.	mBq	795	795	796	796	796
Co58 to air	Non mat.	Bq	1.03	1.03	1.03	1.03	1.03
Co58 to water	Non mat.	Bq	507	507	507	507	508
Co60 to air	Non mat.	Bq	1.56	1.56	1.56	1.56	1.57
Co60 to water	Non mat.	kBq	20.5	20.5	20.5	20.5	20.5
Conv. to continuous urban land	Non mat.	m2	1.91	1.92	1.96	1.99	2.04
Conv. to industrial area	Non mat.	m2	1.19	1.19	1.2	1.2	1.2
Cr51 to air	Non mat.	mBq	130	130	130	130	130
Cr51 to water	Non mat.	Bq	17.1	17.1	17.1	17.1	17.1
Cs134 to air	Non mat.	Bq	26.4	26.4	26.4	26.5	26.5
Cs134 to water	Non mat.	kBq	4.68	4.68	4.68	4.69	4.69
Cs136 to water	Non mat.	mBq	4.16	4.16	4.16	4.16	4.17
Cs137 to air	Non mat.	Bq	51	51	51.1	51.1	51.2
Cs137 to water	Non mat.	kBq	43.2	43.2	43.2	43.3	43.3
Fe59 to air	Non mat.	mBq	1.41	1.41	1.41	1.41	1.41
Fe59 to water	Non mat.	mBq	13.7	13.7	13.7	13.7	13.7
Fission and activation products (RA) to water	Non mat.	Bq	266	266	266	267	267
H3 to air	Non mat.	kBq	567	567	567	568	569
H3 to water	Non mat.	kBq	1.37E5	1.37E5	1.37E5	1.37E5	1.38E5
heat losses to air	Non mat.	GJ	3.62E4	3.62E4	3.62E4	3.62E4	3.62E4

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
heat losses to soil	Non mat.	MJ	92.2	92.2	92.3	92.4	92.4
heat losses to water	Non mat.	GJ	-12.2	-12.2	-12.2	-12.2	-12.2
I129 to air	Non mat.	Bq	199	199	199	199	199
I129 to water	Non mat.	kBq	13.2	13.2	13.2	13.3	13.3
I131 to air	Non mat.	Bq	27.3	27.3	27.3	27.3	27.3
I131 to water	Non mat.	Bq	9.92	9.93	9.93	9.94	9.95
I133 to air	Non mat.	Bq	12.1	12.1	12.1	12.1	12.1
I133 to water	Non mat.	Bq	3.55	3.55	3.55	3.55	3.55
I135 to air	Non mat.	Bq	18	18	18	18	18.1
K40 to air	Non mat.	Bq	134	134	135	135	135
K40 to water	Non mat.	Bq	357	357	358	358	358
Kr85 to air	Non mat.	kBq	3.42E6	3.42E6	3.43E6	3.43E6	3.43E6
Kr85m to air	Non mat.	kBq	5.76	5.76	5.77	5.77	5.78
Kr87 to air	Non mat.	kBq	2.31	2.31	2.31	2.31	2.31
Kr88 to air	Non mat.	kBq	158	158	158	158	158
Kr89 to air	Non mat.	kBq	1.82	1.82	1.82	1.82	1.82
La140 to air	Non mat.	mBq	93	93.1	93.1	93.2	93.3
La140 to water	Non mat.	mBq	161	161	161	161	161
land use (sea floor) II-III	Non mat.	m2a	101	101	101	101	101
land use (sea floor) II-IV	Non mat.	m2a	10.4	10.4	10.4	10.4	10.4
land use II-III	Non mat.	m2a	359	360	360	361	362
land use II-IV	Non mat.	m2a	163	163	163	163	163
land use III-IV	Non mat.	m2a	22.3	22.3	22.4	22.4	22.5
land use IV-IV	Non mat.	m2a	0.239	0.239	0.239	0.239	0.24
Mn54 to air	Non mat.	mBq	37.1	37.2	37.2	37.2	37.3
Mn54 to water	Non mat.	kBq	3.11	3.12	3.12	3.12	3.12

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Mo99 to water	Non mat.	mBq	54.2	54.2	54.2	54.3	54.3
Na24 to water	Non mat.	Bq	23.9	23.9	23.9	23.9	23.9
Nb95 to air	Non mat.	mBq	6.6	6.6	6.61	6.61	6.62
Nb95 to water	Non mat.	mBq	440	440	440	440	441
Np237 to air	Non mat.	µBq	36.4	36.4	36.5	36.5	36.5
Np237 to water	Non mat.	Bq	5.86	5.86	5.86	5.87	5.87
Occup. as contin. urban land	Non mat.	m2a	28.9	29.7	32.2	34.6	38.6
Occup. as convent. arable land	Non mat.	m2a	1.27E3	1.27E3	1.27E3	1.27E3	1.27E3
Occup. as forest land	Non mat.	cm2a	477	477	478	478	478
Occup. as industrial area	Non mat.	m2a	1.03E3	1.04E3	1.05E3	1.07E3	1.09E3
Occup. as rail/road area	Non mat.	m2a	7.76E4	7.76E4	7.76E4	7.76E4	7.76E4
Pa234m to air	Non mat.	Bq	22.1	22.1	22.1	22.1	22.1
Pa234m to water	Non mat.	Bq	409	409	409	410	410
Pb210 to air	Non mat.	Bq	720	721	721	722	723
Pb210 to water	Non mat.	Bq	284	284	285	285	285
Pm147 to air	Non mat.	Bq	18.8	18.8	18.8	18.8	18.8
Po210 to air	Non mat.	kBq	1.11	1.11	1.11	1.11	1.11
Po210 to water	Non mat.	Bq	284	284	285	285	285
Pu alpha to air	Non mat.	Bq	2.21	2.21	2.21	2.21	2.22
Pu alpha to water	Non mat.	Bq	364	364	365	365	365
Pu238 to air	Non mat.	µBq	80.3	80.3	80.4	80.5	80.6
Pu241 beta	Non mat.	kBq	9.05	9.05	9.06	9.07	9.08
Pu241 Beta to air	Non mat.	Bq	60.8	60.8	60.8	60.9	60.9
Ra224 to water	Non mat.	kBq	2.27	2.27	2.28	2.28	2.28
Ra226 to air	Non mat.	Bq	814	815	815	816	817
Ra226 to water	Non mat.	kBq	1.69E3	1.69E3	1.69E3	1.69E3	1.69E3

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Ra228 to air	Non mat.	Bq	66.2	66.2	66.3	66.3	66.5
Ra228 to water	Non mat.	kBq	4.54	4.54	4.55	4.55	4.55
radio active noble gases to air	Non mat.	kBq	8.18	8.18	8.18	8.19	8.19
radioactive substance to air	Non mat.	kBq	5.35E7	5.64E7	5.16E7	4.91E7	4.94E7
radioactive substance to water	Non mat.	kBq	3.2E5	3.2E5	3.21E5	3.21E5	3.21E5
radionuclides (mixed) to water	Non mat.	mBq	205	205	205	205	205
Rn220 to air	Non mat.	kBq	5.4	5.4	5.41	5.41	5.42
Rn222 (long term) to air	Non mat.	kBq	4.92E6	4.92E6	4.92E6	4.93E6	4.93E6
Rn222 to air	Non mat.	kBq	5.33E4	5.33E4	5.33E4	5.34E4	5.35E4
Ru103 to air	Non mat.	µBq	397	397	397	398	398
Ru103 to water	Non mat.	mBq	260	260	260	260	260
Ru106 to air	Non mat.	Bq	221	221	221	221	222
Ru106 to water	Non mat.	kBq	22.1	22.1	22.1	22.1	22.2
Sb122 to water	Non mat.	mBq	772	772	773	773	774
Sb124 to air	Non mat.	mBq	10.1	10.1	10.1	10.1	10.1
Sb124 to water	Non mat.	Bq	68.6	68.6	68.7	68.7	68.8
Sb125 to air	Non mat.	mBq	1.72	1.72	1.72	1.72	1.72
Sb125 to water	Non mat.	Bq	6.31	6.32	6.32	6.32	6.33
Sr89 to air	Non mat.	mBq	65	65	65	65.1	65.2
Sr89 to water	Non mat.	Bq	1.75	1.75	1.75	1.75	1.75
Sr90 to air	Non mat.	Bq	36.4	36.4	36.5	36.5	36.5
Sr90 to water	Non mat.	kBq	4.42	4.42	4.42	4.42	4.43
Tc99 to air	Non mat.	mBq	1.55	1.55	1.55	1.55	1.55
Tc99 to water	Non mat.	kBq	2.32	2.32	2.32	2.32	2.32
Tc99m to water	Non mat.	mBq	366	366	366	366	366
Te123m to air	Non mat.	mBq	162	162	162	162	163

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Te123m to water	Non mat.	mBq	32.7	32.7	32.7	32.7	32.7
Te132 to water	Non mat.	mBq	13.4	13.4	13.4	13.4	13.4
Th228 to air	Non mat.	Bq	56	56	56.1	56.2	56.3
Th228 to water	Non mat.	kBq	9.1	9.1	9.11	9.11	9.11
Th230 to air	Non mat.	Bq	246	246	246	246	247
Th230 to water	Non mat.	kBq	63.9	63.9	63.9	64	64.1
Th232 to air	Non mat.	Bq	35.6	35.6	35.6	35.7	35.7
Th232 to water	Non mat.	Bq	66.6	66.6	66.6	66.7	66.8
Th234 to air	Non mat.	Bq	22.1	22.1	22.1	22.1	22.1
Th234 to water	Non mat.	Bq	412	412	413	413	413
U alpha to air	Non mat.	Bq	790	790	791	792	793
U alpha to water	Non mat.	kBq	26.7	26.7	26.7	26.8	26.8
U234 to air	Non mat.	Bq	265	265	265	265	265
U234 to water	Non mat.	Bq	546	546	547	547	548
U235 to air	Non mat.	Bq	12.8	12.8	12.8	12.8	12.9
U235 to water	Non mat.	Bq	815	815	816	817	818
U238 to air	Non mat.	Bq	363	363	363	364	364
U238 to water	Non mat.	kBq	1.39	1.39	1.4	1.4	1.4
waste heat to air	Non mat.	MJ	636	710	933	1.16E3	1.53E3
waste heat to soil	Non mat.	MJ	328	328	328	328	328
waste heat to water	Non mat.	GJ	6.69	6.69	6.69	6.69	6.69
Xe131m to air	Non mat.	kBq	10.6	10.6	10.6	10.6	10.6
Xe133 to air	Non mat.	kBq	2.44E3	2.45E3	2.45E3	2.45E3	2.45E3
Xe133m to air	Non mat.	kBq	1.2	1.2	1.2	1.2	1.2
Xe135 to air	Non mat.	kBq	445	445	446	446	447
Xe135m to air	Non mat.	kBq	57.4	57.4	57.4	57.4	57.5

*An x means there are no data.

Table C-2. LCI Output from SimaPro for CMU Houses – SI Units (Continued)*

Substance	Compartment	Unit	CMU house				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Xe137 to air	Non mat.	kBq	1.34	1.34	1.34	1.34	1.35
Xe138 to air	Non mat.	kBq	15.7	15.7	15.7	15.7	15.7
Y90 to water	Non mat.	mBq	89.7	89.7	89.7	89.8	89.8
Zn65 to air	Non mat.	mBq	168	168	168	168	168
Zn65 to water	Non mat.	Bq	50.4	50.5	50.5	50.5	50.5
Zr95 to air	Non mat.	mBq	2.36	2.36	2.36	2.36	2.37
Zr95 to water	Non mat.	Bq	188	188	188	188	188

*An x means there are no data.

APPENDIX D – LCI DATA FOR WOOD HOUSES AND CMU HOUSES – U.S. CUSTOMARY UNITS

SIMAPRO: A LIFE CYCLE ASSESSMENT TOOL

The Dutch company PRé Consultants is a leader in developing tools for life cycle assessment. They created and continue to develop SimaPro, the most widely used life cycle assessment tool (www.pre.nl/simapro). SimaPro can be used to perform detailed and robust life cycle assessments of materials, components, buildings, and processes. It contains a large database of products and processes and seven comprehensive, widely-accepted impact assessment methods.

The user can either build up a product or process from scratch using the databases supplied with SimaPro, or the LCI of an existing product or process can be augmented with upstream and downstream profiles for other processes to determine a life cycle assessment. The impact assessment methods can be utilized to determine the impacts of materials, energy use, and pollutants. For example, upstream profiles can be the energy sources or extraction of raw materials. Downstream profiles can be other manufacturing steps used to make a final product.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
air	Raw	lb	375	375	375	375	375
barrage water	Raw	tn.lg	95.3	95.3	95.3	95.3	95.3
baryte	Raw	oz	431	431	431	431	432
bauxite	Raw	lb	490	490	490	490	490
bentonite	Raw	oz	328	328	328	328	328
chromium (in ore)	Raw	lb	161	161	161	161	161
clay	Raw	lb	2E3	2.15E3	2.62E3	3.08E3	3.85E3
clay minerals	Raw	oz	0.246	0.246	0.246	0.246	0.246
coal	Raw	lb	875	956	1.20E3	1.44E3	1.85E3
coal ETH	Raw	tn.lg	6.39	6.42	6.5	6.58	6.72
coal FAL	Raw	tn.lg	390	442	356	307	309
cobalt (in ore)	Raw	oz	1.91E-5	1.91E-5	1.91E-05	1.91E-5	1.91E-5
copper (in ore)	Raw	lb	217	217	217	217	217
crude oil	Raw	oz	123	143	205	267	369
crude oil (feedstock) FAL	Raw	lb	0	64.5	258	451	773
crude oil ETH	Raw	tn.lg	2.13	2.13	2.13	2.13	2.13
crude oil FAL	Raw	tn.lg	19.4	21.3	20.6	19.1	20.9
crude oil IDEMAT	Raw	tn.lg	9.31	9.32	9.34	9.36	9.39
dolomite	Raw	oz	767	767	767	884	884
energy (undef.)	Raw	MWh	8.84	8.84	8.85	8.86	8.88
energy from hydro power	Raw	MWh	176	197	161	141	141
energy from uranium	Raw	kWh	2.43	2.83	4.05	5.27	7.29
feldspar	Raw	oz	767	767	767	884	884
fluorspar	Raw	oz	0.0546	0.0546	0.0546	0.0546	0.0546
gas from oil production	Raw	cu.yd	74.9	74.9	74.9	74.9	75
gravel	Raw	tn.lg	34.2	36.8	44.7	52.6	65.8

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
gypsum	Raw	lb	1.5E3	1.61E3	1.96E3	2.31E3	2.89E3
iron (in ore)	Raw	lb	1.07E3	1.21E3	1.62E3	2.03E3	2.71E3
iron (ore)	Raw	tn.lg	2.63	2.64	2.66	2.68	2.72
K	Raw	lb	87.4	87.4	87.4	87.4	87.4
lead (in ore)	Raw	lb	315	315	315	315	315
lignite	Raw	tn.lg	1.25	1.25	1.25	1.25	1.25
lignite ETH	Raw	tn.lg	1.43	1.43	1.43	1.44	1.44
limestone	Raw	tn.lg	38.6	42.8	41.6	42.4	48.6
manganese (in ore)	Raw	oz	93.6	109	154	199	274
manganese (ore)	Raw	oz	0.0394	0.0394	0.0394	0.0394	0.0394
marl	Raw	tn.lg	7.48	7.71	8.39	9.08	10.2
methane (kg)	Raw	lb	68.7	68.7	68.8	68.8	68.9
methane (kg) ETH	Raw	oz	512	520	546	572	614
molybdene (in ore)	Raw	oz	4.06E-5	4.06E-5	4.06E-05	4.06E-5	4.06E-5
NaCl	Raw	lb	1.33E3	1.33E3	1.33E3	1.33E3	1.33E3
NaOH	Raw	lb	144	144	144	166	166
natural gas	Raw	tn.lg	3.67	3.68	3.68	3.69	3.7
natural gas (feedstock) FAL	Raw	lb	0	16.7	67	117	201
natural gas ETH	Raw	cu.yd	2.21E3	2.21E3	2.21E3	2.21E3	2.22E3
natural gas FAL	Raw	tn.lg	287	277	485	504	632
nickel (in ore)	Raw	oz	11.1	11.1	11.1	11.1	11.1
nitrogen	Raw	oz	464	464	464	464	464
oxygen	Raw	lb	481	481	481	481	481
palladium (in ore)	Raw	oz	6.81E-5	6.81E-5	6.81E-05	6.81E-5	6.81E-5
petroleum gas ETH	Raw	cu.yd	88.3	88.3	88.4	88.4	88.4
phosphate (ore)	Raw	oz	0.0237	0.0237	0.0237	0.0237	0.0237

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
platinum (in ore)	Raw	oz	7.69E-5	7.69E-5	7.69E-05	7.69E-5	7.69E-5
potential energy water ETH	Raw	MWh	2.48	2.48	2.49	2.49	2.49
reservoir content ETH	Raw	m3y	192	192	192	192	192
rhenium (in ore)	Raw	oz	6.41E-5	6.41E-5	6.41E-05	6.41E-5	6.41E-5
rhodium (in ore)	Raw	oz	7.23E-5	7.23E-5	7.23E-05	7.23E-5	7.23E-5
rock salt	Raw	lb	1.45E3	1.45E3	1.45E3	1.45E3	1.45E3
sand	Raw	tn.lg	28	30	35.8	41.7	51.5
scrap, external	Raw	lb	1.87E3	1.87E3	1.87E3	1.87E3	1.87E3
shale	Raw	lb	1.59E3	1.71E3	2.08E3	2.46E3	3.07E3
silicon (in SiO2)	Raw	oz	44.5	51.9	74.2	96.5	134
silver	Raw	oz	0.122	0.123	0.123	0.123	0.123
silver (in ore)	Raw	oz	0.109	0.109	0.109	0.109	0.109
sulphur	Raw	oz	409	409	409	409	409
tin (in ore)	Raw	oz	0.129	0.129	0.129	0.129	0.129
turbine water ETH	Raw	cu.yd	6.02E4	6.02E4	6.02E4	6.03E4	6.03E4
uranium (in ore)	Raw	oz	14.1	14.1	14.1	14.1	14.1
uranium (in ore) ETH	Raw	oz	3.5	3.5	3.51	3.51	3.51
uranium (ore)	Raw	oz	248	248	248	248	248
uranium FAL	Raw	oz	54.8	62.2	50	43	43.2
water	Raw	tn.lg	971	973	977	981	987
wood	Raw	tn.lg	22.4	22.4	22.4	22.4	22.4
wood (dry matter) ETH	Raw	tn.lg	12.6	12.6	12.6	12.6	12.6
wood/wood wastes FAL	Raw	lb	757	816	886	839	954
zeolite	Raw	oz	2.85	2.85	2.85	2.85	2.85
zinc (in ore)	Raw	oz	0.254	0.254	0.254	0.254	0.254
1,2-dichloroethane	Air	oz	0.0021	0.0021	0.00211	0.00211	0.00211

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
acetaldehyde	Air	oz	0.533	0.533	0.533	0.533	0.533
acetic acid	Air	oz	1.79	1.79	1.79	1.79	1.79
acetone	Air	oz	0.426	0.426	0.426	0.427	0.427
acrolein	Air	oz	0.475	0.539	0.434	0.373	0.375
Al	Air	oz	12.6	12.6	12.7	12.7	12.8
aldehydes	Air	oz	160	169	199	195	227
alkanes	Air	oz	5.57	5.57	5.57	5.58	5.58
alkenes	Air	oz	5.94	5.94	5.94	5.95	5.95
ammonia	Air	oz	153	170	143	128	128
As	Air	oz	3.23	3.45	3.1	2.9	2.91
B	Air	oz	2.8	2.81	2.81	2.81	2.81
Ba	Air	oz	0.165	0.165	0.165	0.166	0.166
Be	Air	oz	0.197	0.223	0.181	0.156	0.157
benzaldehyde	Air	oz	2.16E-5	2.16E-5	2.16E-05	2.16E-5	2.16E-5
benzene	Air	oz	6.47	6.56	6.43	6.37	6.4
benzo(a)pyrene	Air	oz	0.00413	0.00458	0.00593	0.00728	0.00953
Br	Air	oz	0.578	0.579	0.579	0.58	0.58
butane	Air	oz	6.88	6.88	6.89	6.89	6.9
butene	Air	oz	0.209	0.209	0.209	0.209	0.209
Ca	Air	oz	4.63	4.64	4.64	4.65	4.66
Cd	Air	oz	0.456	0.5	0.461	0.423	0.448
CFC-11	Air	oz	0.0011	0.0011	0.0011	0.0011	0.00111
CFC-114	Air	oz	0.0292	0.0292	0.0292	0.0293	0.0293
CFC-116	Air	oz	0.0862	0.0862	0.0862	0.0862	0.0862
CFC-12	Air	oz	0.000237	0.000237	0.000237	0.000238	0.000238
CFC-13	Air	oz	0.000149	0.000149	0.000149	0.000149	0.000149

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
CFC-14	Air	oz	0.773	0.773	0.773	0.773	0.773
Cl2	Air	oz	11.9	13.6	18.7	24	32.5
CO	Air	tn.lg	1.79	1.77	2.7	2.77	3.39
CO2	Air	tn.lg	501	462	925	983	1.25E3
CO2 (fossil)	Air	tn.lg	1.09E3	1.23E3	1.05E3	929	965
CO2 (non-fossil)	Air	lb	1.02E3	1.1E3	1.17E3	1.1E3	1.24E3
coal dust	Air	oz	0.00913	0.00913	0.00913	0.00913	0.00913
cobalt	Air	oz	0.737	0.814	0.714	0.643	0.664
Cr	Air	oz	3.06	3.42	2.84	2.5	2.52
Cu	Air	oz	0.367	0.37	0.381	0.392	0.41
CxHy	Air	lb	128	129	129	130	131
CxHy aromatic	Air	oz	0.0623	0.0623	0.0623	0.0624	0.0624
CxHy chloro	Air	oz	0.211	0.211	0.211	0.243	0.243
cyanides	Air	oz	0.00159	0.00163	0.00176	0.00189	0.0021
dichloroethane	Air	oz	0.00693	0.00693	0.00693	0.00693	0.00694
dichloromethane	Air	oz	2.02	2.29	1.84	1.58	1.59
dioxin (TEQ)	Air	oz	4.19E-6	4.77E-6	4.91E-06	5.28E-6	6.47E-6
dust	Air	lb	81	75.4	141	149	187
dust (coarse)	Air	oz	756	756	757	757	758
dust (coarse) process	Air	oz	141	142	144	146	150
dust (PM10)	Air	lb	73.1	78.8	95.9	113	142
dust (PM10) mobile	Air	oz	5.79	5.8	5.8	5.8	5.8
dust (PM10) stationary	Air	oz	307	307	307	307	308
dust (SPM)	Air	oz	187	189	195	203	214
ethane	Air	oz	12.8	12.8	12.8	12.9	12.9
ethanol	Air	oz	0.855	0.855	0.855	0.855	0.856

