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Life Cycle Assessment of an Insulating Concrete Form House Compared to a Wood Frame House

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KEYWORDS

Cement, concrete, emissions, embodied energy, energy, housing, ICF, insulating concrete forms, LCA, LCI, life cycle, life cycle assessment, life cycle characterization, life cycle impact assessment, life cycle inventory, 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 an insulating concrete form (ICF) 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: Phoenix, Miami, Washington, Seattle, and Chicago.

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 results show that in almost all cases, for a given climate, the environmental impact in each category is greater (worse) for the wood house than for the ICF house. 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

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LIFE CYCLE ASSESSMENT OF AN INSULATING CONCRETE FORM 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 (that is, concrete) 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 uncertainty 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 an insulating concrete form (ICF) 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.

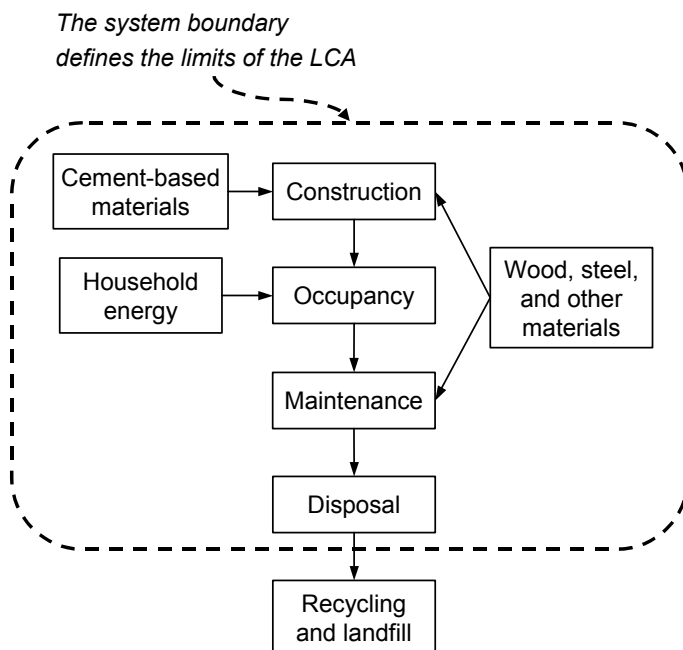


Figure 1. System boundary for house life cycle assessment.

The same layout is assumed for both the wood frame and the ICF 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: Miami, Phoenix, Seattle, Washington, and Chicago.^[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 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. Phoenix was selected because it is a hot dry climate with large temperature swings where thermal mass is most effective in increasing thermal comfort and in reducing energy use. Miami was selected because it is a hot humid climate with small temperature swings where thermal mass works almost as well. Washington and Seattle were selected because they are moderate climates. Chicago was selected because it is a cold climate.

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 $\text{m}^2\cdot\text{K}/\text{W}$ ($\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}/\text{Btu}$) and U-factor refers to thermal transmittance, that is, heat flow per unit area per degree, in $\text{W}/\text{m}^2\cdot\text{K}$ ($\text{Btu}/\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}$). 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 $1.53 \text{ W}/\text{m}^2\cdot\text{K}$ ($0.27 \text{ Btu}/\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}$). 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.

The exterior walls of the wood frame houses consist of medium-colored aluminum siding, 12-mm ($\frac{1}{2}$ -in.) plywood, R_{SI} -1.9 (R-11) fiberglass batt insulation, and 12-mm ($\frac{1}{2}$ -in.) painted gypsum board. The exterior walls of the ICF houses consists of medium-colored aluminum siding; flat panel ICF system with 50 mm (2 in.) expanded polystyrene insulation, 150 mm

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

Location	Opaque walls**				Roof		Windows***	
	Wood frame		Mass (ICF)		W m ² ·K	Btu hr·ft ² ·°F	W m ² ·K	Btu hr·ft ² ·°F
	W m ² ·K	Btu hr·ft ² ·°F	W m ² ·K	Btu hr·ft ² ·°F				
Miami	0.937	0.165	1.164	0.205	0.278	0.049	4.2	0.74
Phoenix	0.960	0.169	1.187	0.209	0.238	0.042	2.4	0.47
Seattle	0.653	0.115	0.750	0.132	0.187	0.033	1.7	0.30
Washington	0.642	0.113	0.732	0.129	0.182	0.032	1.7	0.30
Chicago	0.466	0.082	0.466	0.082	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 Miami and Phoenix.