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
ethene	Air	oz	3.71	3.73	3.8	3.87	3.99
ethylbenzene	Air	oz	2.27	2.27	2.27	2.27	2.28
ethyne	Air	oz	0.0538	0.0546	0.0569	0.0592	0.0631
F2	Air	oz	0.41	0.43	0.49	0.582	0.683
Fe	Air	oz	6.43	6.43	6.45	6.47	6.49
fluoranthene	Air	oz	0.00762	0.0089	0.0127	0.0165	0.0229
fluoride	Air	oz	0.0857	0.0857	0.0857	0.0857	0.0857
formaldehyde	Air	oz	6.51	6.73	6.4	6.21	6.24
H2	Air	oz	7.92	7.92	7.92	7.92	7.92
H2S	Air	oz	2.86	3.11	3.85	4.6	5.84
HALON-1301	Air	oz	0.0234	0.0234	0.0235	0.0235	0.0235
HCFC-21	Air	oz	0.0225	0.0225	0.0225	0.0225	0.0226
HCFC-22	Air	oz	0.000263	0.000263	0.000263	0.000263	0.000263
HCl	Air	lb	157	178	144	125	126
He	Air	oz	2.4	2.4	2.4	2.4	2.4
heptane	Air	oz	1.33	1.33	1.34	1.34	1.34
hexachlorobenzene	Air	oz	4.39E-7	4.39E-7	4.39E-07	4.39E-7	4.39E-7
hexane	Air	oz	2.82	2.82	2.82	2.82	2.82
HF	Air	oz	440	485	411	369	370
HFC-134a	Air	oz	-1.07E-15	-1.07E-15	-1.07E-15	-1.07E-15	-1.06E-15
Hg	Air	oz	0.95	1.07	0.876	0.762	0.77
I	Air	oz	0.214	0.214	0.214	0.214	0.214
K	Air	oz	1.93	1.93	1.94	1.95	1.96
kerosene	Air	oz	12.1	13.7	11	9.49	9.54
La	Air	oz	0.00479	0.0048	0.00482	0.00484	0.00487
metals	Air	oz	9.39	9.94	10.3	9.86	10.8

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
methane	Air	tn.lg	3.77	3.95	4.91	4.81	5.66
methanol	Air	oz	0.878	0.878	0.878	0.878	0.879
Mg	Air	oz	4.15	4.15	4.16	4.18	4.2
Mn	Air	oz	5.81	6.52	5.36	4.69	4.72
Mo	Air	oz	0.0348	0.0348	0.0348	0.0348	0.0349
MTBE	Air	oz	0.00296	0.00296	0.00296	0.00296	0.00296
n-nitrodimethylamine	Air	oz	0.1	0.114	0.0916	0.0788	0.0792
N2	Air	oz	14.3	14.3	14.3	14.3	14.3
N2O	Air	lb	60.6	61.5	76.3	76.3	87.3
Na	Air	oz	2.35	2.35	2.36	2.36	2.36
naphthalene	Air	oz	0.253	0.256	0.255	0.252	0.255
Ni	Air	oz	7.67	8.43	7.61	6.91	7.23
NO2	Air	oz	53	55.9	64.6	73.2	87.7
non methane VOC	Air	tn.lg	2.78	2.71	4.59	4.75	5.93
NOx	Air	tn.lg	4.77	5.2	5.19	4.82	5.31
NOx (as NO2)	Air	oz	932	932	933	935	937
organic substances	Air	lb	35	36.3	44.1	46.1	54.1
P	Air	oz	0.104	0.104	0.104	0.104	0.104
P-tot	Air	oz	0.0498	0.0499	0.0501	0.0503	0.0506
PAH's	Air	oz	0.121	0.121	0.121	0.121	0.121
particulates (PM10)	Air	lb	449	509	409	353	354
particulates (unspecified)	Air	lb	2.33E3	2.63E3	2.16E3	1.89E3	1.91E3
Pb	Air	oz	18.3	18.5	18.3	18.2	18.3
pentachlorobenzene	Air	oz	1.17E-6	1.17E-6	1.18E-06	1.18E-6	1.18E-6
pentachlorophenol	Air	oz	1.9E-7	1.9E-7	1.90E-07	1.9E-7	1.9E-7
pentane	Air	oz	12.8	12.9	12.9	12.9	12.9

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
phenol	Air	oz	1.52	1.68	1.48	1.36	1.4
phosphate	Air	oz	0.0416	0.0416	0.0416	0.0416	0.0416
propane	Air	oz	8.96	8.97	8.98	9	9.03
propene	Air	oz	0.51	0.512	0.516	0.521	0.529
propionic acid	Air	oz	0.0111	0.0111	0.0112	0.0113	0.0114
Pt	Air	oz	2.38E-5	2.38E-5	2.38E-05	2.38E-5	2.38E-5
Sb	Air	oz	0.226	0.253	0.218	0.193	0.2
Sc	Air	oz	0.00193	0.00193	0.00194	0.00195	0.00196
Se	Air	oz	3.46	3.91	3.18	2.75	2.77
silicates	Air	oz	24.6	24.6	24.7	24.7	24.8
Sn	Air	oz	0.00412	0.00412	0.00413	0.00413	0.00414
SO2	Air	lb	829	833	849	861	882
soot	Air	oz	69.4	69.6	70	70.4	71.2
SOx	Air	tn.lg	15.5	15.9	21.7	21.6	26
SOx (as SO2)	Air	lb	98.6	98.6	98.7	98.8	98.9
Sr	Air	oz	0.196	0.196	0.196	0.197	0.198
tetrachloroethene	Air	oz	0.453	0.513	0.413	0.356	0.358
tetrachloromethane	Air	oz	0.749	0.847	0.695	0.603	0.612
Th	Air	oz	0.00909	0.00909	0.00911	0.00912	0.00914
Ti	Air	oz	0.581	0.581	0.582	0.584	0.586
Tl	Air	oz	0.000759	0.000759	0.000761	0.000764	0.000767
toluene	Air	oz	7.83	7.84	7.85	7.86	7.87
trichloroethene	Air	oz	0.449	0.509	0.41	0.353	0.354
trichloromethane	Air	oz	0.000183	0.000183	0.000183	0.000183	0.000183
U	Air	oz	0.00471	0.00471	0.00472	0.00472	0.00473
V	Air	oz	4.44	4.44	4.44	4.44	4.44

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
vinyl chloride	Air	oz	0.00233	0.00233	0.00233	0.00233	0.00234
VOC	Air	lb	49.3	45.4	93.3	99.5	128
water	Air	tn.lg	19.9	19.9	19.9	19.9	19.9
xylene	Air	oz	5.06	5.06	5.07	5.07	5.07
Zn	Air	oz	7.94	7.95	7.98	8.03	8.09
Zr	Air	oz	0.00047	0.000493	0.000564	0.000635	0.000753
1,1,1-trichloroethane	Water	oz	5.72E-6	5.72E-6	5.72E-06	5.72E-6	5.73E-6
acenaphthylene	Water	oz	0.0302	0.0302	0.0302	0.0302	0.0303
Acid as H+	Water	oz	4.02	4.02	4.02	4.02	4.02
acids (unspecified)	Water	oz	0.125	0.17	0.304	0.439	0.663
Ag	Water	oz	0.00251	0.00251	0.00251	0.00251	0.00252
Al	Water	oz	372	374	379	383	391
alkanes	Water	oz	0.507	0.507	0.507	0.507	0.507
alkenes	Water	oz	0.0463	0.0464	0.0464	0.0464	0.0464
AOX	Water	oz	0.0139	0.0139	0.0139	0.0139	0.0139
As	Water	oz	0.753	0.756	0.766	0.776	0.792
B	Water	lb	80.2	90.8	73.4	63.3	63.8
Ba	Water	oz	38.9	39	39.4	39.8	40.4
baryte	Water	oz	87.3	87.3	87.4	87.4	87.5
Be	Water	oz	0.000312	0.000312	0.000312	0.000312	0.000312
benzene	Water	oz	0.514	0.514	0.514	0.514	0.514
BOD	Water	lb	35.3	34.4	56	57.9	71.5
calcium compounds	Water	oz	295	295	295	296	296
calcium ions	Water	lb	523	523	523	523	523
Cd	Water	oz	24.9	24	42	43.6	54.8
chlorinated solvents (unspec.)	Water	oz	0.000257	0.000258	0.000259	0.00026	0.000262

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
chlorobenzenes	Water	oz	1.43E-7	1.43E-7	1.43E-07	1.43E-7	1.43E-7
chromate	Water	oz	0.342	0.381	0.341	0.305	0.323
Cl-	Water	tn.sh	1.39	1.36	1.72	1.98	2.33
Co	Water	oz	0.73	0.734	0.743	0.753	0.769
COD	Water	lb	313	314	453	458	554
Cr	Water	oz	28.7	27.8	45.9	47.5	58.8
Cr (VI)	Water	oz	0.000874	0.000874	0.000874	0.000875	0.000876
crude oil	Water	oz	9.79	9.8	9.82	9.84	9.88
Cs	Water	oz	0.00383	0.00383	0.00384	0.00384	0.00384
Cu	Water	oz	1.91	1.91	1.94	1.97	2.01
CxHy	Water	oz	57.5	57.5	57.5	57.6	57.6
CxHy aromatic	Water	oz	2.38	2.38	2.38	2.38	2.38
CxHy chloro	Water	oz	0.000868	0.000869	0.000869	0.00087	0.000871
cyanide	Water	oz	0.216	0.216	0.246	0.252	0.275
detergent/oil	Water	oz	1.37	1.37	1.37	1.37	1.37
di(2-ethylhexyl)phthalate	Water	oz	3.6E-7	3.6E-7	3.60E-07	3.6E-7	3.6E-7
dibutyl p-phthalate	Water	oz	3.06E-6	3.06E-6	3.06E-06	3.06E-6	3.06E-6
dichloroethane	Water	oz	0.00463	0.00463	0.00463	0.00463	0.00464
dichloromethane	Water	oz	0.0234	0.0234	0.0234	0.0234	0.0234
dimethyl p-phthalate	Water	oz	1.93E-5	1.93E-5	1.93E-05	1.93E-5	1.93E-5
dissolved organics	Water	oz	44.8	44.8	44.8	44.8	44.8
dissolved solids	Water	tn.lg	15.1	14.6	25.5	26.5	33.2
dissolved substances	Water	oz	157	158	160	161	165
DOC	Water	oz	0.808	0.808	0.808	0.808	0.809
ethyl benzene	Water	oz	0.092	0.092	0.092	0.0921	0.0921
F2	Water	oz	0.301	0.301	0.301	0.347	0.347

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
fats/oils	Water	oz	38.3	38.3	38.3	38.3	38.3
fatty acids as C	Water	oz	9.01	9.01	9.01	9.01	9.02
Fe	Water	lb	131	147	121	106	107
fluoride ions	Water	oz	290	297	286	280	280
formaldehyde	Water	oz	0.255	0.255	0.255	0.255	0.255
glutaraldehyde	Water	oz	0.0108	0.0108	0.0108	0.0108	0.0108
H2	Water	oz	9.25	9.25	9.27	9.29	9.32
H2S	Water	oz	0.0249	0.0261	0.0296	0.0332	0.0391
H2SO4	Water	oz	321	363	294	253	255
herbicides	Water	oz	5.21E-8	5.21E-8	5.21E-08	5.21E-8	5.21E-8
hexachloroethane	Water	oz	7.93E-8	7.93E-8	7.93E-08	7.93E-8	7.94E-8
Hg	Water	oz	0.00401	0.00396	0.00542	0.00559	0.00654
HOCL	Water	oz	2.46	2.46	2.46	2.46	2.46
I	Water	oz	0.382	0.382	0.382	0.382	0.383
inorganic general	Water	lb	588	588	588	588	588
K	Water	oz	133	134	135	137	139
Kjeldahl-N	Water	oz	3.83	4.46	6.38	8.3	11.5
metallic ions	Water	oz	34.5	35.9	35.4	34.4	35.8
Mg	Water	oz	314	316	320	323	330
Mn	Water	lb	69	78.1	63.1	54.5	54.7
Mo	Water	oz	1.21	1.21	1.22	1.24	1.26
MTBE	Water	oz	0.000345	0.000345	0.000345	0.000345	0.000345
N-tot	Water	oz	9.4	9.4	9.4	9.4	9.41
N organically bound	Water	oz	0.383	0.383	0.384	0.384	0.384
Na	Water	lb	298	298	298	298	299
NH3	Water	oz	25.5	28.3	24.1	21.5	21.9

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
NH3 (as N)	Water	oz	14.4	14.4	14.4	14.5	14.5
NH4+	Water	oz	0.109	0.109	0.109	0.109	0.109
Ni	Water	oz	1.91	1.91	1.94	1.96	2
nitrate	Water	oz	15.3	15.9	14.9	14.3	14.4
nitrite	Water	oz	0.138	0.139	0.139	0.139	0.139
nitrogen	Water	oz	0.266	0.266	0.266	0.266	0.266
non methane VOC	Water	oz	0	0.105	0.422	0.738	1.27
OCl-	Water	oz	0.561	0.561	0.561	0.562	0.562
oil	Water	lb	606	585	1.02E3	1.06E3	1.33E3
other organics	Water	lb	113	112	179	183	227
P-compounds	Water	oz	0.00164	0.00166	0.0017	0.00174	0.00182
P-tot	Water	oz	0.000465	0.000465	0.000465	0.000465	0.000465
P2O5	Water	oz	0.472	0.472	0.472	0.472	0.472
PAH's	Water	oz	0.0915	0.0915	0.0916	0.0916	0.0917
Pb	Water	oz	2.25	2.26	2.29	2.32	2.36
pesticides	Water	oz	2.65E-8	2.65E-8	2.65E-08	2.65E-8	2.65E-8
phenol	Water	oz	0.515	0.519	0.518	0.514	0.519
phenols	Water	oz	0.247	0.247	0.247	0.247	0.247
phosphate	Water	oz	375	396	362	342	343
Ru	Water	oz	0.0175	0.0176	0.0176	0.0176	0.0176
S	Water	oz	0.0643	0.0643	0.0644	0.0644	0.0644
salt	Water	oz	13.7	13.7	13.7	13.8	13.8
salts	Water	oz	176	176	178	179	180
Sb	Water	oz	0.00557	0.00557	0.00558	0.00558	0.00559
Se	Water	oz	1.86	1.87	1.9	1.92	1.96
Si	Water	oz	0.0532	0.0532	0.0533	0.0533	0.0534

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Sn	Water	oz	0.00441	0.00441	0.00441	0.00441	0.00442
SO3	Water	oz	0.398	0.398	0.398	0.398	0.398
Sr	Water	oz	27.5	27.5	27.6	27.7	27.8
sulphate	Water	lb	1.66E3	1.67E3	2.47E3	2.5E3	3.05E3
sulphates	Water	lb	142	143	143	143	143
sulphide	Water	oz	0.0575	0.0785	0.142	0.205	0.311
suspended solids	Water	lb	1.57E3	1.76E3	1.47E3	1.29E3	1.32E3
suspended substances	Water	oz	164	164	164	164	164
tetrachloroethene	Water	oz	9.4E-6	9.4E-6	9.41E-06	9.41E-6	9.41E-6
tetrachloromethane	Water	oz	1.44E-5	1.44E-5	1.44E-05	1.44E-5	1.44E-5
Ti	Water	oz	21.9	22	22.3	22.6	23.1
TOC	Water	oz	90.3	90.3	90.4	90.5	90.7
toluene	Water	oz	0.447	0.447	0.447	0.447	0.447
tributyltin	Water	oz	0.014	0.0141	0.0141	0.0141	0.0141
trichloroethene	Water	oz	0.000775	0.000775	0.000776	0.000776	0.000776
trichloromethane	Water	oz	0.0022	0.0022	0.0022	0.0022	0.0022
triethylene glycol	Water	oz	0.808	0.808	0.808	0.808	0.809
undissolved substances	Water	lb	129	129	129	129	129
V	Water	oz	1.97	1.98	2	2.02	2.06
vinyl chloride	Water	oz	2.67E-6	2.67E-6	2.67E-06	2.67E-6	2.67E-6
VOC as C	Water	oz	0.61	0.61	0.61	0.61	0.611
W	Water	oz	0.007	0.00701	0.00701	0.00702	0.00703
xylene	Water	oz	0.37	0.37	0.37	0.37	0.371
Zn	Water	oz	12.5	12.2	18.4	19.1	23
aluminium	Solid	kg	0	0	0	0	0
chemical waste	Solid	oz	13.4	13.4	13.4	13.4	13.4

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
chemical waste (inert)	Solid	oz	321	321	321	321	321
chemical waste (regulated)	Solid	oz	137	137	137	137	137
dust - not specified	Solid	oz	4.24	4.94	7.06	9.19	12.7
final waste (inert)	Solid	tn.lg	1.93	1.93	1.93	1.93	1.93
high active nuclear waste	Solid	cu.in	4.15	4.15	4.15	4.15	4.15
incinerator waste	Solid	oz	0.846	0.846	0.846	0.846	0.846
industrial waste	Solid	oz	127	127	127	127	127
inorganic general	Solid	tn.lg	12.5	12.5	12.5	12.5	12.5
low, med. act. nucl. waste	Solid	cu.in	283	283	283	283	283
mineral waste	Solid	lb	124	124	124	124	124
oil	Solid	oz	548	551	558	566	578
plastic production waste	Solid	oz	12	12	12	12	12
produc. waste (not inert)	Solid	lb	266	266	267	267	267
slag	Solid	oz	335	335	335	336	336
slags/ash	Solid	oz	66	66	66	66	66
solid waste	Solid	tn.lg	209	231	213	192	206
unspecified	Solid	oz	0.246	0.246	0.246	0.246	0.246
wood (sawdust)	Solid	tn.lg	1.49	1.49	1.49	1.49	1.49
Al (ind.)	Soil	oz	3.07	3.07	3.08	3.08	3.08
As (ind.)	Soil	oz	0.00123	0.00123	0.00123	0.00123	0.00123
C (ind.)	Soil	oz	9.45	9.45	9.45	9.45	9.46
Ca (ind.)	Soil	oz	12.3	12.3	12.3	12.3	12.3
Cd (ind.)	Soil	oz	5.06E-5	5.07E-5	5.10E-05	5.13E-5	5.18E-5
Co (ind.)	Soil	oz	4.74E-5	4.74E-5	4.75E-05	4.75E-5	4.75E-5
Cr (ind.)	Soil	oz	0.0154	0.0154	0.0154	0.0154	0.0154
Cu (ind.)	Soil	oz	0.000237	0.000237	0.000237	0.000237	0.000237

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Fe (ind.)	Soil	oz	6.16	6.16	6.16	6.17	6.17
Hg (ind.)	Soil	oz	7.69E-6	7.75E-6	7.95E-06	8.15E-6	8.47E-6
Mn (ind.)	Soil	oz	0.123	0.123	0.123	0.123	0.123
N	Soil	oz	0.00305	0.00311	0.00332	0.00353	0.00387
Ni (ind.)	Soil	oz	0.000355	0.000355	0.000356	0.000356	0.000356
oil (ind.)	Soil	oz	10.9	10.9	10.9	10.9	10.9
oil biodegradable	Soil	oz	5.87	5.87	5.87	5.87	5.88
P-tot	Soil	oz	0.163	0.163	0.164	0.165	0.167
Pb (ind.)	Soil	oz	0.00108	0.00108	0.00108	0.00108	0.00109
S (ind.)	Soil	oz	1.85	1.85	1.85	1.85	1.85
Zn (ind.)	Soil	oz	0.0485	0.0485	0.0485	0.0485	0.0485
Ag110m to air	Non mat.	Bq	0.0398	0.0398	0.0398	0.0398	0.0399
Ag110m to water	Non mat.	Bq	272	272	272	272	272
alpha radiation (unspecified) to water	Non mat.	Bq	0.032	0.032	0.032	0.0321	0.0321
Am241 to air	Non mat.	Bq	0.765	0.765	0.766	0.766	0.767
Am241 to water	Non mat.	Bq	101	101	101	101	101
Ar41 to air	Non mat.	Bq	8.62E4	8.62E4	8.62E4	8.63E4	8.64E4
Ba140 to air	Non mat.	Bq	0.181	0.181	0.181	0.182	0.182
Ba140 to water	Non mat.	Bq	0.932	0.932	0.933	0.933	0.934
beta radiation (unspecified) to air	Non mat.	Bq	0.00841	0.00841	0.00842	0.00842	0.00843
C14 to air	Non mat.	Bq	6.26E4	6.26E4	6.26E4	6.27E4	6.27E4
C14 to water	Non mat.	Bq	5.08E3	5.08E3	5.09E3	5.09E3	5.1E3
Cd109 to water	Non mat.	Bq	0.00541	0.00541	0.00541	0.00541	0.00541
Ce141 to air	Non mat.	Bq	0.00372	0.00372	0.00372	0.00373	0.00373
Ce141 to water	Non mat.	Bq	0.14	0.14	0.14	0.14	0.14
Ce144 to air	Non mat.	Bq	8.14	8.14	8.15	8.15	8.16

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Ce144 to water	Non mat.	Bq	2.3E3	2.3E3	2.31E3	2.31E3	2.31E3
Cm (alpha) to air	Non mat.	Bq	1.21	1.21	1.21	1.22	1.22
Cm (alpha) to water	Non mat.	Bq	134	134	134	134	134
Cm242 to air	Non mat.	Bq	3.89E-6	3.89E-6	3.89E-06	3.9E-6	3.9E-6
Cm244 to air	Non mat.	Bq	3.53E-5	3.53E-5	3.54E-05	3.54E-5	3.54E-5
Co57 to air	Non mat.	Bq	6.78E-5	6.78E-5	6.79E-05	6.79E-5	6.8E-5
Co57 to water	Non mat.	Bq	0.96	0.96	0.96	0.961	0.961
Co58 to air	Non mat.	Bq	1.13	1.13	1.13	1.13	1.13
Co58 to water	Non mat.	Bq	586	586	586	586	587
Co60 to air	Non mat.	Bq	1.71	1.71	1.71	1.71	1.72
Co60 to water	Non mat.	Bq	2.25E4	2.25E4	2.26E4	2.26E4	2.26E4
Conv. to continuous urban land	Non mat.	sq.yd	2.05	2.07	2.1	2.14	2.21
Conv. to industrial area	Non mat.	sq.yd	1.43	1.43	1.43	1.43	1.43
Cr51 to air	Non mat.	Bq	0.143	0.143	0.143	0.143	0.143
Cr51 to water	Non mat.	Bq	20.6	20.6	20.6	20.6	20.6
Cs134 to air	Non mat.	Bq	29	29	29	29.1	29.1
Cs134 to water	Non mat.	Bq	5.14E3	5.14E3	5.15E3	5.15E3	5.16E3
Cs136 to water	Non mat.	Bq	0.00502	0.00502	0.00502	0.00502	0.00503
Cs137 to air	Non mat.	Bq	56	56.1	56.1	56.1	56.2
Cs137 to water	Non mat.	Bq	4.75E4	4.75E4	4.75E4	4.76E4	4.76E4
Fe59 to air	Non mat.	Bq	0.00154	0.00154	0.00154	0.00154	0.00154
Fe59 to water	Non mat.	Bq	0.0165	0.0165	0.0165	0.0165	0.0166
Fission and activation products (RA) to water	Non mat.	Bq	291	291	291	291	291
H3 to air	Non mat.	Bq	6.2E5	6.2E5	6.21E5	6.21E5	6.22E5
H3 to water	Non mat.	Bq	1.51E8	1.51E8	1.51E8	1.51E8	1.51E8
heat losses to air	Non mat.	MWh	60.2	60.7	62.3	63.9	66.6

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
heat losses to soil	Non mat.	kWh	25.5	25.5	25.6	25.6	25.6
heat losses to water	Non mat.	MWh	-3.4	-3.4	-3.4	-3.4	-3.39
I129 to air	Non mat.	Bq	218	218	219	219	219
I129 to water	Non mat.	Bq	1.45E4	1.45E4	1.46E4	1.46E4	1.46E4
I131 to air	Non mat.	Bq	31.3	31.3	31.3	31.4	31.4
I131 to water	Non mat.	Bq	11.2	11.2	11.2	11.2	11.2
I133 to air	Non mat.	Bq	13.2	13.2	13.2	13.2	13.2
I133 to water	Non mat.	Bq	4.28	4.28	4.28	4.28	4.29
I135 to air	Non mat.	Bq	19.7	19.7	19.7	19.7	19.7
K40 to air	Non mat.	Bq	143	143	143	143	144
K40 to water	Non mat.	Bq	387	387	387	388	388
Kr85 to air	Non mat.	Bq	3.76E9	3.76E9	3.77E9	3.77E9	3.77E9
Kr85m to air	Non mat.	Bq	6.79E3	6.79E3	6.79E3	6.8E3	6.8E3
Kr87 to air	Non mat.	Bq	2.67E3	2.67E3	2.67E3	2.67E3	2.67E3
Kr88 to air	Non mat.	Bq	1.72E5	1.72E5	1.72E5	1.73E5	1.73E5
Kr89 to air	Non mat.	Bq	2.14E3	2.14E3	2.14E3	2.14E3	2.15E3
La140 to air	Non mat.	Bq	0.102	0.102	0.103	0.103	0.103
La140 to water	Non mat.	Bq	0.194	0.194	0.194	0.194	0.194
land use (sea floor) II-III	Non mat.	m2a	108	108	108	108	108
land use (sea floor) II-IV	Non mat.	m2a	11.1	11.1	11.1	11.1	11.1
land use II-III	Non mat.	m2a	390	390	391	391	392
land use II-IV	Non mat.	m2a	215	215	215	215	215
land use III-IV	Non mat.	m2a	24.6	24.6	24.7	24.7	24.8
land use IV-IV	Non mat.	m2a	0.243	0.243	0.243	0.243	0.244
Mn54 to air	Non mat.	Bq	0.0406	0.0406	0.0407	0.0407	0.0407
Mn54 to water	Non mat.	Bq	3.42E3	3.43E3	3.43E3	3.43E3	3.43E3

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Mo99 to water	Non mat.	Bq	0.0654	0.0654	0.0655	0.0655	0.0655
Na24 to water	Non mat.	Bq	28.8	28.8	28.8	28.8	28.8
Nb95 to air	Non mat.	Bq	0.00723	0.00723	0.00723	0.00724	0.00725
Nb95 to water	Non mat.	Bq	0.531	0.531	0.531	0.531	0.532
Np237 to air	Non mat.	Bq	4E-5	4E-5	4.01E-05	4.01E-5	4.01E-5
Np237 to water	Non mat.	Bq	6.44	6.44	6.44	6.45	6.45
Occup. as contin. urban land	Non mat.	m2a	14	14.8	17.2	19.6	23.6
Occup. as convent. arable land	Non mat.	m2a	1.26E3	1.26E3	1.27E3	1.27E3	1.27E3
Occup. as forest land	Non mat.	m2a	0.0476	0.0476	0.0476	0.0477	0.0477
Occup. as industrial area	Non mat.	m2a	925	930	942	955	976
Occup. as rail/road area	Non mat.	m2a	7.43E4	7.43E4	7.43E4	7.43E4	7.43E4
Pa234m to air	Non mat.	Bq	24.2	24.2	24.3	24.3	24.3
Pa234m to water	Non mat.	Bq	449	449	450	450	450
Pb210 to air	Non mat.	Bq	775	775	776	776	777
Pb210 to water	Non mat.	Bq	308	308	308	308	309
Pm147 to air	Non mat.	Bq	20.6	20.6	20.7	20.7	20.7
Po210 to air	Non mat.	Bq	1.19E3	1.19E3	1.19E3	1.19E3	1.19E3
Po210 to water	Non mat.	Bq	308	308	308	308	309
Pu alpha to air	Non mat.	Bq	2.43	2.43	2.43	2.43	2.43
Pu alpha to water	Non mat.	Bq	400	400	401	401	401
Pu238 to air	Non mat.	Bq	8.77E-5	8.77E-5	8.77E-05	8.78E-5	8.79E-5
Pu241 beta	Non mat.	Bq	9.95E3	9.95E3	9.96E3	9.96E3	9.97E3
Pu241 Beta to air	Non mat.	Bq	66.8	66.8	66.8	66.9	66.9
Ra224 to water	Non mat.	Bq	2.47E3	2.47E3	2.47E3	2.48E3	2.48E3
Ra226 to air	Non mat.	Bq	890	891	891	892	893
Ra226 to water	Non mat.	Bq	1.86E6	1.86E6	1.86E6	1.86E6	1.86E6

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Ra228 to air	Non mat.	Bq	70.4	70.4	70.5	70.5	70.6
Ra228 to water	Non mat.	Bq	4.94E3	4.94E3	4.94E3	4.94E3	4.95E3
radio active noble gases to air	Non mat.	Bq	9.87E3	9.88E3	9.88E3	9.88E3	9.89E3
radioactive substance to air	Non mat.	Bq	5.37E10	5.63E10	5.21E+10	4.97E10	4.98E10
radioactive substance to water	Non mat.	Bq	3.2E8	3.2E8	3.20E8	3.2E8	3.2E8
radionuclides (mixed) to water	Non mat.	Bq	0.227	0.227	0.227	0.227	0.228
Rn220 to air	Non mat.	Bq	5.82E3	5.82E3	5.83E3	5.83E3	5.84E3
Rn222 (long term) to air	Non mat.	Bq	5.4E9	5.4E9	5.41E9	5.41E9	5.42E9
Rn222 to air	Non mat.	Bq	5.86E7	5.86E7	5.86E7	5.86E7	5.87E7
Ru103 to air	Non mat.	Bq	0.000441	0.000441	0.000441	0.000442	0.000442
Ru103 to water	Non mat.	Bq	0.314	0.314	0.314	0.314	0.314
Ru106 to air	Non mat.	Bq	243	243	243	243	243
Ru106 to water	Non mat.	Bq	2.43E4	2.43E4	2.43E4	2.43E4	2.43E4
Sb122 to water	Non mat.	Bq	0.932	0.932	0.933	0.933	0.934
Sb124 to air	Non mat.	Bq	0.011	0.011	0.0111	0.0111	0.0111
Sb124 to water	Non mat.	Bq	76.1	76.2	76.2	76.2	76.3
Sb125 to air	Non mat.	Bq	0.002	0.002	0.002	0.002	0.002
Sb125 to water	Non mat.	Bq	7.62	7.62	7.63	7.63	7.63
Sr89 to air	Non mat.	Bq	0.0711	0.0711	0.0712	0.0712	0.0713
Sr89 to water	Non mat.	Bq	2.11	2.11	2.11	2.11	2.12
Sr90 to air	Non mat.	Bq	40	40	40.1	40.1	40.1
Sr90 to water	Non mat.	Bq	4.85E3	4.85E3	4.86E3	4.86E3	4.87E3
Tc99 to air	Non mat.	Bq	0.0017	0.0017	0.0017	0.0017	0.0017
Tc99 to water	Non mat.	Bq	2.55E3	2.55E3	2.55E3	2.55E3	2.55E3
Tc99m to water	Non mat.	Bq	0.441	0.442	0.442	0.442	0.442
Te123m to air	Non mat.	Bq	0.177	0.177	0.177	0.177	0.177

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Te123m to water	Non mat.	Bq	0.0395	0.0395	0.0395	0.0395	0.0395
Te132 to water	Non mat.	Bq	0.0162	0.0162	0.0162	0.0162	0.0162
Th228 to air	Non mat.	Bq	59.6	59.6	59.7	59.7	59.8
Th228 to water	Non mat.	Bq	9.9E3	9.9E3	9.90E3	9.9E3	9.91E3
Th230 to air	Non mat.	Bq	270	270	270	271	271
Th230 to water	Non mat.	Bq	7.02E4	7.02E4	7.03E4	7.03E4	7.04E4
Th232 to air	Non mat.	Bq	37.8	37.8	37.9	37.9	38
Th232 to water	Non mat.	Bq	72.1	72.1	72.2	72.2	72.3
Th234 to air	Non mat.	Bq	24.2	24.2	24.3	24.3	24.3
Th234 to water	Non mat.	Bq	453	453	453	454	454
U alpha to air	Non mat.	Bq	868	868	869	870	871
U alpha to water	Non mat.	Bq	2.93E4	2.93E4	2.94E4	2.94E4	2.94E4
U234 to air	Non mat.	Bq	291	291	291	291	292
U234 to water	Non mat.	Bq	600	600	601	601	602
U235 to air	Non mat.	Bq	14.1	14.1	14.1	14.1	14.1
U235 to water	Non mat.	Bq	896	896	896	897	898
U238 to air	Non mat.	Bq	395	395	396	396	396
U238 to water	Non mat.	Bq	1.53E3	1.53E3	1.53E3	1.53E3	1.53E3
waste heat to air	Non mat.	kWh	-1.16E4	-1.15E4	-1.15E4	-1.14E4	-1.13E4
waste heat to soil	Non mat.	kWh	104	105	105	105	105
waste heat to water	Non mat.	MWh	1.89	1.89	1.89	1.89	1.89
Xe131m to air	Non mat.	Bq	1.23E4	1.23E4	1.23E4	1.23E4	1.23E4
Xe133 to air	Non mat.	Bq	2.68E6	2.68E6	2.69E6	2.69E6	2.69E6
Xe133m to air	Non mat.	Bq	1.31E3	1.31E3	1.31E3	1.31E3	1.31E3
Xe135 to air	Non mat.	Bq	4.96E5	4.96E5	4.97E5	4.97E5	4.98E5
Xe135m to air	Non mat.	Bq	6.73E4	6.73E4	6.73E4	6.73E4	6.74E4

*An x means there are no data.

Table D-1. LCI Output from SimaPro for Wood Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	Wood				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Xe137 to air	Non mat.	Bq	1.56E3	1.56E3	1.56E3	1.56E3	1.56E3
Xe138 to air	Non mat.	Bq	1.84E4	1.84E4	1.84E4	1.84E4	1.84E4
Y90 to water	Non mat.	Bq	0.108	0.108	0.108	0.108	0.108
Zn65 to air	Non mat.	Bq	0.186	0.186	0.186	0.186	0.186
Zn65 to water	Non mat.	Bq	60.9	60.9	60.9	60.9	61
Zr95 to air	Non mat.	Bq	0.00258	0.00258	0.00258	0.00258	0.00258
Zr95 to water	Non mat.	Bq	207	207	207	207	207

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
air	Raw	lb	375	375	375	375	375
barrage water	Raw	tn.lg	94.1	94.1	94.1	94.1	94.1
baryte	Raw	oz	416	416	416	416	417
bauxite	Raw	lb	490	490	490	490	490
bentonite	Raw	oz	322	322	322	323	323
chromium (in ore)	Raw	lb	161	161	161	161	161
clay	Raw	lb	6.51E3	6.66E3	7.12E3	7.58E3	8.35E3
clay minerals	Raw	oz	0.246	0.246	0.246	0.246	0.246
coal	Raw	lb	2.38E3	2.46E3	2.71E3	2.95E3	3.36E3
coal ETH	Raw	tn.lg	7.15	7.18	7.27	7.35	7.49
coal FAL	Raw	tn.lg	388	447	348	296	303
cobalt (in ore)	Raw	oz	1.72E-5	1.72E-5	1.72E-5	1.72E-5	1.72E-5
copper (in ore)	Raw	lb	216	216	216	216	216
crude oil	Raw	oz	504	525	586	648	750
crude oil (feedstock) FAL	Raw	lb	259	323	258	451	773
crude oil ETH	Raw	tn.lg	2.06	2.06	2.06	2.06	2.06
crude oil FAL	Raw	tn.lg	19.9	22	20.6	18.9	21
crude oil IDEMAT	Raw	tn.lg	9.39	9.4	9.43	9.45	9.48
dolomite	Raw	oz	460	460	767	884	884
energy (undef.)	Raw	MWh	8.87	8.87	8.88	8.89	8.91
energy from hydro power	Raw	MWh	169	193	152	131	133
energy from uranium	Raw	kWh	9.96	10.4	11.6	12.8	14.8
feldspar	Raw	oz	460	460	767	884	884
fluorspar	Raw	oz	0.0546	0.0546	0.0546	0.0546	0.0546
gas from oil production	Raw	cu.yd	75	75	75	75.1	75.1
gravel	Raw	tn.lg	50.4	53	60.9	68.8	82

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
gypsum	Raw	lb	4.9E3	5.01E3	5.36E3	5.71E3	6.29E3
iron (in ore)	Raw	lb	3.59E3	3.73E3	4.14E3	4.55E3	5.23E3
iron (ore)	Raw	tn.lg	2.85	2.86	2.88	2.9	2.93
K	Raw	lb	87.4	87.4	87.4	87.4	87.4
lead (in ore)	Raw	lb	315	315	315	315	315
lignite	Raw	tn.lg	1.25	1.25	1.25	1.25	1.25
lignite ETH	Raw	tn.lg	1.32	1.32	1.32	1.32	1.32
limestone	Raw	tn.lg	74	78.6	76.6	77.3	83.8
manganese (in ore)	Raw	oz	372	387	432	477	552
manganese (ore)	Raw	oz	x	x	x	x	x
marl	Raw	tn.lg	14.1	14.3	15	15.7	16.9
methane (kg)	Raw	lb	69	69.1	69.2	69.3	69.4
methane (kg) ETH	Raw	oz	759	768	793	819	862
molybdene (in ore)	Raw	oz	3.69E-5	3.69E-5	3.69E-5	3.69E-5	3.69E-5
NaCl	Raw	lb	1.19E3	1.19E3	1.19E3	1.19E3	1.19E3
NaOH	Raw	lb	86.2	86.2	144	166	166
natural gas	Raw	tn.lg	3.64	3.64	3.67	3.69	3.69
natural gas (feedstock) FAL	Raw	lb	67.2	84	67	117	201
natural gas ETH	Raw	cu.yd	2.13E3	2.13E3	2.13E3	2.14E3	2.14E3
natural gas FAL	Raw	tn.lg	293	280	473	478	618
nickel (in ore)	Raw	oz	10.9	10.9	10.9	10.9	10.9
nitrogen	Raw	oz	464	464	464	464	464
oxygen	Raw	lb	483	483	483	483	483
palladium (in ore)	Raw	oz	5.73E-5	5.73E-5	5.73E-5	5.73E-5	5.73E-5
petroleum gas ETH	Raw	cu.yd	81.2	81.2	81.3	81.3	81.3
phosphate (ore)	Raw	oz	x	x	x	x	x

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
platinum (in ore)	Raw	oz	6.47E-5	6.47E-5	6.47E-5	6.47E-5	6.47E-5
potential energy water ETH	Raw	MWh	2.28	2.28	2.28	2.28	2.28
reservoir content ETH	Raw	m3y	175	175	175	175	176
rhenium (in ore)	Raw	oz	5.48E-5	5.48E-5	5.48E-5	5.48E-5	5.48E-5
rhodium (in ore)	Raw	oz	6.08E-5	6.08E-5	6.08E-5	6.09E-5	6.09E-5
rock salt	Raw	lb	1.45E3	1.45E3	1.45E3	1.45E3	1.45E3
sand	Raw	tn.lg	108	110	116	122	131
scrap, external	Raw	lb	1.88E3	1.88E3	1.88E3	1.88E3	1.88E3
shale	Raw	lb	5.2E3	5.32E3	5.7E3	6.07E3	6.69E3
silicon (in SiO2)	Raw	oz	183	190	212	235	272
silver	Raw	oz	0.123	0.123	0.123	0.123	0.123
silver (in ore)	Raw	oz	0.101	0.101	0.101	0.101	0.101
sulphur	Raw	oz	409	409	409	409	409
tin (in ore)	Raw	oz	0.124	0.124	0.124	0.124	0.124
turbine water ETH	Raw	cu.yd	5.53E4	5.53E4	5.54E4	5.54E4	5.54E4
uranium (in ore)	Raw	oz	14.1	14.1	14.1	14.1	14.1
uranium (in ore) ETH	Raw	oz	3.19	3.19	3.19	3.19	3.2
uranium (ore)	Raw	oz	248	248	248	248	248
uranium FAL	Raw	oz	54.3	62.6	48.6	41.2	42.2
water	Raw	tn.lg	992	993	998	1E3	1.01E3
wood	Raw	tn.lg	23.4	23.4	23.4	23.4	23.4
wood (dry matter) ETH	Raw	tn.lg	9.21	9.21	9.21	9.22	9.22
wood/wood wastes FAL	Raw	lb	759	824	864	801	933
zeolite	Raw	oz	2.86	2.86	2.86	2.86	2.86
zinc (in ore)	Raw	oz	0.236	0.236	0.236	0.236	0.237
1,2-dichloroethane	Air	oz	0.00211	0.00211	0.00212	0.00212	0.00212

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
acetaldehyde	Air	oz	0.498	0.498	0.499	0.499	0.499
acetic acid	Air	oz	1.76	1.76	1.77	1.77	1.77
acetone	Air	oz	0.42	0.42	0.421	0.421	0.421
acrolein	Air	oz	0.47	0.542	0.421	0.357	0.365
Al	Air	oz	12.8	12.8	12.9	12.9	13
aldehydes	Air	oz	171	181	204	197	232
alkanes	Air	oz	5.06	5.06	5.06	5.07	5.07
alkenes	Air	oz	4.61	4.61	4.61	4.62	4.62
ammonia	Air	oz	148	166	135	119	121
As	Air	oz	3.22	3.47	3.06	2.84	2.88
B	Air	oz	2.65	2.65	2.66	2.66	2.66
Ba	Air	oz	0.165	0.165	0.166	0.166	0.167
Be	Air	oz	0.195	0.225	0.176	0.15	0.154
benzaldehyde	Air	oz	2.08E-5	2.08E-5	2.08E-5	2.08E-5	2.09E-5
benzene	Air	oz	5.94	6.05	5.9	5.83	5.87
benzo(a)pyrene	Air	oz	0.0126	0.013	0.0144	0.0157	0.018
Br	Air	oz	0.564	0.564	0.565	0.566	0.566
butane	Air	oz	6.63	6.63	6.64	6.65	6.66
butene	Air	oz	0.193	0.193	0.194	0.194	0.194
Ca	Air	oz	4.42	4.42	4.43	4.44	4.45
Cd	Air	oz	0.464	0.513	0.46	0.417	0.449
CFC-11	Air	oz	0.001	0.001	0.00101	0.00101	0.00101
CFC-114	Air	oz	0.0266	0.0266	0.0266	0.0266	0.0267
CFC-116	Air	oz	0.0861	0.0861	0.0861	0.0861	0.0861
CFC-12	Air	oz	0.000216	0.000216	0.000216	0.000217	0.000217
CFC-13	Air	oz	0.000136	0.000136	0.000136	0.000136	0.000136

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
CFC-14	Air	oz	0.772	0.772	0.772	0.772	0.772
Cl2	Air	oz	42.8	44.5	50.2	55.5	64
CO	Air	tn.lg	1.82	1.8	2.65	2.66	3.33
CO2	Air	tn.lg	536	488	925	956	1.25E3
CO2 (fossil)	Air	tn.lg	1.08E3	1.23E3	1.02E3	887	941
CO2 (non-fossil)	Air	lb	1.02E3	1.11E3	1.14E3	1.05E3	1.21E3
coal dust	Air	oz	0.00913	0.00913	0.00913	0.00913	0.00913
cobalt	Air	oz	0.729	0.816	0.695	0.617	0.647
Cr	Air	oz	2.97	3.37	2.71	2.35	2.41
Cu	Air	oz	0.416	0.419	0.43	0.441	0.46
CxHy	Air	lb	129	129	130	130	131
CxHy aromatic	Air	oz	0.0592	0.0592	0.0593	0.0593	0.0593
CxHy chloro	Air	oz	0.126	0.126	0.211	0.243	0.243
cyanides	Air	oz	0.00285	0.00289	0.00302	0.00315	0.00336
dichloroethane	Air	oz	0.00576	0.00576	0.00576	0.00576	0.00576
dichloromethane	Air	oz	1.99	2.3	1.79	1.51	1.55
dioxin (TEQ)	Air	oz	8.5E-6	9.13E-6	9.17E-6	9.53E-6	1.08E-5
dust	Air	lb	83	76.1	138	142	183
dust (coarse)	Air	oz	759	759	760	761	762
dust (coarse) process	Air	oz	157	158	160	162	166
dust (PM10)	Air	lb	216	222	239	256	284
dust (PM10) mobile	Air	oz	5.32	5.32	5.32	5.32	5.33
dust (PM10) stationary	Air	oz	251	251	251	251	251
dust (SPM)	Air	oz	205	208	217	225	236
ethane	Air	oz	12.6	12.6	12.6	12.7	12.7
ethanol	Air	oz	0.843	0.843	0.843	0.843	0.844

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
ethene	Air	oz	4	4.03	4.1	4.17	4.29
ethylbenzene	Air	oz	2.28	2.28	2.28	2.28	2.29
ethyne	Air	oz	0.0779	0.0787	0.081	0.0834	0.0872
F2	Air	oz	0.619	0.639	0.783	0.876	0.976
Fe	Air	oz	6.41	6.42	6.44	6.45	6.48
fluoranthene	Air	oz	0.0313	0.0325	0.0364	0.0402	0.0465
fluoride	Air	oz	0.0857	0.0857	0.0857	0.0857	0.0857
formaldehyde	Air	oz	6.16	6.4	6.01	5.81	5.86
H2	Air	oz	7.91	7.91	7.91	7.91	7.91
H2S	Air	oz	7.68	7.92	8.67	9.41	10.6
HALON-1301	Air	oz	0.0224	0.0224	0.0224	0.0224	0.0224
HCFC-21	Air	oz	0.0197	0.0197	0.0197	0.0198	0.0198
HCFC-22	Air	oz	0.000239	0.000239	0.000239	0.00024	0.00024
HCl	Air	lb	156	178	140	120	123
He	Air	oz	2.21	2.21	2.21	2.21	2.21
heptane	Air	oz	1.29	1.29	1.29	1.29	1.29
hexachlorobenzene	Air	oz	3.56E-7	3.56E-7	3.56E-7	3.56E-7	3.56E-7
hexane	Air	oz	2.71	2.71	2.71	2.71	2.71
HF	Air	oz	395	445	361	316	322
HFC-134a	Air	oz	-1.06E-15	-1.06E-15	-1.06E-15	-1.05E-15	-1.05E-15
Hg	Air	oz	0.941	1.08	0.853	0.732	0.753
I	Air	oz	0.207	0.207	0.207	0.208	0.208
K	Air	oz	1.93	1.93	1.94	1.94	1.95
kerosene	Air	oz	12	13.8	10.7	9.09	9.31
La	Air	oz	0.00487	0.00488	0.0049	0.00492	0.00495
metals	Air	oz	9.44	10	10.2	9.59	10.6