(6 in.) normal weight concrete, and 50 mm (2 in.) expanded polystyrene insulation with plastic ties; and 12-mm (½-in.) painted gypsum board. These 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/m²·K (0.50 Btu/hr·ft²·°F). Interior walls are wood frame construction and uninsulated.

Roofs are wood frame construction with R_{SI}-3.3, R_{SI}-5.3, or R_{SI}-6.7 (R-19, 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 coating. To meet the SHGC requirement, windows in Miami and Phoenix are tinted and contain air in the space between panes. Windows in Seattle, Chicago, and Washington 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.

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.^[12] 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.

Table 2. Assembly U-Factors*

Location	Walls				Roof**		Windows	
	Wood frame		Mass (ICF)		W m ² ·K	Btu hr·ft ² ·°F	W m ² ·K	Btu hr·ft ² ·°F
	W m ² ·K	Btu hr·ft ² ·°F	W m ² ·K	Btu hr·ft ² ·°F				
Miami	0.47	0.082	0.31	0.055	0.27	0.048	2.4	0.43
Phoenix					0.18	0.032		
Seattle								
Washington							1.5	0.27
Chicago	0.15	0.026						

*The maximum U-factor is equal to the inverse of the minimum R-value.

**R_{SI}-3.3 (R-19) attic insulation is used in Miami, R_{SI}-6.7 (R-38) attic insulation is used in Chicago, and R_{SI}-5.3 (R-30) attic insulation is used in the remaining 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,^[12] and it assumes the houses have an electric clothes dryer and an electric stove.

Air infiltration rates are based on ASHRAE Standard 62.^[13] 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.

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.^[1, 4, 14] 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.^[15] 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 3. House Component Replacement Schedules

House component	Replacement schedule (years)
Siding, air barrier, and exterior fixtures	33.3
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.

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 ICF 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 ICF houses have lower occupant energy use than the wood frame houses. In the simulations, the ICF houses were modeled with a standard ICF wall configuration while the wood frame houses were modeled

with standard materials needed to meet IECC requirements. In all cases but one (the wood frame house in Chicago), the R-values of ICF and wood frame walls significantly exceed IECC requirements. Wood frame walls have R-values that range from 0 to 105% in excess of IECC requirements, while ICF walls have R-values that range from 50 to 210% in excess of IECC requirements.

Table 4. Sources of LCI Data

Material and energy	Database name	Source
Aluminum	Franklin US LCI	Reference 16: PRé Consultants and Sylvatica, 2001.
Cement-based materials	PCA	Reference 14: Nisbet, et al., 2000.
Copper	IDEMAT 2001	Reference 17: PRé Consultants and Delft University of Technology, 2001.
Electrical wire	IDEMAT 2001 and Data Archive	References 17 and 18: PRé Consultants and Delft University of Technology, 2001; and PRé Consultants, 2001.
Expanded polystyrene insulation	Franklin US LCI	Reference 16: PRé Consultants and Sylvatica, 2001.
Fiberglass insulation	IDEMAT 2001	Reference 17: PRé Consultants and Delft University of Technology, 2001.
Galvanized steel and other sheet metals	Franklin US LCI	Reference 16: PRé Consultants and Sylvatica, 2001.
Linoleum	IDEMAT 2001	Reference 17: PRé Consultants and Delft University of Technology, 2001.
Paint	ETH-ESU 96	Reference 19: PRé Consultants and ESU-services, 2001.
Plywood and wood sheathing	ETH-ESU 96	Reference 19: PRé Consultants and ESU-services, 2001.
Polyester fabric	IDEMAT 2001	Reference 17: PRé Consultants and Delft University of Technology, 2001.
PVC	IDEMAT 2001	Reference 17: PRé Consultants and Delft University of Technology, 2001.
Steel	IDEMAT 2001	Reference 17: PRé Consultants and Delft University of Technology, 2001.
Tile	IDEMAT 2001	Reference 17: PRé Consultants and Delft University of Technology, 2001.
Windows	ETH 1996 and IDEMAT 2001	References 19 and 17: PRé Consultants and ESU-services, 2001; and PRé Consultants and Delft University of Technology, 2001.
Wood: framing, treated, and miscellaneous	IDEMAT 2001	Reference 17: PRé Consultants and Delft University of Technology, 2001.
Coal	Franklin US LCI	Reference 16: PRé Consultants and Sylvatica, 2001.
Distillate fuel oil	Franklin US LCI	Reference 16: PRé Consultants and Sylvatica, 2001.
Electricity	Franklin US LCI	Reference 16: PRé Consultants and Sylvatica, 2001.
Gasoline	Franklin US LCI	Reference 16: PRé Consultants and Sylvatica, 2001.
Liquefied petroleum gas	Franklin US LCI	Reference 16: PRé Consultants and Sylvatica, 2001.
Natural gas	Franklin US LCI	Reference 16: PRé Consultants and Sylvatica, 2001.
Petroleum coke	Franklin US LCI	Reference 19: PRé Consultants and ESU-services, 2001.
Residual fuel oil	Franklin US LCI	Reference 16: 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 14. 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 part not 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		ICF	
	Amount		Amount	
	kg	lb	kg	lb
Gypsum wall board	8,900	19,600	9,700	21,300
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	29,800	65,370
Total mass of house (average)	148,000	326,000	272,000	599,000
Percent of total mass excluded from LCA	20		11	

Table 7. Annual Occupant Energy-Use by Location

Location	Variation	Annual operating data				
		Electricity		Natural gas		Total energy, GJ
		GJ	kWh	GJ	therms	
Miami	Wood frame	65.3	18,130	41.1	390	106.4
	ICF	61.1	16,980	39.6	380	100.7
Phoenix	Wood frame	75.6	21,000	69.5	670	145.1
	ICF	70.2	19,500	63.6	600	133.8
Seattle	Wood frame	35.4	9,840	184.6	1,750	220.0
	ICF	34.6	9,600	165.7	1,570	200.3
Washington	Wood frame	43.4	12,060	170.2	1,610	213.7
	ICF	41.5	11,520	155.7	1,480	197.1
Chicago	Wood frame	41.5	11,540	214.4	2,030	256.0
	ICF	39.8	11,060	195.5	1,850	235.3

Another important difference between the two houses is that the system capacity for heating, ventilating, and air-conditioning is less for the ICF 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 ICF house moderates temperature swings and peak loads, and results in lower HVAC system requirements. The large capacity required in Phoenix is due to the large daily temperature swings in that city.

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

Location	Variation	System capacity			
		Heating		Cooling	
		kW	kBtu/hr	kW	kBtu/hr
Miami	Wood frame	25	87	13	44
	ICF	21	73	11	37
Phoenix	Wood frame	35	119	21	70
	ICF	30	103	18	61
Seattle	Wood frame	26	90	14	46
	ICF	21	71	11	36
Washington	Wood frame	27	93	14	48
	ICF	23	79	12	41
Chicago	Wood frame	26	90	14	46
	ICF	22	76	12	39

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 CO₂, methane, and N₂O 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 CO₂, methane, and N₂O contribute to climate change. In terms of global warming potential, one pound of methane is 20 times more potent than one pound of CO₂, and one pound of N₂O is 320 times more potent than one pound of CO₂. Therefore, in assessing the potential for global warming, CO₂ is assigned a weighting factor of 1, methane a factor of 20, and N₂O a factor of 320. It is important to remember that there is no scientific basis for comparing across impact categories.^[20]

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.^[20] 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.^[20] 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.

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)	

Results of the characterization phase for each method are shown in Tables 10 through 14. The data show that in almost all cases, for a given climate the impact indicators in each category are greater (worse) for the wood house than for the ICF house. The exceptions are in the category “minerals” in the Eco-Indicator methods and the category “severe nuisance” in the EPS 2000 method.

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 country. In weighting, the impact assessment values in several or all categories are multiplied by