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
methane	Air	tn.lg	3.81	4	4.8	4.59	5.54
methanol	Air	oz	0.865	0.865	0.866	0.866	0.866
Mg	Air	oz	4.19	4.19	4.2	4.22	4.24
Mn	Air	oz	5.68	6.48	5.15	4.43	4.54
Mo	Air	oz	0.0341	0.0341	0.0341	0.0341	0.0341
MTBE	Air	oz	0.00222	0.00222	0.00222	0.00222	0.00222
n-nitrodimethylamine	Air	oz	0.0992	0.114	0.0888	0.0753	0.0771
N2	Air	oz	13.6	13.6	13.6	13.6	13.6
N2O	Air	lb	60.9	61.8	74.9	73.6	85.7
Na	Air	oz	2.32	2.32	2.33	2.33	2.33
naphthalene	Air	oz	0.26	0.264	0.261	0.258	0.262
Ni	Air	oz	7.6	8.45	7.4	6.63	7.05
NO2	Air	oz	88	90.9	99.6	108	123
non methane VOC	Air	tn.lg	2.84	2.74	4.47	4.51	5.79
NOx	Air	tn.lg	4.81	5.3	5.11	4.67	5.25
NOx (as NO2)	Air	oz	844	845	846	848	850
organic substances	Air	lb	49.7	50.9	57.7	59.3	67.7
P	Air	oz	0.104	0.104	0.105	0.105	0.105
P-tot	Air	oz	0.0481	0.0482	0.0484	0.0486	0.0489
PAH's	Air	oz	0.119	0.119	0.12	0.12	0.12
particulates (PM10)	Air	lb	447	515	400	340	348
particulates (unspecified)	Air	lb	2.28E3	2.61E3	2.07E3	1.77E3	1.83E3
Pb	Air	oz	18.6	18.8	18.6	18.5	18.7
pentachlorobenzene	Air	oz	9.53E-7	9.53E-7	9.53E-7	9.53E-7	9.53E-7
pentachlorophenol	Air	oz	1.54E-7	1.54E-7	1.54E-7	1.54E-7	1.54E-7
pentane	Air	oz	12.7	12.7	12.7	12.7	12.8

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
phenol	Air	oz	1.43	1.61	1.43	1.3	1.36
phosphate	Air	oz	0.0416	0.0416	0.0416	0.0416	0.0416
propane	Air	oz	8.76	8.77	8.79	8.81	8.84
propene	Air	oz	0.517	0.519	0.524	0.528	0.536
propionic acid	Air	oz	0.011	0.011	0.0112	0.0113	0.0113
Pt	Air	oz	2.05E-5	2.05E-5	2.05E-5	2.05E-5	2.05E-5
Sb	Air	oz	0.224	0.254	0.212	0.184	0.195
Sc	Air	oz	0.00196	0.00197	0.00198	0.00198	0.002
Se	Air	oz	3.42	3.93	3.08	2.63	2.7
silicates	Air	oz	24.3	24.3	24.4	24.4	24.5
Sn	Air	oz	0.00409	0.00409	0.0041	0.00411	0.00412
SO2	Air	lb	899	902	918	930	951
soot	Air	oz	74.1	74.2	74.6	75.1	75.8
SOx	Air	tn.lg	15.6	16.1	21.1	20.5	25.4
SOx (as SO2)	Air	lb	92.3	92.3	92.4	92.5	92.7
Sr	Air	oz	0.197	0.197	0.197	0.198	0.199
tetrachloroethene	Air	oz	0.448	0.516	0.401	0.34	0.349
tetrachloromethane	Air	oz	0.741	0.852	0.675	0.576	0.596
Th	Air	oz	0.00913	0.00913	0.00915	0.00917	0.00919
Ti	Air	oz	0.583	0.584	0.585	0.587	0.589
Tl	Air	oz	0.000753	0.000754	0.000757	0.000759	0.000762
toluene	Air	oz	7.7	7.71	7.72	7.73	7.75
trichloroethene	Air	oz	0.444	0.512	0.397	0.337	0.345
trichloromethane	Air	oz	0.000152	0.000152	0.000152	0.000152	0.000152
U	Air	oz	0.00469	0.00469	0.0047	0.00471	0.00472
V	Air	oz	4.36	4.36	4.36	4.37	4.37

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
vinyl chloride	Air	oz	0.00215	0.00215	0.00215	0.00215	0.00215
VOC	Air	lb	54.9	50.1	95.2	98.8	129
water	Air	tn.lg	20.7	20.7	20.7	20.7	20.7
xylene	Air	oz	4.7	4.7	4.7	4.71	4.71
Zn	Air	oz	8.11	8.12	8.2	8.25	8.31
Zr	Air	oz	0.00121	0.00124	0.00131	0.00138	0.0015
1,1,1-trichloroethane	Water	oz	4.88E-6	4.88E-6	4.88E-6	4.88E-6	4.88E-6
acenaphthylene	Water	oz	0.0278	0.0278	0.0278	0.0278	0.0278
Acid as H+	Water	oz	1.36	1.36	1.36	1.36	1.36
acids (unspecified)	Water	oz	0.467	0.512	0.49	0.624	0.849
Ag	Water	oz	0.00242	0.00242	0.00242	0.00242	0.00243
Al	Water	oz	416	418	423	428	436
alkanes	Water	oz	0.488	0.489	0.489	0.489	0.489
alkenes	Water	oz	0.0447	0.0447	0.0447	0.0447	0.0447
AOX	Water	oz	0.0134	0.0134	0.0134	0.0134	0.0134
As	Water	oz	0.841	0.844	0.855	0.864	0.88
B	Water	lb	79.3	91.3	71.3	60.5	62.2
Ba	Water	oz	42.1	42.2	42.6	43	43.7
baryte	Water	oz	84.3	84.3	84.4	84.4	84.5
Be	Water	oz	0.000302	0.000302	0.000302	0.000302	0.000302
benzene	Water	oz	0.494	0.494	0.494	0.494	0.495
BOD	Water	lb	34.3	33.2	52.9	53.5	68.3
calcium compounds	Water	oz	296	296	297	297	297
calcium ions	Water	lb	523	524	524	524	524
Cd	Water	oz	25.4	24.2	40.9	41.4	53.5
chlorinated solvents (unspec.)	Water	oz	0.000244	0.000245	0.000246	0.000247	0.00025

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
chlorobenzenes	Water	oz	1.08E-7	1.08E-7	1.08E-7	1.08E-7	1.08E-7
chromate	Water	oz	0.339	0.383	0.331	0.291	0.315
Cl-	Water	tn.sh	1.41	1.38	1.9	1.91	2.29
Co	Water	oz	0.819	0.822	0.832	0.842	0.858
COD	Water	lb	294	294	419	415	519
Cr	Water	oz	29.6	28.5	45.2	45.8	57.9
Cr (VI)	Water	oz	0.000866	0.000867	0.000868	0.000869	0.00087
crude oil	Water	oz	9.98	9.98	10	10	10.1
Cs	Water	oz	0.0037	0.0037	0.0037	0.0037	0.0037
Cu	Water	oz	2.13	2.14	2.17	2.19	2.24
CxHy	Water	oz	57.3	57.3	57.4	57.5	57.5
CxHy aromatic	Water	oz	2.3	2.3	2.3	2.3	2.3
CxHy chloro	Water	oz	0.000872	0.000872	0.000874	0.000874	0.000875
cyanide	Water	oz	0.247	0.246	0.275	0.279	0.303
detergent/oil	Water	oz	1.35	1.35	1.35	1.35	1.35
di(2-ethylhexyl)phthalate	Water	oz	3E-7	3E-7	3E-7	3E-7	3E-7
dibutyl p-phthalate	Water	oz	2.81E-6	2.81E-6	2.82E-6	2.82E-6	2.82E-6
dichloroethane	Water	oz	0.00403	0.00403	0.00403	0.00403	0.00403
dichloromethane	Water	oz	0.0219	0.0219	0.0219	0.0219	0.0219
dimethyl p-phthalate	Water	oz	1.77E-5	1.77E-5	1.77E-5	1.78E-5	1.78E-5
dissolved organics	Water	oz	43.8	43.8	43.8	43.8	43.8
dissolved solids	Water	tn.lg	15.4	14.7	24.8	25.1	32.4
dissolved substances	Water	oz	174	175	177	179	182
DOC	Water	oz	0.771	0.771	0.771	0.771	0.771
ethyl benzene	Water	oz	0.0886	0.0886	0.0887	0.0887	0.0888
F2	Water	oz	0.18	0.18	0.301	0.347	0.347

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
fats/oils	Water	oz	34.4	34.4	34.4	34.4	34.5
fatty acids as C	Water	oz	8.29	8.29	8.29	8.3	8.3
Fe	Water	lb	130	148	118	103	105
fluoride ions	Water	oz	284	291	279	273	273
formaldehyde	Water	oz	0.187	0.187	0.187	0.187	0.187
glutaraldehyde	Water	oz	0.0104	0.0104	0.0104	0.0104	0.0104
H2	Water	oz	9.37	9.37	9.39	9.41	9.44
H2S	Water	oz	0.0621	0.0633	0.0669	0.0705	0.0764
H2SO4	Water	oz	317	365	285	242	248
herbicides	Water	oz	x	x	x	x	x
hexachloroethane	Water	oz	6.59E-8	6.59E-8	6.59E-8	6.59E-8	6.59E-8
Hg	Water	oz	0.0043	0.00422	0.00558	0.00566	0.00668
HOCL	Water	oz	2.42	2.42	2.42	2.42	2.42
I	Water	oz	0.368	0.368	0.369	0.369	0.369
inorganic general	Water	lb	588	588	588	588	588
K	Water	oz	146	146	148	149	152
Kjeldahl-N	Water	oz	15.7	16.3	18.2	20.2	23.4
metallic ions	Water	oz	24.3	25.9	24.8	23.6	25.3
Mg	Water	oz	349	351	355	359	365
Mn	Water	lb	68.6	79	61.6	52.5	53.8
Mo	Water	oz	1.31	1.32	1.33	1.34	1.36
MTBE	Water	oz	0.000257	0.000257	0.000257	0.000257	0.000257
N-tot	Water	oz	9.14	9.14	9.15	9.15	9.15
N organically bound	Water	oz	0.347	0.347	0.347	0.347	0.347
Na	Water	lb	297	298	298	298	298
NH3	Water	oz	23.2	26.4	21.5	18.7	19.5

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
NH3 (as N)	Water	oz	14.1	14.1	14.2	14.2	14.2
NH4+	Water	oz	0.109	0.109	0.109	0.109	0.109
Ni	Water	oz	2.13	2.14	2.16	2.19	2.23
nitrate	Water	oz	15.1	15.8	14.6	14	14.1
nitrite	Water	oz	0.127	0.127	0.127	0.127	0.128
nitrogen	Water	oz	0.266	0.266	0.266	0.266	0.266
non methane VOC	Water	oz	0.424	0.529	0.422	0.738	1.27
OCl-	Water	oz	0.515	0.515	0.515	0.516	0.516
oil	Water	lb	615	587	989	1E3	1.29E3
other organics	Water	lb	115	113	174	174	222
P-compounds	Water	oz	0.002	0.00202	0.00206	0.0021	0.00218
P-tot	Water	oz	0.000465	0.000465	0.000465	0.000465	0.000466
P2O5	Water	oz	0.464	0.464	0.464	0.464	0.464
PAH's	Water	oz	0.0899	0.0899	0.09	0.09	0.0901
Pb	Water	oz	2.48	2.49	2.51	2.54	2.58
pesticides	Water	oz	x	x	x	x	x
phenol	Water	oz	0.502	0.507	0.504	0.5	0.505
phenols	Water	oz	0.228	0.228	0.228	0.228	0.228
phosphate	Water	oz	364	388	349	327	331
Ru	Water	oz	0.0161	0.0161	0.0161	0.0162	0.0162
S	Water	oz	0.0644	0.0644	0.0645	0.0645	0.0645
salt	Water	oz	13.8	13.8	13.9	13.9	13.9
salts	Water	oz	172	172	173	174	176
Sb	Water	oz	0.0055	0.00551	0.00552	0.00552	0.00553
Se	Water	oz	2.08	2.09	2.12	2.14	2.18
Si	Water	oz	0.05	0.05	0.05	0.0501	0.0501

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Sn	Water	oz	0.00437	0.00437	0.00437	0.00438	0.00438
SO3	Water	oz	0.337	0.337	0.338	0.338	0.338
Sr	Water	oz	27.2	27.2	27.3	27.4	27.5
sulphate	Water	lb	1.69E3	1.69E3	2.41E3	2.39E3	2.99E3
sulphates	Water	lb	143	143	143	143	143
sulphide	Water	oz	0.137	0.158	0.137	0.2	0.306
suspended solids	Water	lb	1.53E3	1.75E3	1.41E3	1.22E3	1.27E3
suspended substances	Water	oz	164	164	164	165	165
tetrachloroethene	Water	oz	7.81E-6	7.81E-6	7.81E-6	7.82E-6	7.82E-6
tetrachloromethane	Water	oz	1.19E-5	1.19E-5	1.19E-5	1.19E-5	1.19E-5
Ti	Water	oz	24.6	24.7	25	25.3	25.8
TOC	Water	oz	85.2	85.2	85.4	85.5	85.7
toluene	Water	oz	0.43	0.43	0.431	0.431	0.431
tributyltin	Water	oz	0.0139	0.0139	0.0139	0.0139	0.0139
trichloroethene	Water	oz	0.000675	0.000675	0.000676	0.000676	0.000676
trichloromethane	Water	oz	0.00183	0.00183	0.00183	0.00183	0.00183
triethylene glycol	Water	oz	0.771	0.771	0.771	0.771	0.771
undissolved substances	Water	lb	129	129	129	129	129
V	Water	oz	2.19	2.19	2.22	2.24	2.28
vinyl chloride	Water	oz	2.22E-6	2.22E-6	2.22E-6	2.22E-6	2.22E-6
VOC as C	Water	oz	0.561	0.561	0.561	0.561	0.561
W	Water	oz	0.00678	0.00679	0.00679	0.0068	0.00681
xylene	Water	oz	0.356	0.356	0.356	0.356	0.357
Zn	Water	oz	13.1	12.8	18.5	18.8	23
aluminium	Solid	kg	0	0	0	0	0
chemical waste	Solid	oz	13.4	13.4	13.4	13.4	13.4

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
chemical waste (inert)	Solid	oz	320	320	320	320	320
chemical waste (regulated)	Solid	oz	137	137	137	137	137
dust - not specified	Solid	oz	17.4	18.1	20.2	22.3	25.9
final waste (inert)	Solid	tn.lg	1.93	1.93	1.94	1.94	1.94
high active nuclear waste	Solid	cu.in	4.15	4.15	4.15	4.15	4.15
incinerator waste	Solid	oz	0.846	0.846	0.846	0.846	0.846
industrial waste	Solid	oz	124	124	124	124	124
inorganic general	Solid	tn.lg	12.5	12.5	12.5	12.5	12.5
low, med. act. nucl. waste	Solid	cu.in	284	284	284	284	284
mineral waste	Solid	lb	123	123	123	123	123
oil	Solid	oz	612	614	622	629	642
plastic production waste	Solid	oz	12	12	12	12	12
produc. waste (not inert)	Solid	lb	267	267	268	268	268
slag	Solid	oz	337	337	337	338	338
slags/ash	Solid	oz	58.5	58.5	58.5	58.5	58.5
solid waste	Solid	tn.lg	207	232	206	184	200
unspecified	Solid	oz	0.246	0.246	0.246	0.246	0.246
wood (sawdust)	Solid	tn.lg	1.55	1.55	1.55	1.55	1.55
Al (ind.)	Soil	oz	2.86	2.86	2.86	2.87	2.87
As (ind.)	Soil	oz	0.00115	0.00115	0.00115	0.00115	0.00115
C (ind.)	Soil	oz	8.8	8.8	8.8	8.81	8.81
Ca (ind.)	Soil	oz	11.5	11.5	11.5	11.5	11.5
Cd (ind.)	Soil	oz	4.97E-5	4.98E-5	5.01E-5	5.04E-5	5.09E-5
Co (ind.)	Soil	oz	4.36E-5	4.36E-5	4.36E-5	4.37E-5	4.37E-5
Cr (ind.)	Soil	oz	0.0143	0.0143	0.0143	0.0143	0.0143
Cu (ind.)	Soil	oz	0.000218	0.000218	0.000218	0.000218	0.000218

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Fe (ind.)	Soil	oz	5.74	5.74	5.74	5.74	5.75
Hg (ind.)	Soil	oz	9.21E-6	9.27E-6	9.47E-6	9.66E-6	9.99E-6
Mn (ind.)	Soil	oz	0.115	0.115	0.115	0.115	0.115
N	Soil	oz	0.00506	0.00513	0.00534	0.00554	0.00588
Ni (ind.)	Soil	oz	0.000327	0.000327	0.000327	0.000327	0.000327
oil (ind.)	Soil	oz	8.29	8.29	8.29	8.29	8.29
oil biodegradable	Soil	oz	4.31	4.31	4.31	4.31	4.31
P-tot	Soil	oz	0.164	0.164	0.165	0.166	0.168
Pb (ind.)	Soil	oz	0.000999	0.000999	0.001	0.001	0.001
S (ind.)	Soil	oz	1.72	1.72	1.72	1.72	1.72
Zn (ind.)	Soil	oz	0.0451	0.0451	0.0452	0.0452	0.0452
Ag110m to air	Non mat.	Bq	0.0364	0.0364	0.0364	0.0365	0.0365
Ag110m to water	Non mat.	Bq	249	249	249	249	250
alpha radiation (unspecified) to water	Non mat.	Bq	0.0293	0.0293	0.0294	0.0294	0.0294
Am241 to air	Non mat.	Bq	0.696	0.696	0.697	0.698	0.698
Am241 to water	Non mat.	Bq	91.5	91.5	91.6	91.7	91.8
Ar41 to air	Non mat.	Bq	7.9E4	7.9E4	7.9E4	7.91E4	7.92E4
Ba140 to air	Non mat.	Bq	0.161	0.161	0.161	0.162	0.162
Ba140 to water	Non mat.	Bq	0.772	0.772	0.773	0.773	0.774
beta radiation (unspecified) to air	Non mat.	Bq	0.00708	0.00708	0.00708	0.00709	0.00709
C14 to air	Non mat.	Bq	5.67E4	5.67E4	5.68E4	5.68E4	5.69E4
C14 to water	Non mat.	Bq	4.62E3	4.63E3	4.63E3	4.63E3	4.64E3
Cd109 to water	Non mat.	Bq	0.00448	0.00448	0.00448	0.00448	0.00449
Ce141 to air	Non mat.	Bq	0.0034	0.0034	0.0034	0.00341	0.00341
Ce141 to water	Non mat.	Bq	0.116	0.116	0.116	0.116	0.116
Ce144 to air	Non mat.	Bq	7.41	7.41	7.41	7.42	7.43

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Ce144 to water	Non mat.	Bq	2.1E3	2.1E3	2.1E3	2.1E3	2.1E3
Cm (alpha) to air	Non mat.	Bq	1.1	1.1	1.11	1.11	1.11
Cm (alpha) to water	Non mat.	Bq	122	122	122	122	122
Cm242 to air	Non mat.	Bq	3.56E-6	3.57E-6	3.57E-6	3.57E-6	3.58E-6
Cm244 to air	Non mat.	Bq	3.24E-5	3.24E-5	3.24E-5	3.24E-5	3.25E-5
Co57 to air	Non mat.	Bq	6.21E-5	6.22E-5	6.22E-5	6.23E-5	6.23E-5
Co57 to water	Non mat.	Bq	0.795	0.795	0.796	0.796	0.796
Co58 to air	Non mat.	Bq	1.03	1.03	1.03	1.03	1.03
Co58 to water	Non mat.	Bq	507	507	507	507	508
Co60 to air	Non mat.	Bq	1.56	1.56	1.56	1.56	1.57
Co60 to water	Non mat.	Bq	2.05E4	2.05E4	2.05E4	2.05E4	2.05E4
Conv. to continuous urban land	Non mat.	sq.yd	2.29	2.3	2.34	2.38	2.44
Conv. to industrial area	Non mat.	sq.yd	1.43	1.43	1.43	1.43	1.43
Cr51 to air	Non mat.	Bq	0.13	0.13	0.13	0.13	0.13
Cr51 to water	Non mat.	Bq	17.1	17.1	17.1	17.1	17.1
Cs134 to air	Non mat.	Bq	26.4	26.4	26.4	26.5	26.5
Cs134 to water	Non mat.	Bq	4.68E3	4.68E3	4.68E3	4.69E3	4.69E3
Cs136 to water	Non mat.	Bq	0.00416	0.00416	0.00416	0.00416	0.00417
Cs137 to air	Non mat.	Bq	51	51	51.1	51.1	51.2
Cs137 to water	Non mat.	Bq	4.32E4	4.32E4	4.32E4	4.33E4	4.33E4
Fe59 to air	Non mat.	Bq	0.00141	0.00141	0.00141	0.00141	0.00141
Fe59 to water	Non mat.	Bq	0.0137	0.0137	0.0137	0.0137	0.0137
Fission and activation products (RA) to water	Non mat.	Bq	266	266	266	267	267
H3 to air	Non mat.	Bq	5.67E5	5.67E5	5.67E5	5.68E5	5.69E5
H3 to water	Non mat.	Bq	1.37E8	1.37E8	1.37E8	1.37E8	1.38E8
heat losses to air	Non mat.	MWh	1E4	1E4	1.01E4	1.01E4	1.01E4

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
heat losses to soil	Non mat.	kWh	25.6	25.6	25.6	25.7	25.7
heat losses to water	Non mat.	MWh	-3.39	-3.39	-3.38	-3.38	-3.38
I129 to air	Non mat.	Bq	199	199	199	199	199
I129 to water	Non mat.	Bq	1.32E4	1.32E4	1.32E4	1.33E4	1.33E4
I131 to air	Non mat.	Bq	27.3	27.3	27.3	27.3	27.3
I131 to water	Non mat.	Bq	9.92	9.93	9.93	9.94	9.95
I133 to air	Non mat.	Bq	12.1	12.1	12.1	12.1	12.1
I133 to water	Non mat.	Bq	3.55	3.55	3.55	3.55	3.55
I135 to air	Non mat.	Bq	18	18	18	18	18.1
K40 to air	Non mat.	Bq	134	134	135	135	135
K40 to water	Non mat.	Bq	357	357	358	358	358
Kr85 to air	Non mat.	Bq	3.42E9	3.42E9	3.43E9	3.43E9	3.43E9
Kr85m to air	Non mat.	Bq	5.76E3	5.76E3	5.77E3	5.77E3	5.78E3
Kr87 to air	Non mat.	Bq	2.31E3	2.31E3	2.31E3	2.31E3	2.31E3
Kr88 to air	Non mat.	Bq	1.58E5	1.58E5	1.58E5	1.58E5	1.58E5
Kr89 to air	Non mat.	Bq	1.82E3	1.82E3	1.82E3	1.82E3	1.82E3
La140 to air	Non mat.	Bq	0.093	0.0931	0.0931	0.0932	0.0933
La140 to water	Non mat.	Bq	0.161	0.161	0.161	0.161	0.161
land use (sea floor) II-III	Non mat.	m2a	101	101	101	101	101
land use (sea floor) II-IV	Non mat.	m2a	10.4	10.4	10.4	10.4	10.4
land use II-III	Non mat.	m2a	359	360	360	361	362
land use II-IV	Non mat.	m2a	163	163	163	163	163
land use III-IV	Non mat.	m2a	22.3	22.3	22.4	22.4	22.5
land use IV-IV	Non mat.	m2a	0.239	0.239	0.239	0.239	0.24
Mn54 to air	Non mat.	Bq	0.0371	0.0372	0.0372	0.0372	0.0373
Mn54 to water	Non mat.	Bq	3.11E3	3.12E3	3.12E3	3.12E3	3.12E3