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					ICF house				
		Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Carcinogens	DALY*	0.0455	0.0611	0.0965	0.0931	0.1110	0.0443	0.0576	0.0890	0.0871	0.1040
Respiratory organics	DALY	2.54E-3	3.55E-3	6.15E-3	5.88E-3	7.14E-3	2.55E-3	3.41E-3	5.72E-3	5.56E-3	6.69E-3
Respiratory inorganics	DALY	1.34	1.66	1.64	1.69	1.91	1.31	1.59	1.56	1.62	1.82
Climate change	DALY	0.348	0.429	0.403	0.420	0.469	0.335	0.405	0.382	0.399	0.444
Radiation	DALY	2.54E-5	2.54E-5	2.54E-5	2.55E-5	2.55E-5	2.30E-5	2.31E-5	2.31E-5	2.31E-5	2.31E-5
Ozone layer	DALY	4.18E-5	4.70E-5	2.79E-5	3.18E-5	3.12E-5	3.94E-5	4.40E-5	2.71E-5	3.04E-5	2.99E-5
Ecotoxicity	PAF·m ² ·yr**	47,700	52,800	44,100	46,300	47,900	46,300	50,700	43,000	45,000	46,500
Acidification/eutrophication	PDF·m ² ·yr***	44,800	54,600	47,800	50,400	55,500	42,900	51,400	45,400	48,000	52,600
Land use	PDF·m ² ·yr	65,200	65,200	65,200	65,200	65,200	58,700	58,700	58,700	58,700	58,700
Minerals	MJ surplus	4,950	4,950	4,950	4,960	4,970	5,020	5,020	5,020	5,030	5,040
Fossil fuels	MJ surplus	1.80E+6	2.30E+6	2.70E+6	2.71E+6	3.13E+6	1.74E+6	2.17E+6	2.52E+6	2.55E+6	2.93E+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					ICF house				
		Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Carcinogens	DALY*	0.0455	0.0611	0.0965	0.0931	0.1110	0.0443	0.0576	0.0890	0.0871	0.1040
Respiratory organics	DALY	2.54E-3	3.55E-3	6.15E-3	5.88E-3	7.14E-3	2.55E-3	3.41E-3	5.72E-3	5.56E-3	6.69E-3
Respiratory inorganics	DALY	1.34	1.66	1.64	1.69	1.9	1.31	1.58	1.56	1.62	1.81
Climate change	DALY	0.348	0.429	0.403	0.420	0.469	0.335	0.405	0.382	0.399	0.444
Radiation	DALY	2.54E-5	2.54E-5	2.54E-5	2.55E-5	2.55E-5	2.30E-5	2.31E-5	2.31E-5	2.31E-5	2.31E-5
Ozone layer	DALY	4.18E-5	4.70E-5	2.79E-5	3.18E-5	3.12E-5	3.94E-5	4.40E-5	2.71E-5	3.04E-5	2.99E-5
Ecotoxicity	PAF·m ² ·yr**	47,700	52,800	44,100	46,300	47,900	46,300	50,700	43,000	45,000	46,500
Acidification/eutrophication	PDF·m ² ·yr***	44,800	54,600	47,800	50,400	55,500	42,900	51,400	45,400	48,000	52,600
Land use	PDF·m ² ·yr	65,200	65,200	65,200	65,200	65,200	58,700	58,700	58,700	58,700	58,700
Minerals	MJ surplus	4,950	4,950	4,950	4,960	4,970	5,020	5,020	5,020	5,030	5,040
Fossil fuels	MJ surplus	1.64E+6	2.26E+6	3.76E+6	3.61E+6	4.35E+6	1.60E+6	2.13E+6	3.46E+6	3.37E+6	4.05E+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					ICF house				
		Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Carcinogens	DALY*	0.0203	0.0280	0.0479	0.0459	0.0554	0.0197	0.0263	0.0440	0.0428	0.0514
Respiratory organics	DALY	2.36E-3	3.30E-3	5.72E-3	5.47E-3	6.64E-3	2.37E-3	3.17E-3	5.31E-3	5.17E-3	6.22E-3
Respiratory inorganics	DALY	0.629	0.795	0.886	0.897	1.03	0.618	0.761	0.842	0.86	0.981
Climate change	DALY	0.332	0.410	0.385	0.401	0.448	0.320	0.386	0.365	0.381	0.424
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	3.38E-5	3.81E-5	2.26E-5	2.57E-5	2.52E-5	3.19E-5	3.56E-5	2.19E-5	2.46E-5	2.42E-5
Ecotoxicity	PAF·m ² ·yr**	6,830	8,160	9,400	9,400	10,600	6,570	7,710	8,810	8,880	9,950
Acidification/eutrophication	PDF·m ² ·yr***	44,800	54,600	47,800	50,400	55,500	42,900	51,400	45,400	48,000	52,600
Land use	PDF·m ² ·yr	65,200	65,200	65,200	65,200	65,200	58,700	58,700	58,700	58,700	58,700
Minerals	MJ surplus	4,950	4,950	4,950	4,960	4,970	5,020	5,020	5,020	5,030	5,040

*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					ICF house				
		Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Global warming (GWP 100)	g CO ₂	1.68E+9	2.07E+9	1.96E+9	2.04E+9	2.28E+9	1.62E+9	1.95E+9	1.85E+9	1.94E+9	2.15E+9
Ozone depletion	g CFC-11	39.8	44.8	26.6	30.3	29.7	37.5	41.9	25.8	29.0	28.4
Acidification	g SO ₂	1.77E+7	2.23E+7	2.45E+7	2.48E+7	2.84E+7	1.70E+7	2.10E+7	2.29E+7	2.34E+7	2.66E+7
Eutrophication	g NO ₃	7.24E+6	8.59E+6	6.17E+6	6.77E+6	7.15E+6	6.94E+6	8.11E+6	5.96E+6	6.51E+6	6.87E+6
Photochemical smog	g ethene	6.89E+4	8.85E+4	1.17E+5	1.15E+5	1.35E+5	6.88E+4	8.56E+4	1.11E+5	1.11E+5	1.28E+5
Ecotoxicity water, chronic	g/m ³	1.45E+8	1.78E+8	2.22E+8	2.20E+8	2.52E+8	1.43E+8	1.71E+8	2.10E+8	2.10E+8	2.39E+8
Ecotoxicity water, acute	g/m ³	1.28E+7	1.59E+7	2.06E+7	2.04E+7	2.35E+7	1.26E+7	1.53E+7	1.95E+7	1.94E+7	2.23E+7
Ecotoxicity soil, chronic	g/m ³	5.72E+5	5.84E+5	5.58E+5	5.65E+5	5.68E+5	5.60E+5	5.71E+5	5.48E+5	5.53E+5	5.56E+5
Human toxicity, air	g/m ³	2.97E+11	3.32E+11	2.84E+11	2.97E+11	3.11E+11	2.89E+11	3.20E+11	2.77E+11	2.89E+11	3.02E+11
Human toxicity, water	g/m ³	5.49E+7	6.32E+7	5.29E+7	5.59E+7	5.93E+7	5.31E+7	6.02E+7	5.12E+7	5.39E+7	5.70E+7
Human toxicity, soil	g/m ³	1.63E+5	1.86E+5	1.52E+5	1.61E+5	1.69E+5	1.57E+5	1.77E+5	1.47E+5	1.55E+5	1.62E+5
Bulk waste	kg	2.57E+5	2.99E+5	1.90E+5	2.14E+5	2.19E+5	2.44E+5	2.81E+5	1.85E+5	2.06E+5	2.10E+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	11.1	11.1	11.1	11.1	11.1
Resources (all)	kg	28.5	33.7	42.5	41.9	47.3	28.2	32.7	40.4	40.2	45.1

*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					ICF house				
		Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Life expectancy	Person-year	1.07	1.40	1.89	1.86	2.19	1.07	1.34	1.78	1.78	2.08
Severe morbidity	Person-year	0.022	0.054	0.243	0.217	0.281	0.028	0.054	0.222	0.204	0.261
Morbidity	Person-year	0.394	0.549	0.963	0.920	1.120	0.391	0.522	0.890	0.863	1.040
Severe nuisance	Person-year	0.154	0.157	0.148	0.150	0.151	0.156	0.159	0.151	0.153	0.154
Nuisance	Person-year	104	131	149	150	173	99	123	139	141	162
Crop growth capacity	kg	3.87E+3	4.65E+3	3.78E+3	4.05E+3	4.39E+3	3.72E+3	4.40E+3	3.63E+3	3.88E+3	4.19E+3
Wood growth capacity	kg	-2.53E+4	-3.40E+4	-5.27E+4	-5.10E+4	-6.11E+4	-2.50E+4	-3.25E+4	-4.91E+4	-4.82E+4	-5.72E+4
Fish and meat production	kg	-165	-194	-129	-144	-150	-158	-183	-126	-139	-144
Soil acidification	H+ eq.	2.76E+4	3.49E+4	3.82E+4	3.88E+4	4.44E+4	2.65E+4	3.27E+4	3.57E+4	3.65E+4	4.16E+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**	3.07E+5	4.04E+5	6.37E+5	6.14E+5	7.31E+5	3.01E+5	3.83E+5	5.90E+5	5.77E+5	6.82E+5
Species extinction	[-]	3.19E-8	3.29E-8	3.92E-8	3.84E-8	4.05E-8	2.89E-8	2.98E-8	3.54E-8	3.48E-8	3.67E-8

*An x means there are no data.

**ELU is environmental load unit.

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.^[20] The tables in Appendix H show the normalized and weighted results for each category of each method. In each of the five methods, the ICF house has a lower score 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.