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Mo99 to water	Non mat.	Bq	0.0542	0.0542	0.0542	0.0543	0.0543
Na24 to water	Non mat.	Bq	23.9	23.9	23.9	23.9	23.9
Nb95 to air	Non mat.	Bq	0.0066	0.0066	0.00661	0.00661	0.00662
Nb95 to water	Non mat.	Bq	0.44	0.44	0.44	0.44	0.441
Np237 to air	Non mat.	Bq	3.64E-5	3.64E-5	3.65E-5	3.65E-5	3.65E-5
Np237 to water	Non mat.	Bq	5.86	5.86	5.86	5.87	5.87
Occup. as contin. urban land	Non mat.	m2a	28.9	29.7	32.2	34.6	38.6
Occup. as convent. arable land	Non mat.	m2a	1.27E3	1.27E3	1.27E3	1.27E3	1.27E3
Occup. as forest land	Non mat.	m2a	0.0477	0.0477	0.0478	0.0478	0.0478
Occup. as industrial area	Non mat.	m2a	1.03E3	1.04E3	1.05E3	1.07E3	1.09E3
Occup. as rail/road area	Non mat.	m2a	7.76E4	7.76E4	7.76E4	7.76E4	7.76E4
Pa234m to air	Non mat.	Bq	22.1	22.1	22.1	22.1	22.1
Pa234m to water	Non mat.	Bq	409	409	409	410	410
Pb210 to air	Non mat.	Bq	720	721	721	722	723
Pb210 to water	Non mat.	Bq	284	284	285	285	285
Pm147 to air	Non mat.	Bq	18.8	18.8	18.8	18.8	18.8
Po210 to air	Non mat.	Bq	1.11E3	1.11E3	1.11E3	1.11E3	1.11E3
Po210 to water	Non mat.	Bq	284	284	285	285	285
Pu alpha to air	Non mat.	Bq	2.21	2.21	2.21	2.21	2.22
Pu alpha to water	Non mat.	Bq	364	364	365	365	365
Pu238 to air	Non mat.	Bq	8.03E-5	8.03E-5	8.04E-5	8.05E-5	8.06E-5
Pu241 beta	Non mat.	Bq	9.05E3	9.05E3	9.06E3	9.07E3	9.08E3
Pu241 Beta to air	Non mat.	Bq	60.8	60.8	60.8	60.9	60.9
Ra224 to water	Non mat.	Bq	2.27E3	2.27E3	2.28E3	2.28E3	2.28E3
Ra226 to air	Non mat.	Bq	814	815	815	816	817
Ra226 to water	Non mat.	Bq	1.69E6	1.69E6	1.69E6	1.69E6	1.69E6

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Ra228 to air	Non mat.	Bq	66.2	66.2	66.3	66.3	66.5
Ra228 to water	Non mat.	Bq	4.54E3	4.54E3	4.55E3	4.55E3	4.55E3
radio active noble gases to air	Non mat.	Bq	8.18E3	8.18E3	8.18E3	8.19E3	8.19E3
radioactive substance to air	Non mat.	Bq	5.35E10	5.64E10	5.16E10	4.91E10	4.94E10
radioactive substance to water	Non mat.	Bq	3.2E8	3.2E8	3.21E8	3.21E8	3.21E8
radionuclides (mixed) to water	Non mat.	Bq	0.205	0.205	0.205	0.205	0.205
Rn220 to air	Non mat.	Bq	5.4E3	5.4E3	5.41E3	5.41E3	5.42E3
Rn222 (long term) to air	Non mat.	Bq	4.92E9	4.92E9	4.92E9	4.93E9	4.93E9
Rn222 to air	Non mat.	Bq	5.33E7	5.33E7	5.33E7	5.34E7	5.35E7
Ru103 to air	Non mat.	Bq	0.000397	0.000397	0.000397	0.000398	0.000398
Ru103 to water	Non mat.	Bq	0.26	0.26	0.26	0.26	0.26
Ru106 to air	Non mat.	Bq	221	221	221	221	222
Ru106 to water	Non mat.	Bq	2.21E4	2.21E4	2.21E4	2.21E4	2.22E4
Sb122 to water	Non mat.	Bq	0.772	0.772	0.773	0.773	0.774
Sb124 to air	Non mat.	Bq	0.0101	0.0101	0.0101	0.0101	0.0101
Sb124 to water	Non mat.	Bq	68.6	68.6	68.7	68.7	68.8
Sb125 to air	Non mat.	Bq	0.00172	0.00172	0.00172	0.00172	0.00172
Sb125 to water	Non mat.	Bq	6.31	6.32	6.32	6.32	6.33
Sr89 to air	Non mat.	Bq	0.065	0.065	0.065	0.0651	0.0652
Sr89 to water	Non mat.	Bq	1.75	1.75	1.75	1.75	1.75
Sr90 to air	Non mat.	Bq	36.4	36.4	36.5	36.5	36.5
Sr90 to water	Non mat.	Bq	4.42E3	4.42E3	4.42E3	4.42E3	4.43E3
Tc99 to air	Non mat.	Bq	0.00155	0.00155	0.00155	0.00155	0.00155
Tc99 to water	Non mat.	Bq	2.32E3	2.32E3	2.32E3	2.32E3	2.32E3
Tc99m to water	Non mat.	Bq	0.366	0.366	0.366	0.366	0.366
Te123m to air	Non mat.	Bq	0.162	0.162	0.162	0.162	0.163

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Te123m to water	Non mat.	Bq	0.0327	0.0327	0.0327	0.0327	0.0327
Te132 to water	Non mat.	Bq	0.0134	0.0134	0.0134	0.0134	0.0134
Th228 to air	Non mat.	Bq	56	56	56.1	56.2	56.3
Th228 to water	Non mat.	Bq	9.1E3	9.1E3	9.11E3	9.11E3	9.11E3
Th230 to air	Non mat.	Bq	246	246	246	246	247
Th230 to water	Non mat.	Bq	6.39E4	6.39E4	6.39E4	6.4E4	6.41E4
Th232 to air	Non mat.	Bq	35.6	35.6	35.6	35.7	35.7
Th232 to water	Non mat.	Bq	66.6	66.6	66.6	66.7	66.8
Th234 to air	Non mat.	Bq	22.1	22.1	22.1	22.1	22.1
Th234 to water	Non mat.	Bq	412	412	413	413	413
U alpha to air	Non mat.	Bq	790	790	791	792	793
U alpha to water	Non mat.	Bq	2.67E4	2.67E4	2.67E4	2.68E4	2.68E4
U234 to air	Non mat.	Bq	265	265	265	265	265
U234 to water	Non mat.	Bq	546	546	547	547	548
U235 to air	Non mat.	Bq	12.8	12.8	12.8	12.8	12.9
U235 to water	Non mat.	Bq	815	815	816	817	818
U238 to air	Non mat.	Bq	363	363	363	364	364
U238 to water	Non mat.	Bq	1.39E3	1.39E3	1.4E3	1.4E3	1.4E3
waste heat to air	Non mat.	kWh	177	197	259	321	424
waste heat to soil	Non mat.	kWh	91.1	91.2	91.2	91.2	91.2
waste heat to water	Non mat.	MWh	1.86	1.86	1.86	1.86	1.86
Xe131m to air	Non mat.	Bq	1.06E4	1.06E4	1.06E4	1.06E4	1.06E4
Xe133 to air	Non mat.	Bq	2.44E6	2.45E6	2.45E6	2.45E6	2.45E6
Xe133m to air	Non mat.	Bq	1.2E3	1.2E3	1.2E3	1.2E3	1.2E3
Xe135 to air	Non mat.	Bq	4.45E5	4.45E5	4.46E5	4.46E5	4.47E5
Xe135m to air	Non mat.	Bq	5.74E4	5.74E4	5.74E4	5.74E4	5.75E4

*An x means there are no data.

Table D-2. LCI Output from SimaPro for CMU Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	CMU House				
			Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Xe137 to air	Non mat.	Bq	1.34E3	1.34E3	1.34E3	1.34E3	1.35E3
Xe138 to air	Non mat.	Bq	1.57E4	1.57E4	1.57E4	1.57E4	1.57E4
Y90 to water	Non mat.	Bq	0.0897	0.0897	0.0897	0.0898	0.0898
Zn65 to air	Non mat.	Bq	0.168	0.168	0.168	0.168	0.168
Zn65 to water	Non mat.	Bq	50.4	50.5	50.5	50.5	50.5
Zr95 to air	Non mat.	Bq	0.00236	0.00236	0.00236	0.00236	0.00237
Zr95 to water	Non mat.	Bq	188	188	188	188	188

*An x means there are no data.

APPENDIX E – THE ECO-INDICATOR IMPACT ASSESSMENT METHOD
(used with permission)

2.4 Eco-indicator 99

2.4.1 Introduction

Eco-indicator 99 is the successor of Eco-indicator 95. Both methods use the damage-oriented approach. The development of the Eco-indicator 99 methodology started with the design of the weighting procedure. Traditionally in LCA the emissions and resource extractions are expressed as 10 or more different impact categories, like acidification, ozone layer depletion, ecotoxicity and resource extraction. For a panel of experts or non-experts it is very difficult to give meaningful weighting factors for such a large number and rather abstract impact categories. It was concluded that the panel should not be asked to weight the impact categories but the different types of damage that are caused by these impact categories. The other improvement was to limit the number of items that are to be assessed. As a result the panel, consisting of 365 persons from a Swiss LCA interest group, was asked to assess the seriousness of three damage categories:

1. Damage to Human Health, expressed as the number of year life lost and the number of years lived disabled. These are combined as Disability Adjusted Life Years (DALYs), an index that is also used by the Worldbank and WHO.
2. Damage to Ecosystem Quality, express as the loss of species over an certain area, during a certain time
3. Damage to Resources, expressed as the surplus energy needed for future extractions of minerals and fossil fuels.

In order to be able to use the weights for the three damage categories a series of complex damage models had to be developed. In figure 2 these models are represented in a schematic way.

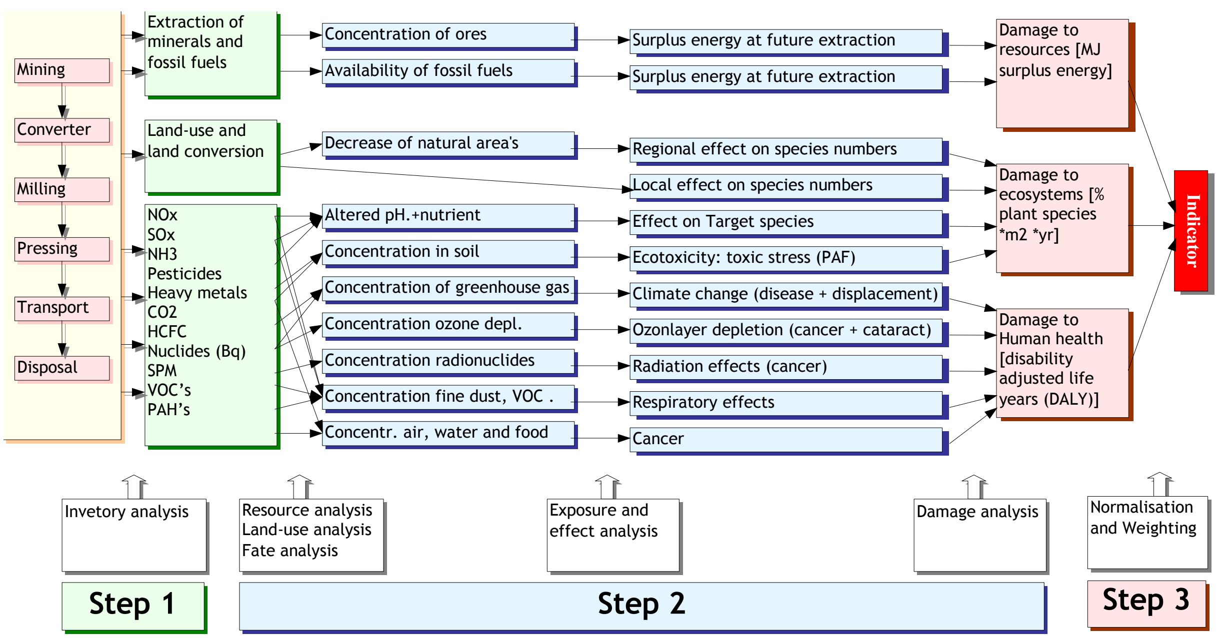

Figure 1: Detailed representation of the damage model

In general, the factors used in SimaPro do not deviate from the ones in the (updated) report. In case the report contained synonyms of substance names already available in the substance list of the SimaPro database, the existing names in the database are used. A distinction is made for emissions to agricultural soil and industrial soil, indicated with respectively (agr.) or (ind.) behind substance names emitted to soil.

2.4.2 Characterisation

Emissions

Characterisation is factors are calculated at end-point level (damage). The damage model for emissions includes fate analysis, exposure, effects analysis and damage analysis.
This model is applied for the following impact categories:

- **Carcinogens**
  Carcinogenic affects due to emissions of carcinogenic substances to air, water and soil. Damage is expressed in Disability adjusted Life Years (DALY) / kg emission.
- **Respiratory organics**
  Respiratory effects resulting from summer smog, due to emissions of organic substances to air, causing respiratory effects. Damage is expressed in Disability adjusted Life Years (DALY) / kg emission.
- **Respiratory inorganics**
  Respiratory effects resulting from winter smog caused by emissions of dust, sulphur and nitrogen oxides to air. Damage is expressed in Disability adjusted Life Years (DALY) / kg emission.
- **Climate change**
  Damage, expressed in DALY/kg emission, resulting from an increase of diseases and death caused by climate change.
- **Radiation**
  Damage, expressed in DALY/kg emission, resulting from radioactive radiation
- **Ozone layer**
  Damage, expressed in DALY/kg emission, due to increased UV radiation as a result of emission of ozone depleting substances to air.
- **Ecotoxicity**
  Damage to ecosystem quality, as a result of emission of ecotoxic substances to air, water and soil. Damage is expressed in Potentially Affected Fraction (PAF)*m2*year/kg emission.
- **Acidification/ Eutrophication**
  Damage to ecosystem quality, as a result of emission of acidifying substances to air. Damage is expressed in Potentially Disappeared Fraction (PDF)*m2*year/kg emission.

Land use

Land use (in man made systems) has impact on species diversity. Based on field observations, a scale is developed expressing species diversity per type of land use. Species diversity depends on the type of land use and the size of the area. Both regional effects and local effects are taken into account in the impact category:

- **Land use**
  Damage as a result of either conversion of land or occupation of land. Damage is expressed in Potentially Disappeared Fraction (PDF)*m2*year/m2 or m2a.

Resource depletion

Mankind will always extracts the best resources first, leaving the lower quality resources for future extraction. The damage of resources will be experienced by future generations, as they will have to use more effort to extract remaining resources. This extra effort is expressed as “surplus energy”.

- **Minerals**
  Surplus energy per kg mineral or ore, as a result of decreasing ore grades.

- **Fossil fuels**
  Surplus energy per extracted MJ, kg or m3 fossil fuel, as a result of lower quality resources.

2.4.3 Uncertainties

Of course it is very important to pay attention to the uncertainties in the methodology that is used to calculate the indicators. Two types are distinguished:

1. Uncertainties about the correctness of the models used
2. Data uncertainties

Data uncertainties are specified for most damage factors as squared geometric standard deviation in the original reports, but not in the method in SimaPro. It is not useful to express the uncertainties of the model as a distribution. Uncertainties about the model are related to subjective choices in the model. In order to deal with them we developed three different versions of the methodology, using the archetypes specified in Cultural Theory. The three versions of Eco-indicator 99 are:

1. the egalitarian perspective
2. the hierarchist perspective
3. the individualist perspective

Hierarchist perspective

In the hierarchist perspective the chosen time perspective is long-term, substances are included if there is consensus regarding their effect. For instance all carcinogenic substances in IARC class 1, 2a and 2b are included, while class 3 has deliberately been excluded. In the hierarchist perspective damages are assumed to be avoidable by good management. For instance the danger people have to flee from rising water levels is not included. In the case of fossil fuels the assumption is made that fossil fuels cannot easily be substituted. Oil and gas are to be replaced by shale, while coal is replaced by brown coal. In the DALY calculations age weighting is not included.

Egalitarian perspective

In the egalitarian perspective the chosen time perspective is extremely long-term, Substances are included if there is just an indication regarding their effect. For instance all carcinogenic substances in IARC class 1, 2a, 2b and 3 are included, as far as information was available. In the egalitarian perspective, damages cannot be avoided and may lead to catastrophic events. In the case of fossil fuels the assumption is made that fossil fuels cannot be substituted. Oil, coal and gas are to be replaced by a future mix of brown coal and shale. In the DALY calculations age weighting is not included.

Individualist perspective

In the individualist perspective the chosen time perspective is short-term (100 years or less). Substances are included if there is complete proof regarding their effect. For instance only carcinogenic substances in IARC class 1 included, while class 2a, 2b and 3 have deliberately been excluded. In the individualist perspective damages are assumed to be recoverable by technological and economic development. In the case of fossil fuels the assumption is made that fossil fuels cannot really be depleted. Therefore they are left out. In the DALY calculations age weighting is included.

Damage assessment

Damages of the impact categories result in three types of damages:

1. Damage to **Human Health**, expressed as the number of year life lost and the number of years lived disabled. These are combined as Disability Adjusted Life Years (DALYs), an index that is also used by the World bank and the WHO.
2. Damage to **Ecosystem Quality**, express as the loss of species over an certain area, during a certain time
3. Damage to **Resources**, expressed as the surplus energy needed for future extractions of minerals and fossil fuels.

2.4.4 Normalisation

Normalisation is performed on damage category level. Normalisation data is calculated on European level, mostly based on 1993 as base years, with some updates for the most important emissions.

2.4.5 Weighting

In this method weighting is performed at damage category level (endpoint level in ISO). A panel performed weighting of the three damage categories. For each perspective, a specific weighting set is available. The average result of the panel assessment is available as weighting set.

2.4.6 Default

The hierarchist version of Eco-indicator 99 with average weighting is chosen default. In general value choices made in the hierarchist version are scientifically and politically accepted.

APPENDIX F – THE EDIP/UMIP 96 IMPACT ASSESSMENT METHOD
(used with permission)

2.7 EDIP/UMIP 96

2.7.1 Introduction

The EDIP method (Environmental Design of Industrial Products, in Danish UMIP) was developed in 1996. Excluded in this version of the method in SimaPro are working environment and emissions to waste water treatment plants (WWTP). An update of the method is expected by the beginning of 2002.

2.7.2 Characterisation

Global warming is based on the IPCC 1994 Status report. Is SimaPro GWP 100 is used. Stratospheric ozone depletion potentials are based on the status reports (1992/1995) of the Global Ozone Research Project (infinite time period used in SimaPro). Photochemical ozone creation potentials (POCP) were taken from UNECE reports (1990/1992). POCP values depend on the background concentration of NOx, in SimaPro we have chosen to use the POCPs for high background concentrations. Acidification is based on the number of hydrogen ions (H+) that can be released. Eutrophication potential is based on N and P content in organisms. Waste streams are divided in 4 categories, bulk waste (not hazardous), hazardous waste, radioactive waste and slags and ashes. All wastes are reported on a mass basis.

Ecotoxicity is based on a chemical hazard screening method, which looks at toxicity, persistency and bioconcentration. Fate or the distribution of substances into various environmental compartments is also taken account. Ecotoxicity potentials are calculated for acute and chronic ecotoxicity to water and chronic ecotoxicity for soil. As fate is included, an emission to water may lead not only to chronic and acute ecotoxicity for water, but also to soil. Similarly an emission to air gives ecotoxicity for water and soil. This is the reason you will find emissions to various compartments in each ecotoxicity category.

Human toxicity is based on a chemical hazard screening method, which looks at toxicity, persistency and bioconcentration. Fate or the distribution of substances into various environmental compartments is also taken account. Human toxicity potentials are calculated for exposure via air, soil, and surface water. As fate is included, an emission to water may lead not only to toxicity via water, but also via soil. Similarly an emission to air gives human toxicity via water and soil. This is the reason you will find emissions to various compartments in each human toxicity category.

Resources

As resources use a different method of weighting, it cannot be compared with the other impact categories, for which reason the weighting factor is set at zero. Resources should be handled with great care when analysing results, the characterisation and normalisation results cannot be compared with the other impact categories.
To give the user some information in a useful way all resources have been added into one impact category. As equivalency factor the result of the individual normalisation and weighting scores have been used, i.e. the resulting score per kg if they would have been calculated individually.
For detailed information on resources, including normalisation and weighting, choose the "EDIP/UMIP resources only" method.

EDIP/UMIP resources only

In the "EDIP/UMIP resources only" method only resources are reported. Opposite to the default EDIP/UMIP method, resources are given in individual impact categories, on a mass basis of the pure resource (i.e. 100% metal in ore, rather than ore). Normalisation is based on global production per world citizen, derived from World Resources 1992. Weighting of non-renewables is based on the supply-horizon (World Reserves Life Index), which specifies the period for which known reserves will last at current rates of consumption. If no normalisation data are known for an individual impact category, the normalisation value is set at one and the calculation of the weighting factor is adjusted so that the final result is still consistent. However this may give strange looking graphs in the normalisation step.

2.7.3 Normalisation

The normalisation value is based on person equivalents for 1990. For resources, normalisation and weighing are already included in the characterisation factor and therefore set at zero.

2.7.4 Weighting

The weighting factors are set to the politically set target emissions per person in the year 2000, the weighted result are expressed except for resources which is based on the proven reserves per person in 1990. For resources, normalisation and weighing are already included in the characterisation factor and therefore set at zero.

A note on weighting:
Presenting the EDIP method as a single score (addition) is allowed, however it is not recommended by the authors. Note that due to a different weighting method for resources (based on reserves rather than political targets), resources may never be included in a single score. This is the reason that the weighting factor for resources is set at zero.

2.7.5 References:

For background information, and information on how to calculate additional factors, please read:

Environmental Assessment of Products.
Volume 1 (methodology, tools and case studies in product development)
Henrik Wenzel, Michael Hauschild and Leo Alting
Chapman and Hall, 1997, ISBN 0 412 80800 5
See http://www.wkap.nl/book.htm/0-7923-7859-8

Environmental Assessment of Products.
Volume 2 (scientific background)
Michael Hauschild and Henrik Wenzel
Chapman and Hall, 1998, ISBN 0 412 80810 2
See http://www.wkap.nl/book.htm/0-412-80810-2

APPENDIX G – THE EPS 2000 IMPACT ASSESSMENT METHOD
(used with permission)

2.6 EPS 2000 default

2.6.1 Introduction

The EPS 2000 default methodology (Environmental Priority Strategies in product design) is a damage oriented method. In the EPS system willingness to pay to restore changes in the safe guard subjects is chosen as the monetary measure. The indicator unit is ELU (Environmental Load Unit). This method includes characterisation and weighting. Normalisation is not applied.

The top-down development of the EPS system has led to an outspoken hierarchy among its principles and rules. The general principles of its development are:

- The top-down principle (highest priority is given to the usefulness of the system);
- The index principle (ready made indices represent weighted and aggregated impacts)
- The default principle (an operative method as default is required)
- The uncertainty principle (uncertainty of input data has to be estimated)
- Choice of default data and models to determine them

The EPS system is mainly aimed to be a tool for a company's internal product development process. The system is developed to assist designers and product developers in finding which one of two product concepts has the least impact on the environment. The models and data in EPS are intended to improve environmental performance of products. The choice and design of the models and data are made from an anticipated utility perspective of a product developer. They are, for instance not intended to be used as a basis for environmental protection strategies for single substances, or as a sole basis for environmental product declarations. In most of those cases additional site-specific information and modelling is necessary.

The EPS 2000 default method is an update of the 1996 version. The impact categories are identified from five safe guard subjects: human health, ecosystem production capacity, abiotic stock resource, biodiversity and cultural and recreational values.

2.6.2 Classification

Emissions and resources are assigned to impact categories when actual effects are likely to occur in the environment, based on likely exposure.

2.6.3 Characterisation

Empirical, equivalency and mechanistic models are used to calculate default characterisation values.

Human Health

In EPS weighting factors for damage to human health are included for the following indictors:

- Life expectancy, expressed in Years of life lost (person year)
- Severe morbidity and suffering, in person year, including starvation
- Morbidity, in person year, like cold or flue
- Severe nuisance, in person year, which would normally cause a reaction to avoid the nuisance
- Nuisance, in person year, irritating, but not causing any direct action

Ecosystem production capacity

The default impact categories of production capacity of ecosystems are:

- Crop production capacity, in kg weight at harvest
- Wood production capacity, in kg dry weight
- Fish and meat production capacity, in kg full weight of animals
- Base cat-ion capacity, in H+ mole equivalents (used only when models including the other indicators are not available)

- Production capacity of (irrigation) water, in kg which is acceptable for irrigation, with respect to persistent toxic substances
- Production capacity of (drinking) water, in kg of water fulfilling WHO criteria on drinking water.

Abiotic stock resources

Abiotic stock resource indicators are depletion of elemental or mineral reserves and depletion of fossil reserves. Some classification factors are defined 0 (zero).
In SimaPro characterisation values for abiotic depletion result from both the impact of depletion and impacts due to extraction of the element/mineral or resource.

Biodiversity

Default impact category for biodiversity is extinction of species, expressed in Normalised Extinction of species (NEX).

Cultural and recreational values

Changes in cultural and recreational values are difficult to describe by general indicators as they are highly specific and qualitative in nature. Indicators should be defined when needed, and thus are not included in the default methodology in SimaPro.

2.6.4 Weighting

In the EPS default method, weighting is made through valuation. Weighting factors represent the willingness to pay to avoid changes. The environmental reference is the present state of the environment. The indicator unit is ELU (Environmental Load Unit).

2.6.5 References:

Bengt Steen (1999) A systematic approach to environmental strategies in product development (EPS). Version 2000 - General system characteristics. Centre for Environmental Assessment of Products and Material Systems. Chalmers University of Technology, Technical Environmental Planning. CPM report 1999:4.
Download as PDF file (246 kb) from http://www.cpm.chalmers.se/cpm/publications/EPS2000.PDF

Bengt Steen (1999) A systematic approach to environmental strategies in product development (EPS). Version 2000 - Models and data of the default methods. Centre for Environmental Assessment of Products and Material Systems. Chalmers University of Technology, Technical Environmental Planning. CPM report 1999:5.
Download as zipped PDF file (1140 kb) from
http://www.cpm.chalmers.se/cpm/publications/EPS1999_5.zip

APPENDIX H – LCA SUMMARY OF WOOD HOUSES AND CMU HOUSES

(Output from SimaPro)

Table H-1. Normalized and Weighted LCA Results Assuming an Egalitarian Perspective using the Eco-Indicator 99 Method of Impact Assessment (Output from SimaPro)

Impact category*	Wood frame houses					CMU houses				
	Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Carcinogens	1,220	1,200	1,890	1,940	2,380	1,240	1,220	1,850	1,850	2,340
Respiratory organics	73	71	119	123	154	75	72	116	117	150
Respiratory inorganics	27,500	28,900	34,900	34,000	39,800	28,200	29,700	34,600	33,100	39,500
Climate change	6,970	7,380	8,670	8,390	9,730	7,070	7,510	8,530	8,080	9,590
Radiation	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.5
Ozone layer	0.7	0.8	0.7	0.6	0.6	0.7	0.8	0.6	0.6	0.6
Ecotoxicity	446	468	470	452	479	449	473	467	446	477
Acidification/eutrophication	4,360	4,650	5,240	5,020	5,750	4,410	4,720	5,140	4,830	5,660
Land use	6,350	6,360	6,360	6,360	6,360	6,630	6,630	6,630	6,630	6,640
Minerals	166	166	167	167	168	168	168	169	169	170
Fossil fuels	69,800	71,900	96,100	95,500	114,000	70,700	72,700	93,800	91,200	112,000
Total (rounded)	**117,000**	**121,000**	**154,000**	**152,000**	**179,000**	**119,000**	**123,000**	**151,000**	**146,000**	**176,000**

*No units: data have been normalized and weighted.

Table H-2. Normalized and Weighted LCA Results Assuming a Hierarchic Perspective using the Eco-Indicator 99 Method of Impact Assessment (Output from SimaPro)

Impact category*	Wood frame houses					CMU houses				
	Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Carcinogens	1,630	1,610	2,530	2,600	3,190	1,670	1,630	2,480	2,490	3,130
Respiratory organics	98	96	160	165	206	100	97	156	157	201
Respiratory inorganics	36,800	38,700	46,700	45,600	53,200	37,700	39,800	46,300	44,300	52,800
Climate change	9,350	9,890	11,600	11,300	13,100	9,490	10,100	11,400	10,800	12,900
Radiation	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6
Ozone layer	0.9	1.0	0.9	0.8	0.8	0.9	1.0	0.9	0.8	0.8
Ecotoxicity	357	374	376	362	383	359	378	373	356	381
Acidification/eutrophication	3,490	3,720	4,190	4,020	4,600	3,520	3,780	4,110	3,860	4,530
Land use	5,080	5,080	5,090	5,090	5,090	5,300	5,300	5,310	5,310	5,310
Minerals	118	118	118	118	119	119	119	120	120	120
Fossil fuels	56,100	54,900	89,700	92,400	115,000	57,100	55,500	87,500	87,900	112,000
Total (rounded)	**113,000**	**115,000**	**160,000**	**162,000**	**194,000**	**115,000**	**117,000**	**158,000**	**155,000**	**191,000**

*No units: data have been normalized and weighted.

Table H-3. Normalized and Weighted LCA Results Assuming an Individualist Perspective using the Eco-Indicator 99 Method of Impact Assessment (Output from SimaPro)

Impact category*	Wood frame houses					CMU houses				
	Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Carcinogens	1,980	1,930	3,180	3,290	4,080	2,020	1,960	3,120	3,140	4,000
Respiratory organics	233	227	380	393	490	238	230	371	374	478
Respiratory inorganics	46,900	48,600	63,100	62,500	74,400	48,500	50,200	62,800	60,900	74,000
Climate change	22,800	24,100	28,400	27,500	31,900	23,200	24,600	27,900	26,500	31,400
Radiation	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Ozone layer	1.9	2.1	1.8	1.7	1.7	1.9	2.1	1.8	1.6	1.6
Ecotoxicity	42	43	54	54	63	43	44	54	53	62
Acidification/eutrophication	2,480	2,650	2,980	2,860	3,270	2,510	2,690	2,930	2,750	3,220
Land use	3,620	3,620	3,620	3,620	3,620	3,770	3,770	3,780	3,780	3,780
Minerals	6,610	6,610	6,630	6,640	6,660	6,690	6,690	6,710	6,720	6,750
Total (rounded)	**84,700**	**87,800**	**108,000**	**107,000**	**124,000**	**86,900**	**90,200**	**108,000**	**104,000**	**124,000**

*No units: data have been normalized and weighted.

Table H-4. Normalized and Weighted LCA Results using the EDIP/UMIP 96 Method of Impact Assessment (Output from SimaPro)

Impact category*	Wood frame houses					CMU houses				
	Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Global warming (GWP 100)	260,000	275,000	324,000	313,000	364,000	263,000	280,000	318,000	302,000	359,000
Ozone depletion	3,890	4,270	3,680	3,330	3,360	3,810	4,240	3,560	3,180	3,250
Acidification	206,000	214,000	275,000	271,000	322,000	208,000	216,000	269,000	259,000	315,000
Eutrophication	26,900	29,300	29,300	27,300	30,000	27,100	29,800	28,900	26,400	29,700
Photochemical smog	5,060	5,120	7,250	7,330	8,860	5,150	5,190	7,120	7,040	8,700
Ecotoxicity water, chronic	8,110	8,200	11,000	11,100	13,000	7,640	7,710	10,200	10,000	12,200
Ecotoxicity water, acute	735	740	1,020	1,030	1,220	686	688	936	927	1,140
Ecotoxicity soil, chronic	27	27	27	27	27	27	27	27	27	27
Human toxicity, air	88	92	95	91	98	89	93	94	90	97
Human toxicity, water	2,250	2,380	2,480	2,380	2,600	2,210	2,360	2,410	2,270	2,530
Human toxicity, soil	1,260	1,340	1,370	1,300	1,410	1,260	1,340	1,340	1,260	1,390
Bulk waste	185	203	188	171	182	183	204	183	164	178
Hazardous waste	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Radioactive waste**	x	x	x	x	x	x	x	x	x	x
Slags/ashes	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Resources (all)	0	0	0	0	0	0	0	0	0	0
Total (rounded)	**514,000**	**540,000**	**655,000**	**639,000**	**747,000**	**520,000**	**548,000**	**642,000**	**613,000**	**733,000**

*No units: data have been normalized and weighted.
**An x means there are no data.

Table H-5. Normalized and Weighted LCA Results using the EPS 2000 Method of Impact Assessment (Output from SimaPro)

Impact category*	Wood frame houses					CMU houses				
	Lake Charles	Tucson	St. Louis	Denver	Minneapolis	Lake Charles	Tucson	St. Louis	Denver	Minneapolis
Life expectancy	114,000	115,000	166,000	168,000	204,000	119,000	120,000	166,000	164,000	204,000
Severe morbidity	10,100	8,490	22,300	24,400	31,900	11,300	9,300	22,500	23,900	31,900
Morbidity	5,890	5,720	9,590	9,930	12,400	6,150	5,920	9,500	9,600	12,200
Severe nuisance	1,510	1,530	1,510	1,510	1,520	1,540	1,560	1,540	1,530	1,550
Nuisance	11,700	12,100	15,900	15,700	18,700	11,800	12,300	15,500	15,000	18,300
Crop growth capacity	561	603	648	615	694	570	616	640	597	688
Wood growth capacity	-1,380	-1,370	-2,130	-2,190	-2,690	-1,440	-1,420	-2,120	-2,130	-2,670
Fish and meat production	-148	-162	-155	-142	-154	-149	-165	-153	-139	-153
Soil acidification	307	319	410	404	479	310	323	401	386	470
Prod. cap. irrigation water**	x	x	x	x	x	x	x	x	x	x
Prod. cap. drinking water	x	x	x	x	x	x	x	x	x	x
Depletion of reserves	419,000	412,000	639,000	657,000	802,000	427,000	416,000	626,000	629,000	787,000
Species extinction	3,800	3,740	4,240	4,320	4,600	4,000	3,930	4,410	4,460	4,760
Total (rounded)	**565,000**	**557,000**	**857,000**	**879,000**	**1,070,000**	**580,000**	**568,000**	**844,000**	**846,000**	**1,060,000**

*No units: data have been normalized and weighted.
**An x means there are no data.

APPENDIX I – GRAPHICAL PRESENTATION OF LCA SINGLE-SCORE SUMMARY

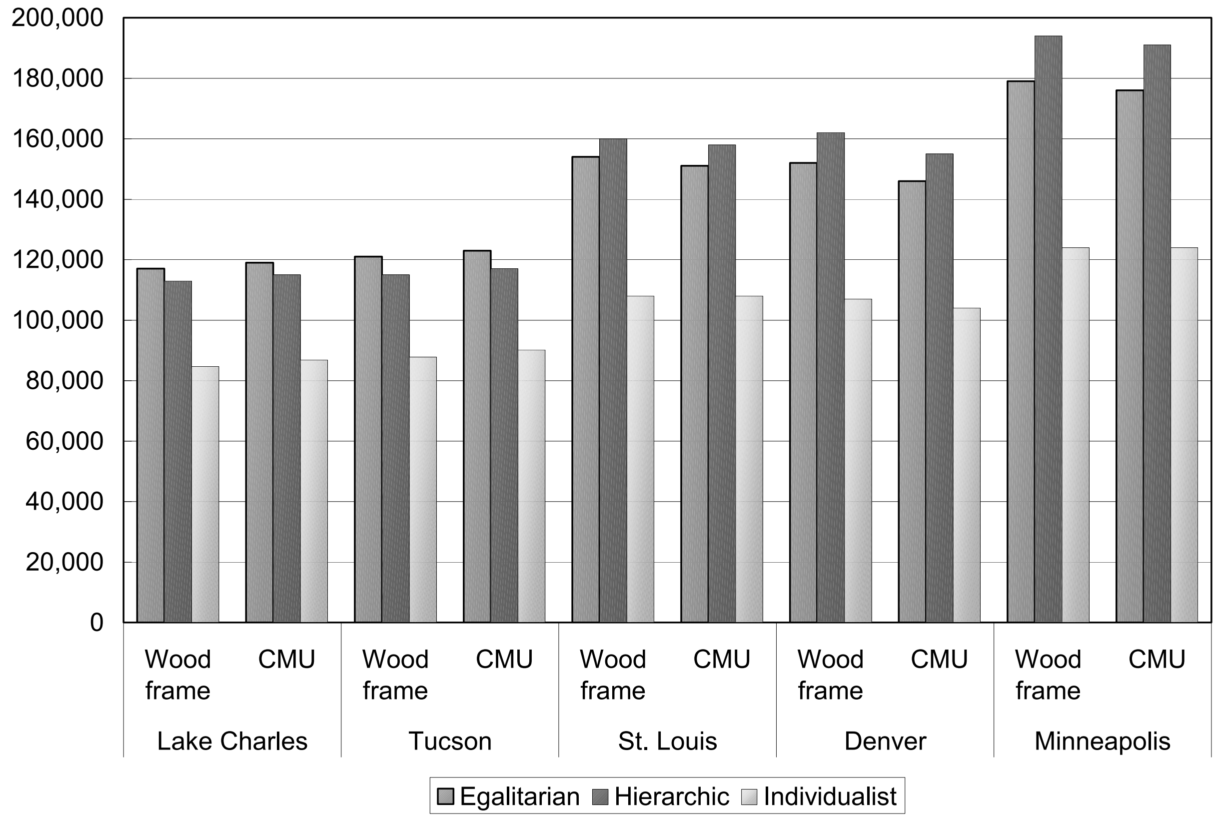

Figure I-1. LCA single score summary using the Eco-Indicator 99 method of impact assessment (there are no units because the data have been weighted and normalized).

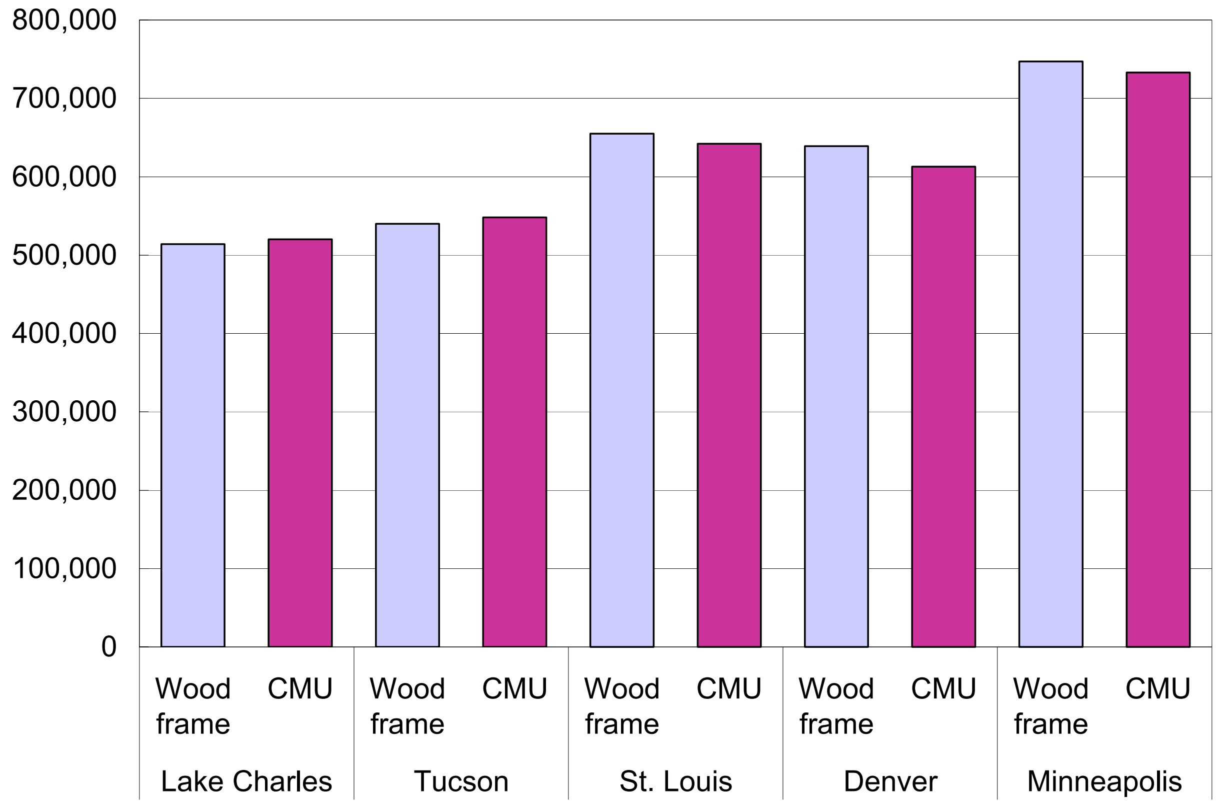

Figure I-2. LCA single score summary using the EDIP/UMIP 96 method of impact assessment (there are no units because the data have been weighted and normalized).

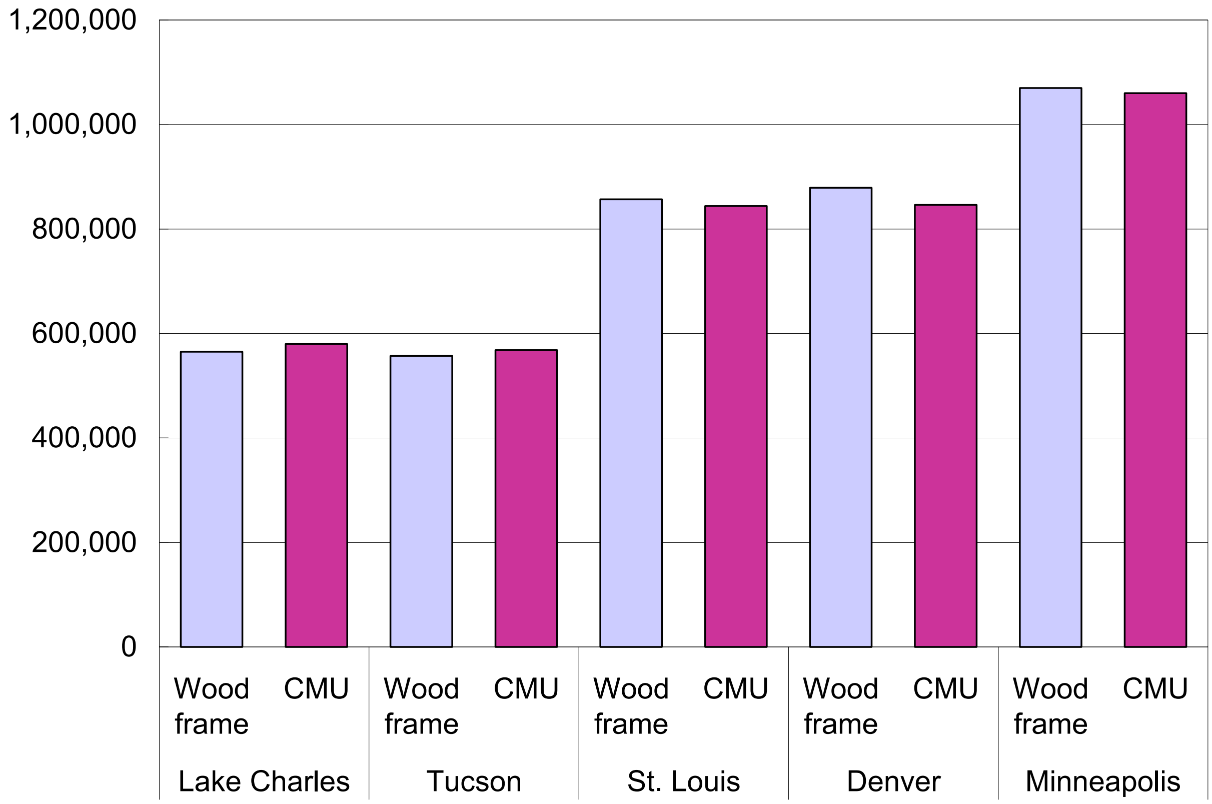

Figure I-3. LCA single score summary using the EPS 2000 method of impact assessment (there are no units because the data have been weighted and normalized).

APPENDIX J – LCA SINGLE-SCORE SUMMARY
(Output from SimaPro)

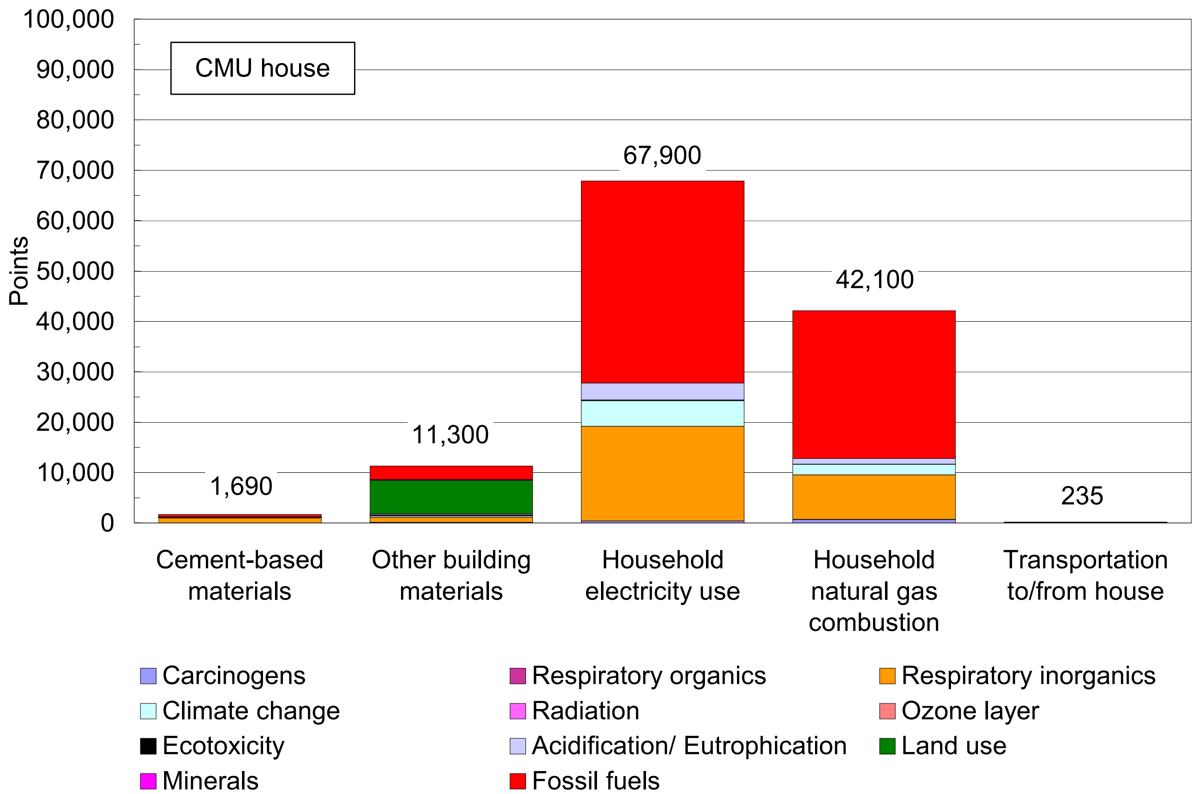

Figure J-1. Single-score life cycle inventory assessment of CMU house in Tucson showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

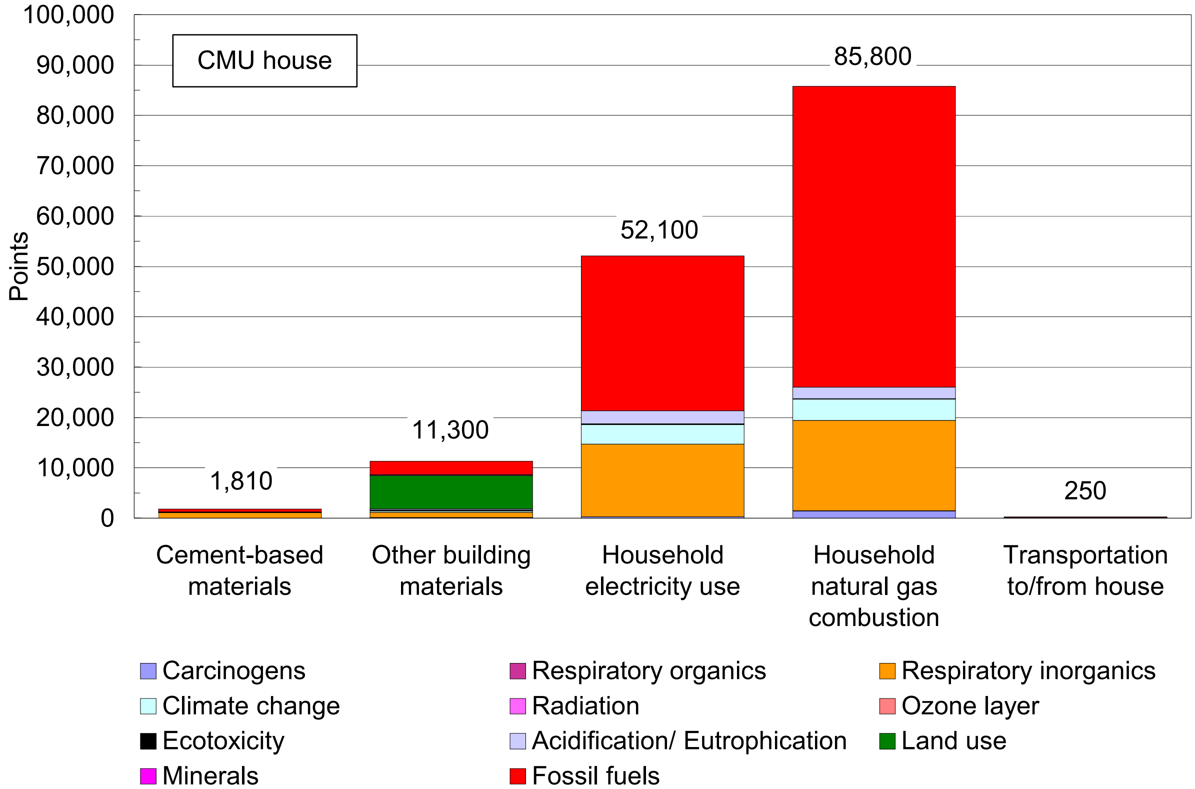

Figure J-2. Single-score life cycle inventory assessment of CMU house in St. Louis showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

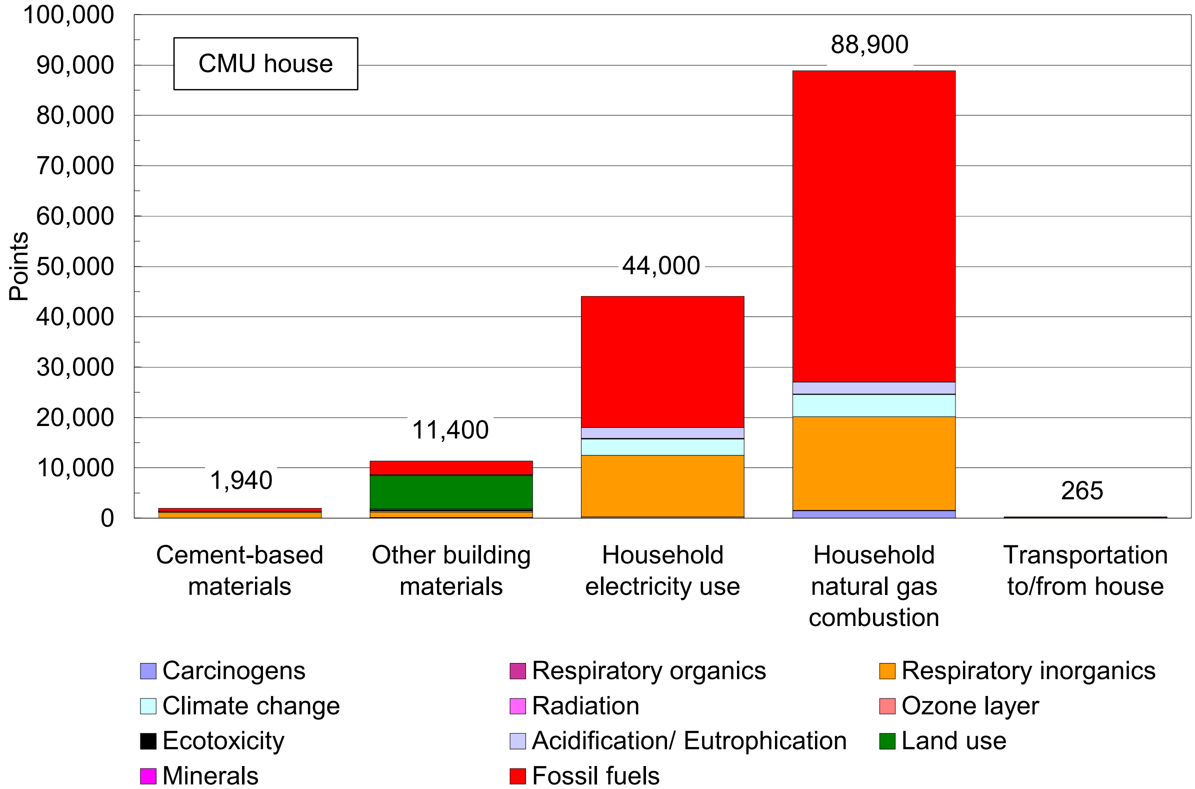

Figure J-3. Single-score life cycle inventory assessment of CMU house in Denver, showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

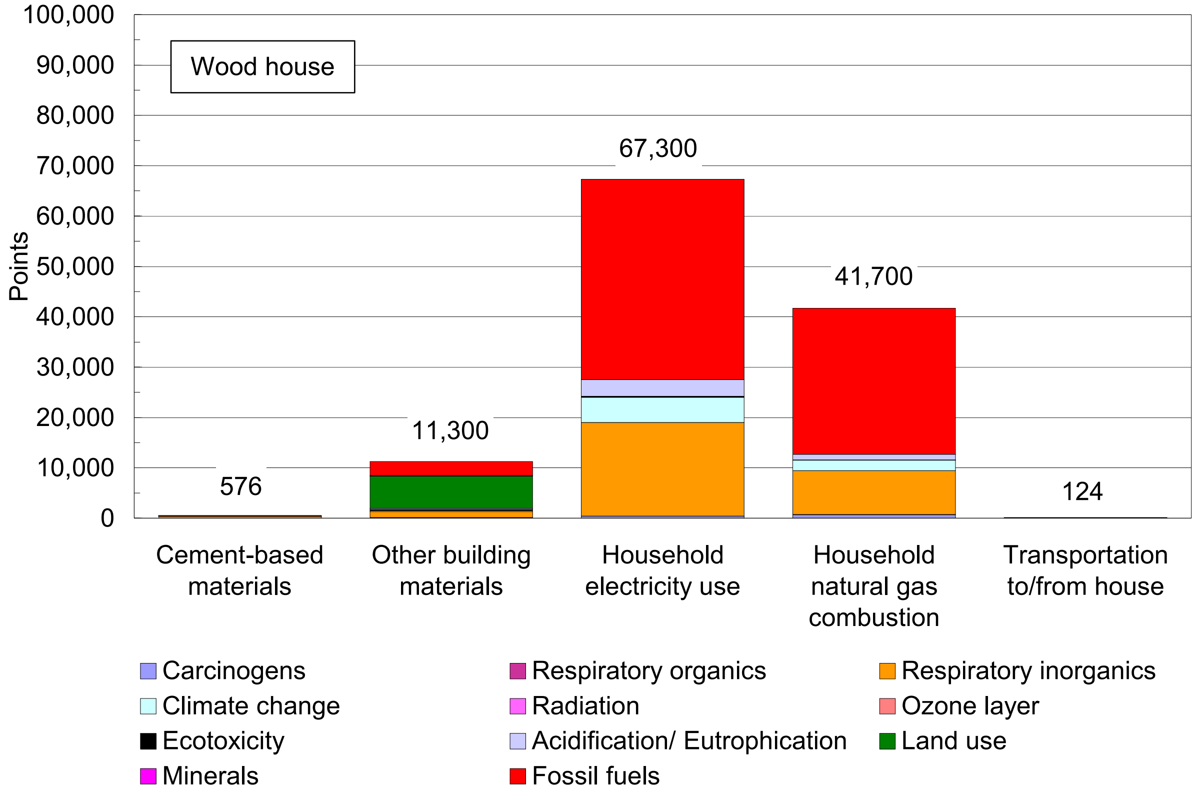

Figure J-4. Single-score life cycle inventory assessment of wood house in Tucson showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

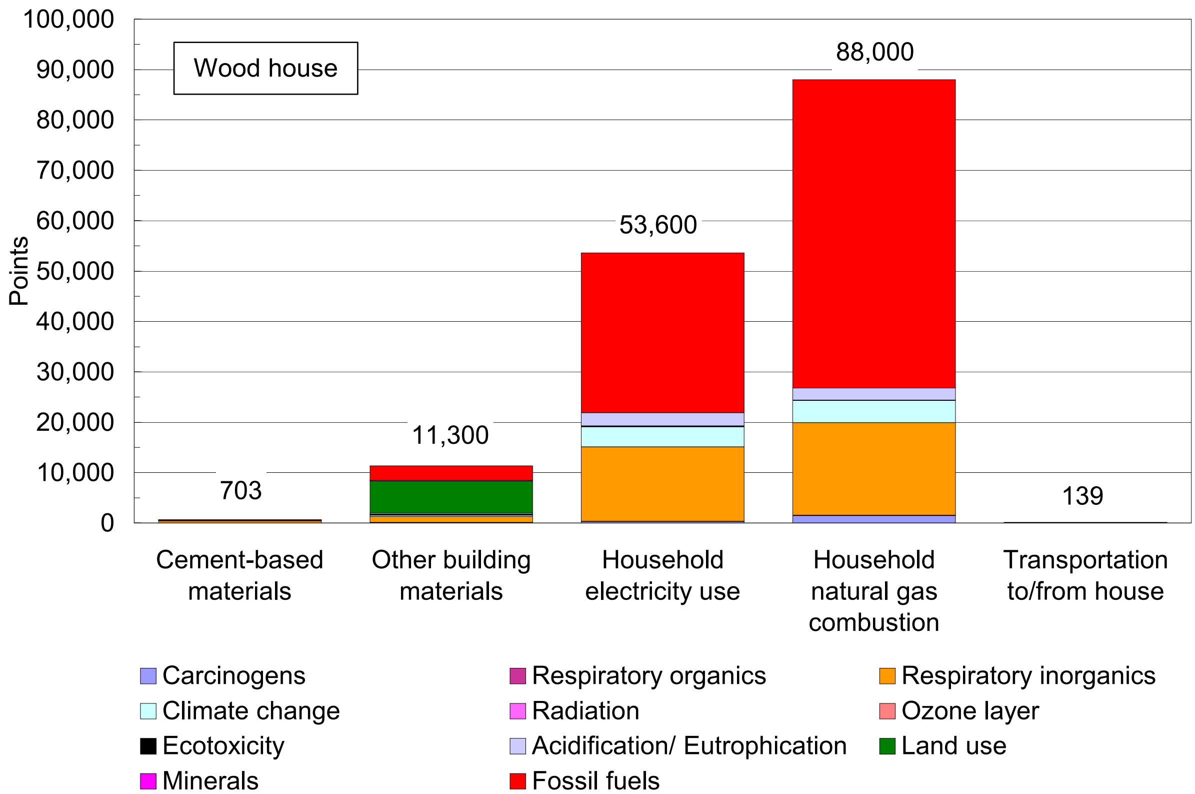

Figure J-5. Single-score life cycle inventory assessment of wood house in St. Louis showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

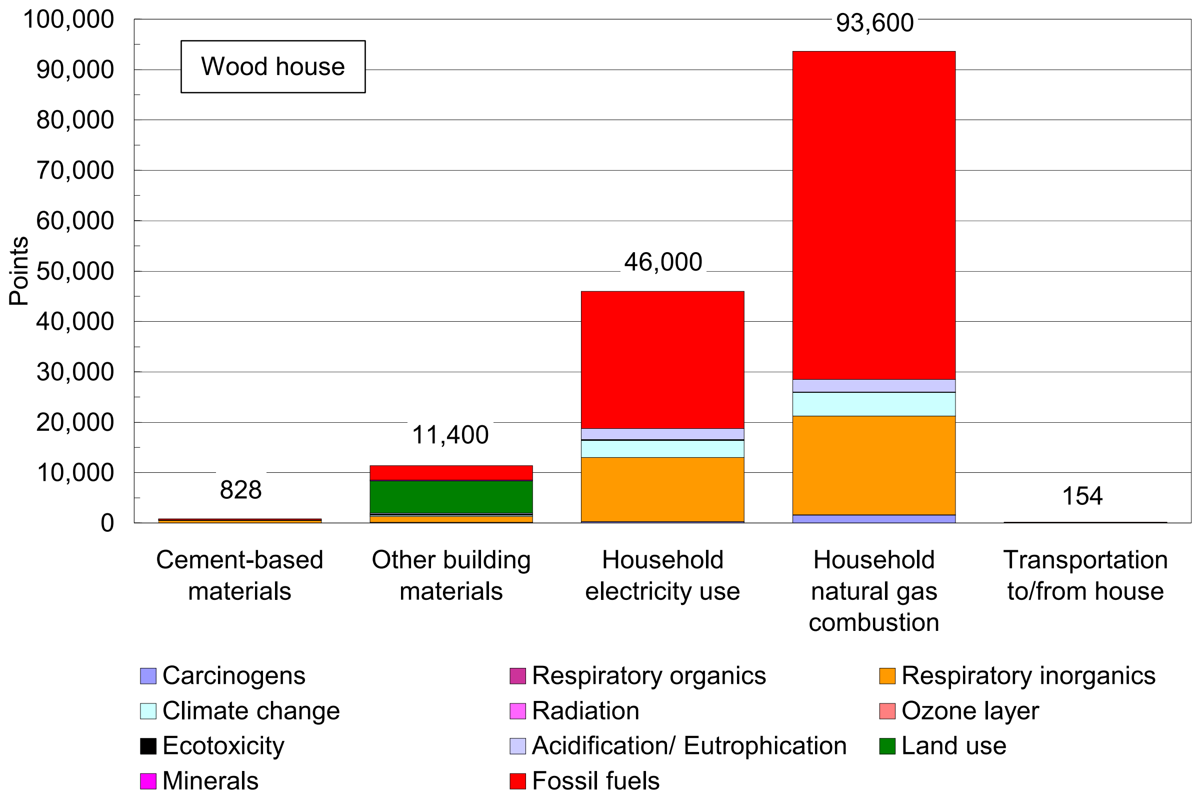

Figure J-6. Single-score life cycle inventory assessment of wood house in Denver, showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

APPENDIX K – BREAKDOWN OF SINGLE-SCORE LCA OF BUILDING MATERIALS
(Output from SimaPro)

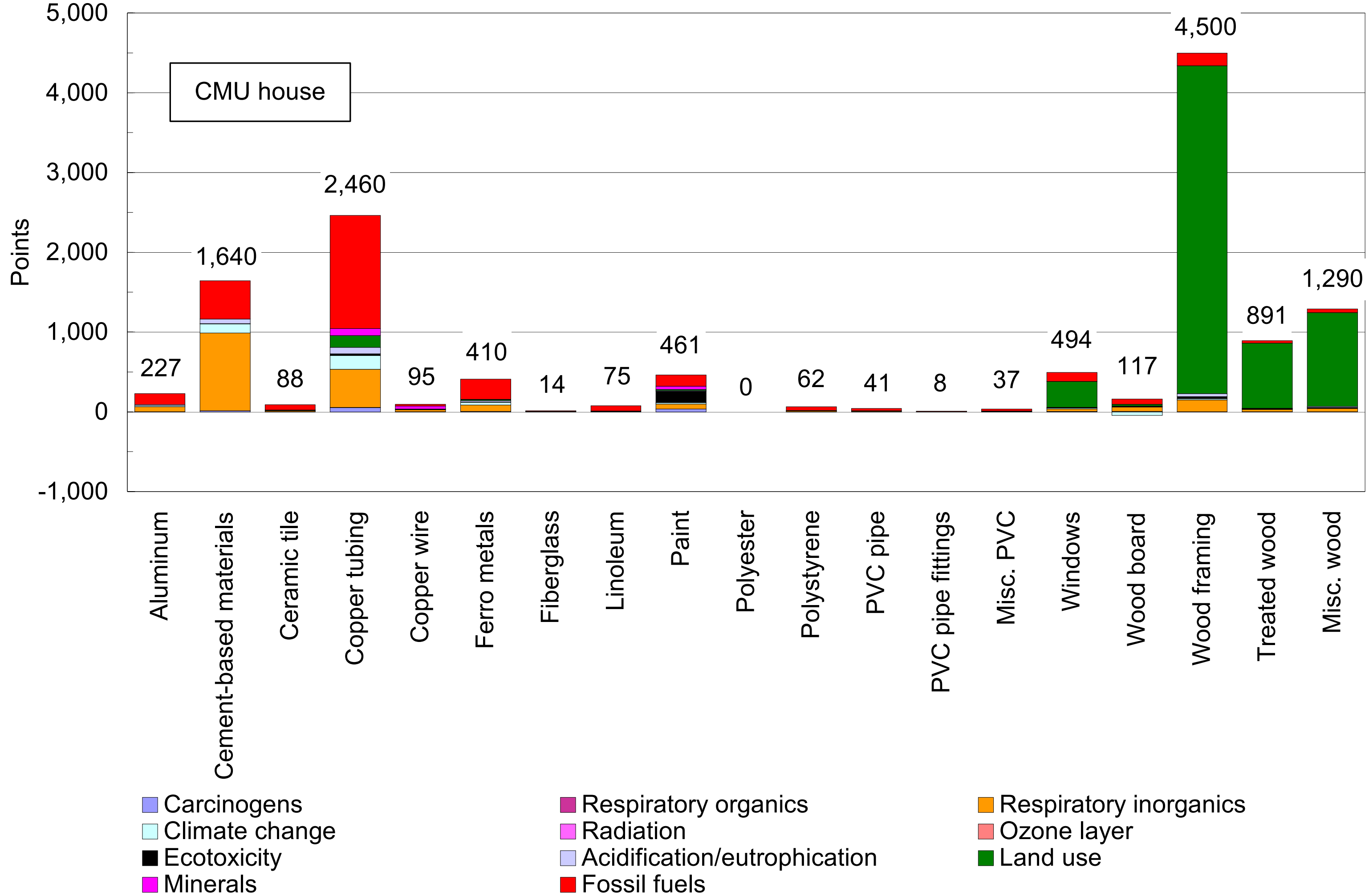

Figure K-1. Single-score life cycle inventory assessment for construction materials in the CMU house in Lake Charles (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

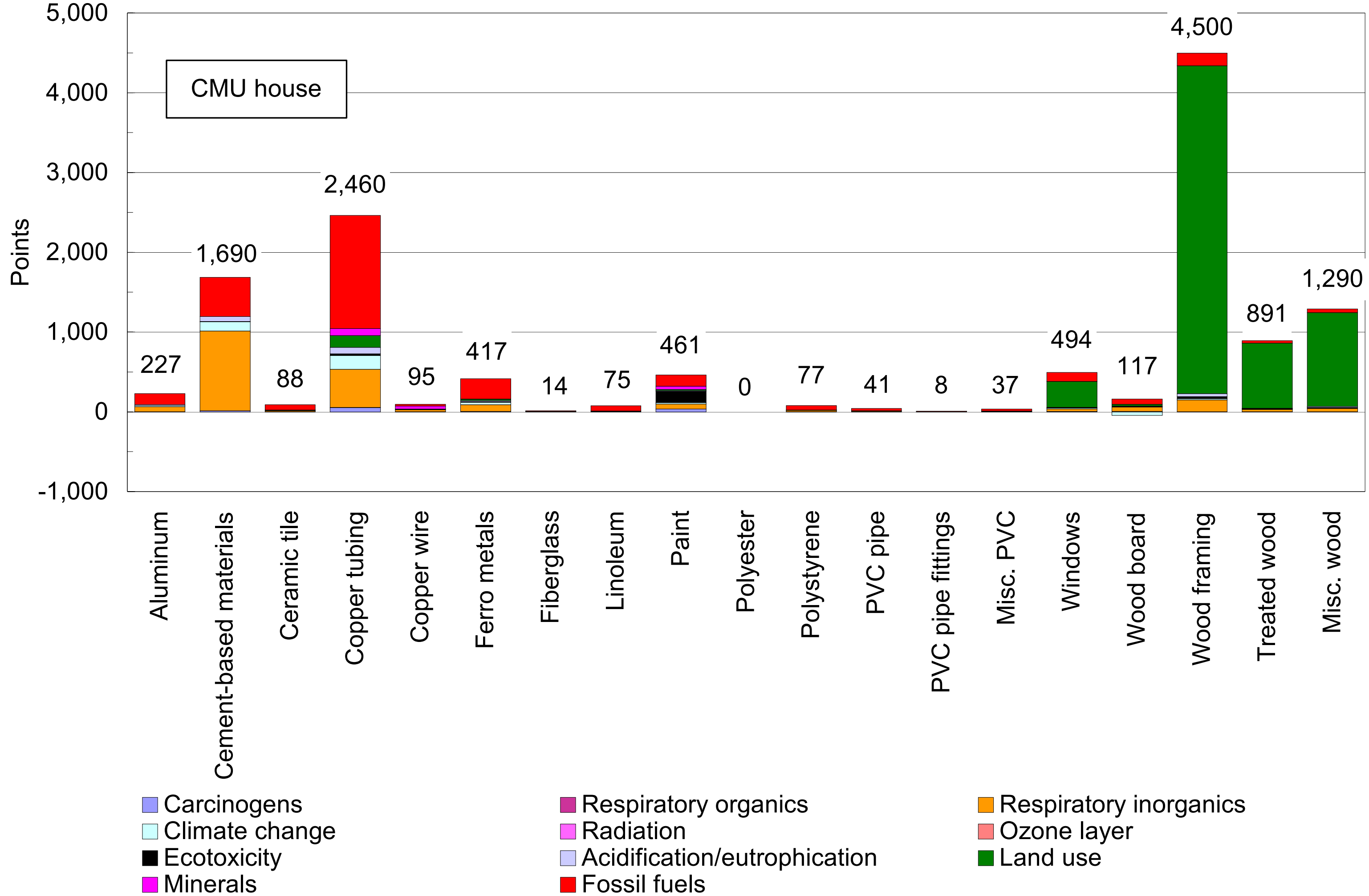

Figure K-2. Single-score life cycle inventory assessment for construction materials in the CMU house in Tucson (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

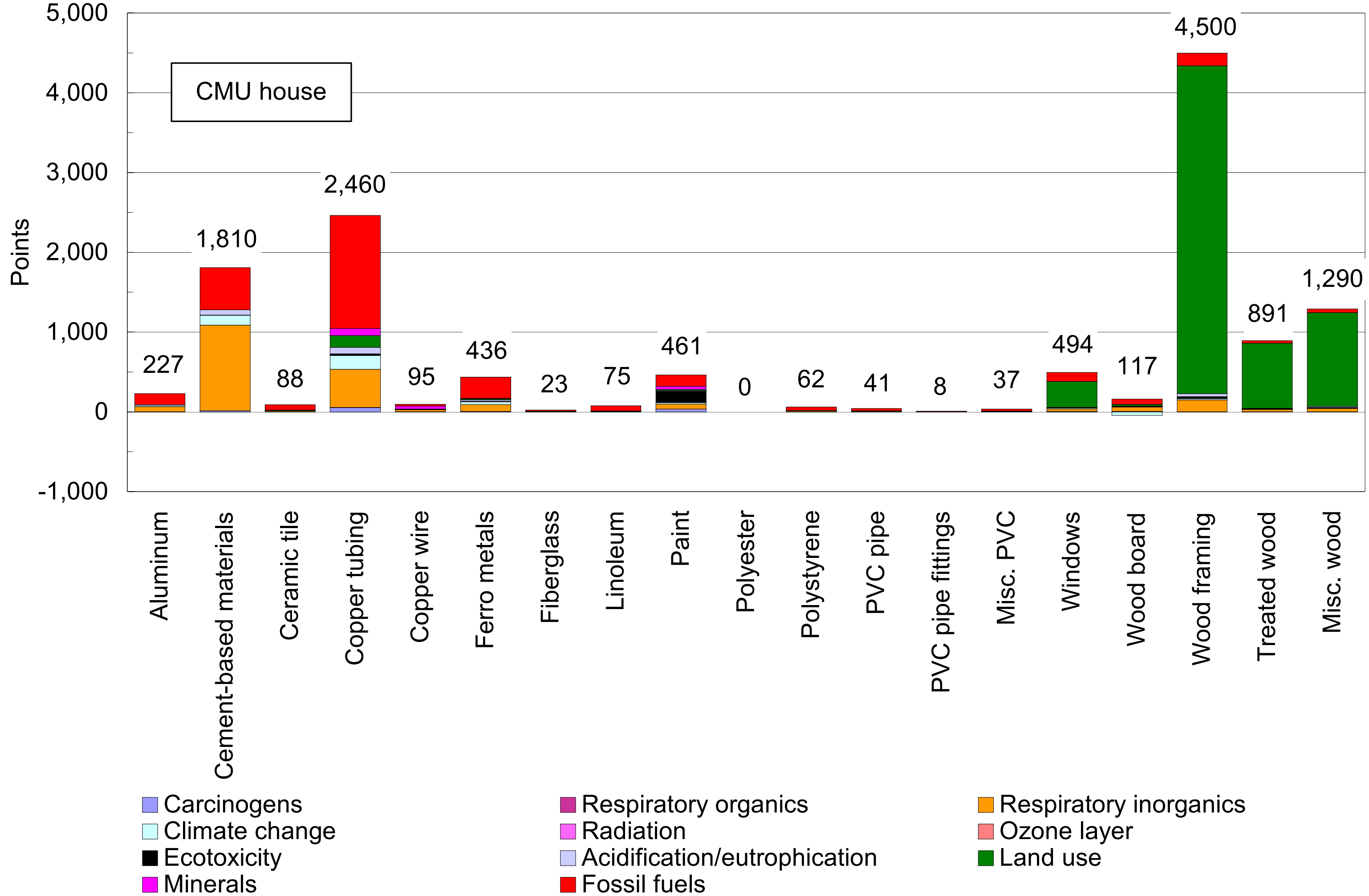

Figure K-3. Single-score life cycle inventory assessment for construction materials in the CMU house in St. Louis (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

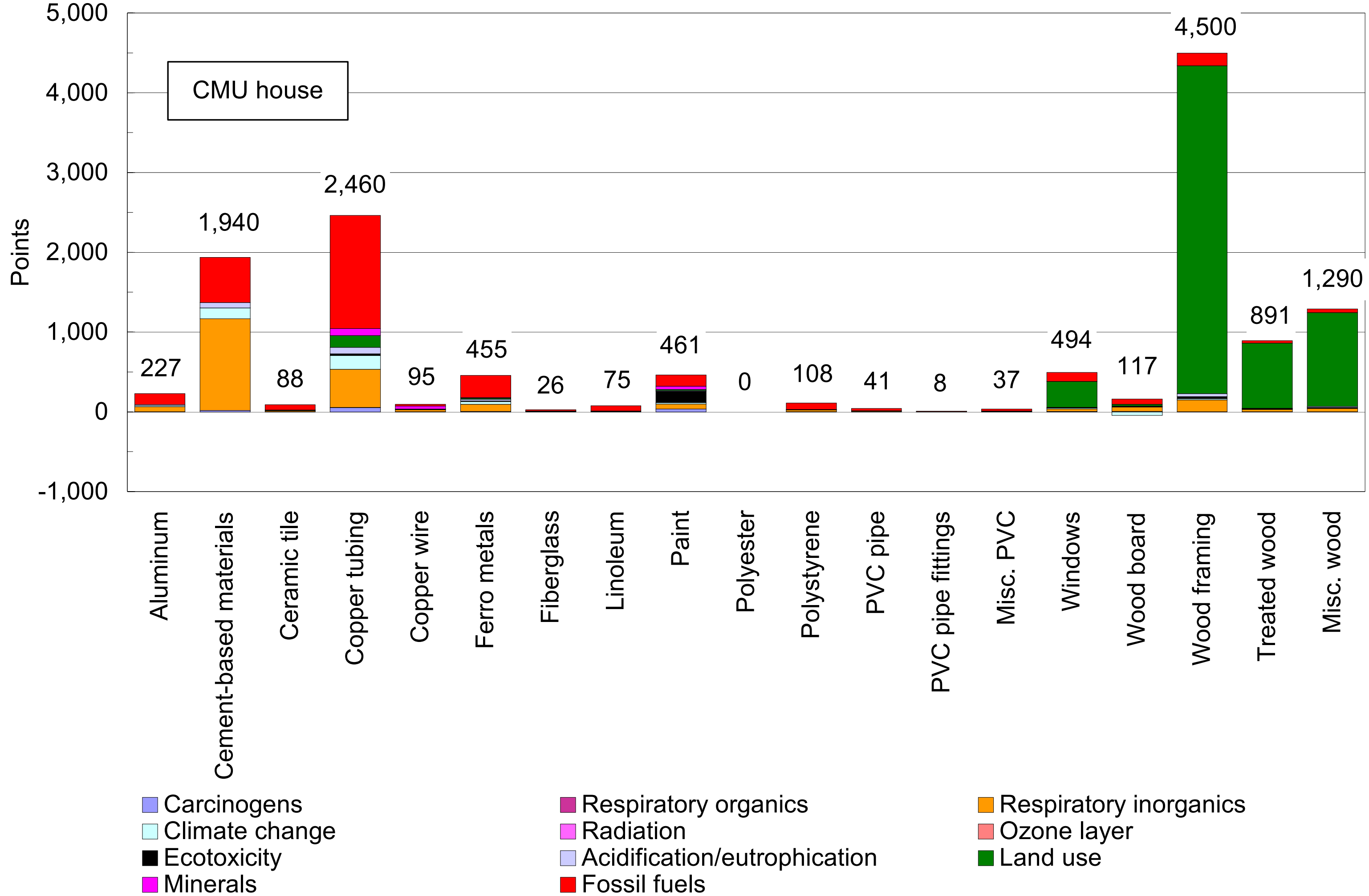

Figure K-4. Single-score life cycle inventory assessment for construction materials in the CMU house in Denver (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

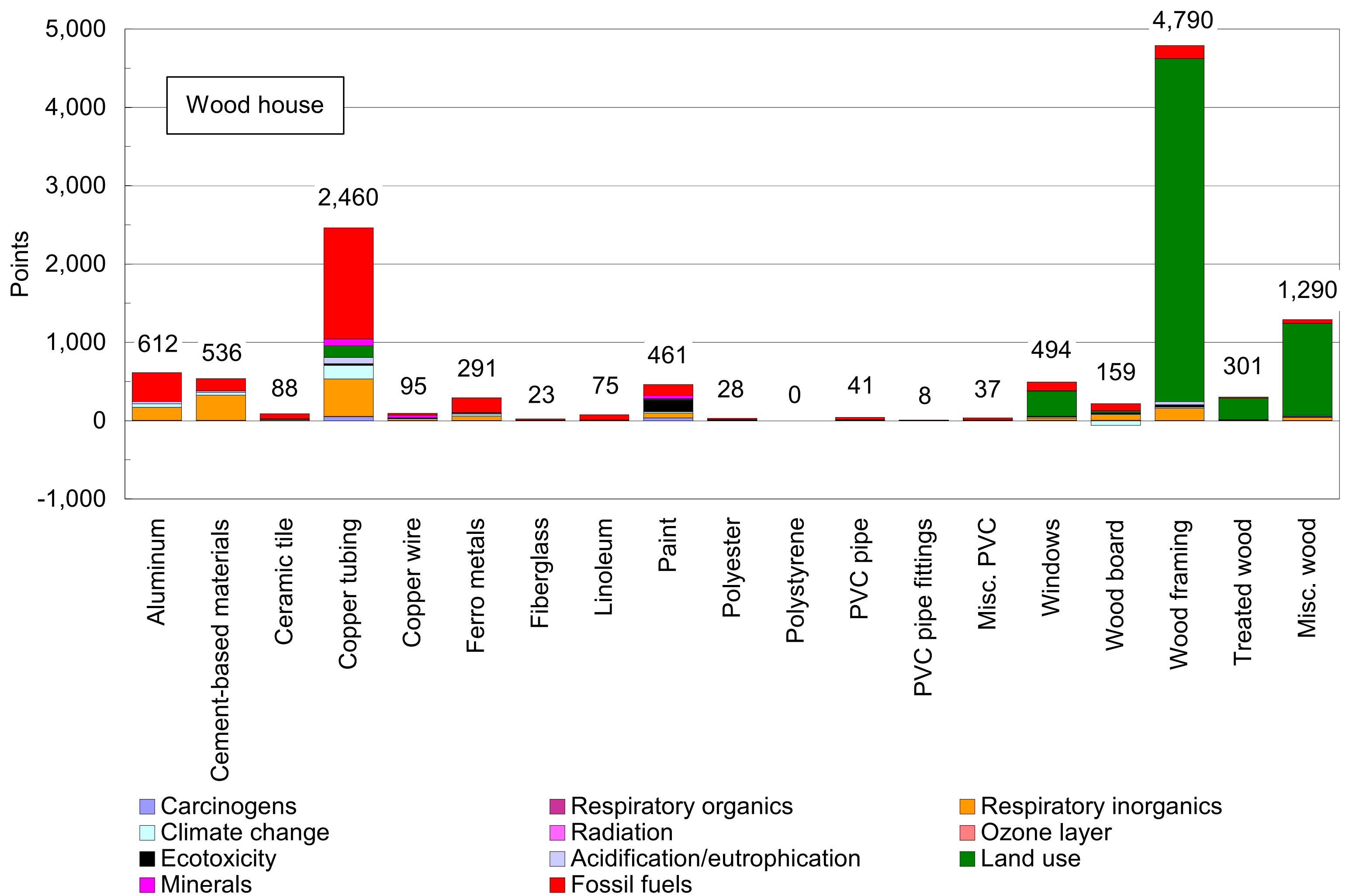

Figure K-5. Single-score life cycle inventory assessment for construction materials in the wood frame house in Lake Charles (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

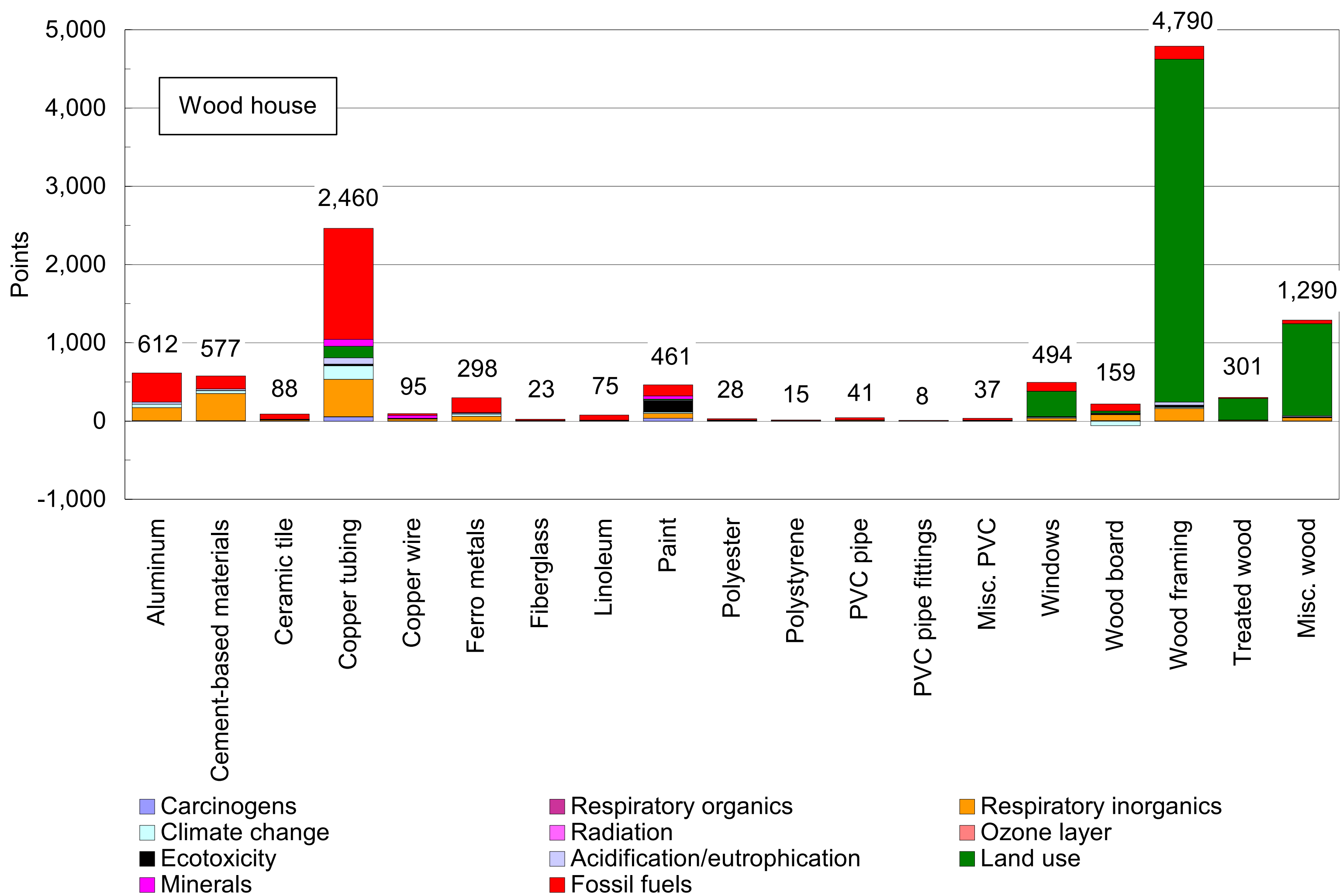

Figure K-6. Single-score life cycle inventory assessment for construction materials in the wood frame house in Tucson (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

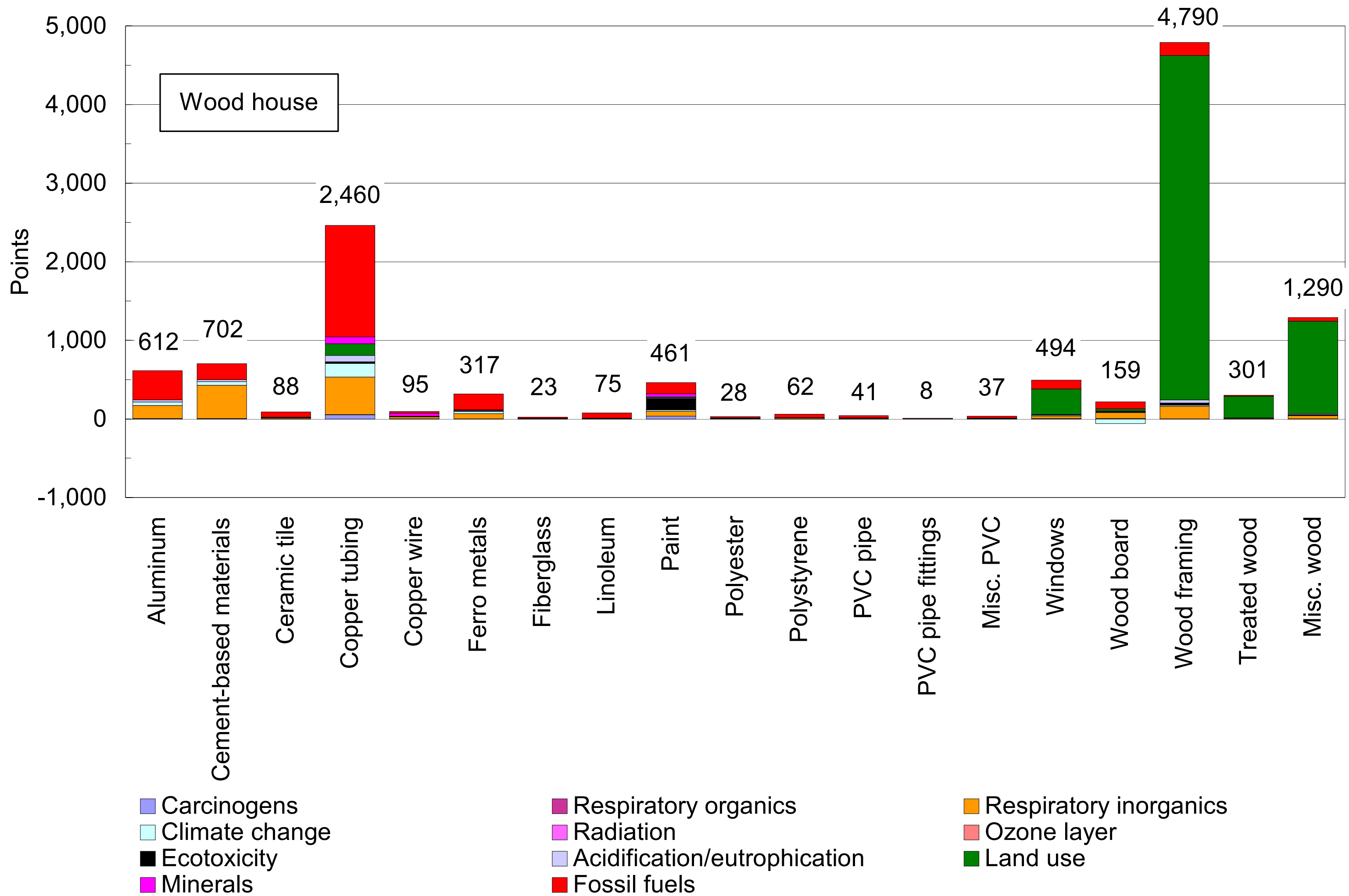

Figure K-7. Single-score life cycle inventory assessment for construction materials in the wood frame house in St. Louis (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

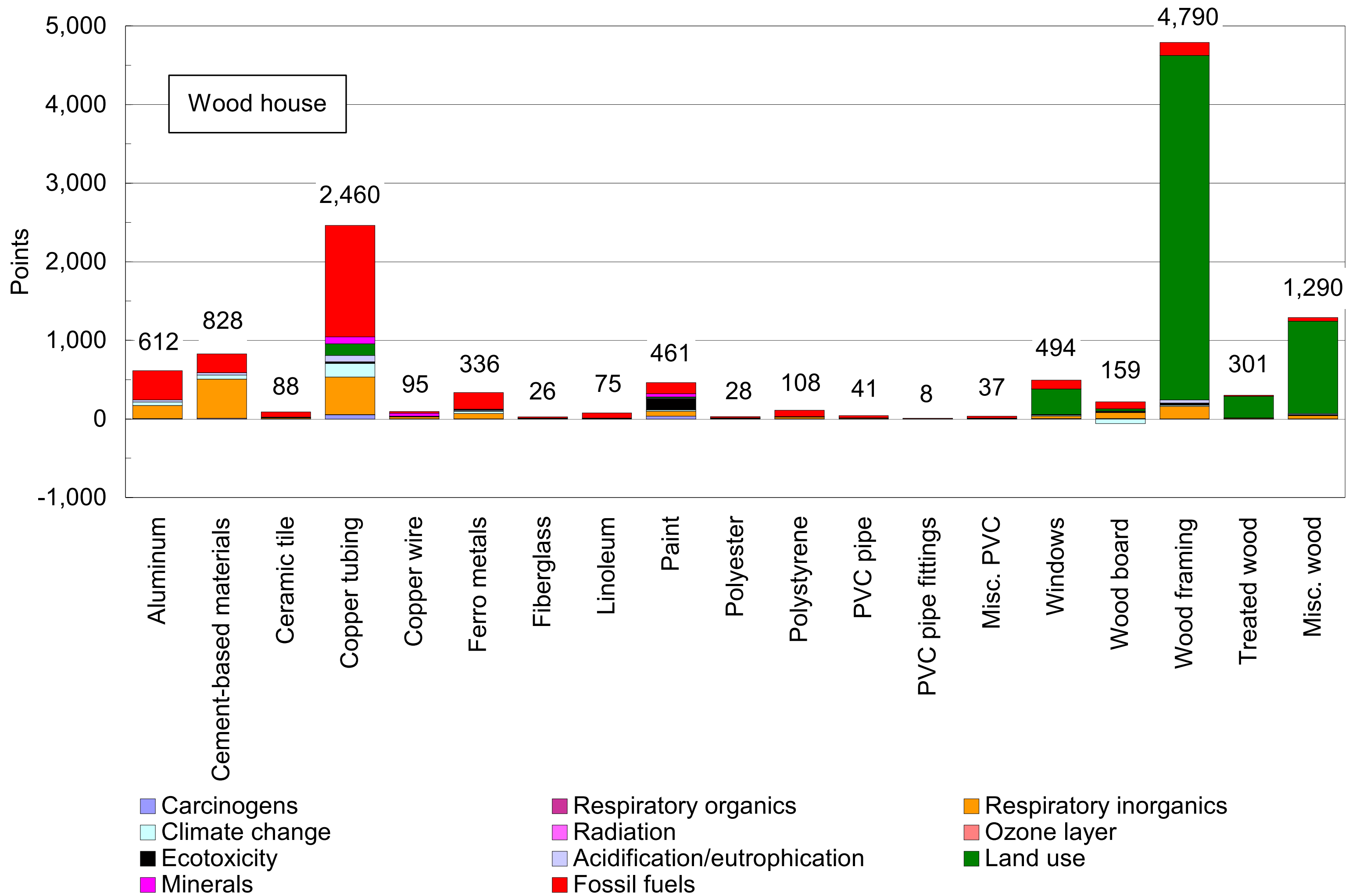

Figure K-8. Single-score life cycle inventory assessment for construction materials in the wood frame house in Denver (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.