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	Miami	106,000	93,200	78,200	486,000	419,000
	Phoenix	132,000	120,000	95,500	603,000	551,000
	Seattle	144,000	154,000	101,000	599,000	851,000
	DC	146,000	153,000	103,000	618,000	823,000
	Chicago	166,000	178,000	116,000	696,000	978,000
ICF house	Miami	102,000	90,400	76,300	467,000	412,000
	Phoenix	124,000	113,000	91,200	568,000	525,000
	Seattle	135,000	144,000	96,100	565,000	791,000
	DC	138,000	144,000	98,400	585,000	775,000
	Chicago	156,000	167,000	110,000	656,000	915,000

*No units: data have been normalized and weighted.

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 ICF houses in Miami and Chicago, 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 84% to 91% of the environmental load of the ICF houses. The household-use of electricity and natural gas represents 87% to 92% of the environmental load of the wood frame houses. Household-use of energy is less in milder climates (like Miami) than in more severe climates (like Chicago), 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 load in cooling-dominant climates like Miami. Household natural gas use (mostly for heating) contributes the most to the total environmental load in heating-dominant climate like Chicago. 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.

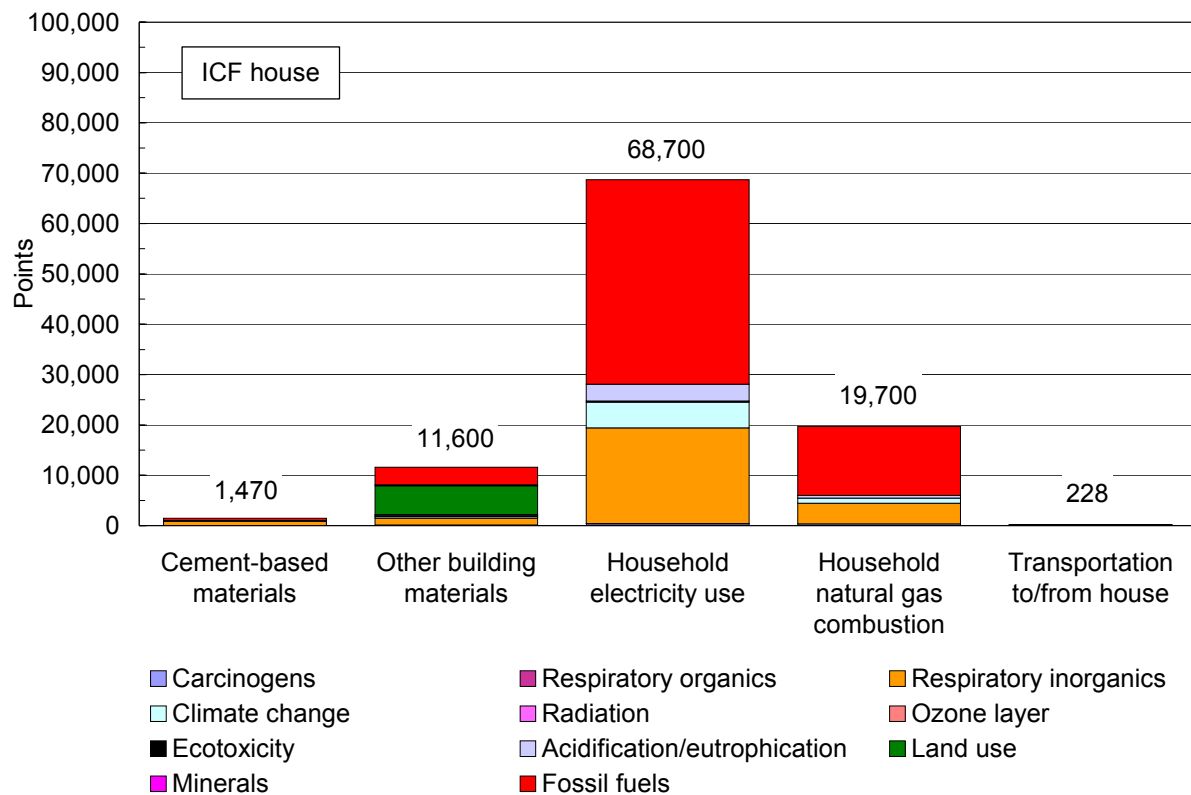


Figure 2. Single-score life cycle inventory assessment of ICF house in Miami showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

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 Chicago 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 an ICF 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: Miami, Phoenix, Seattle, Washington, and Chicago.

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,

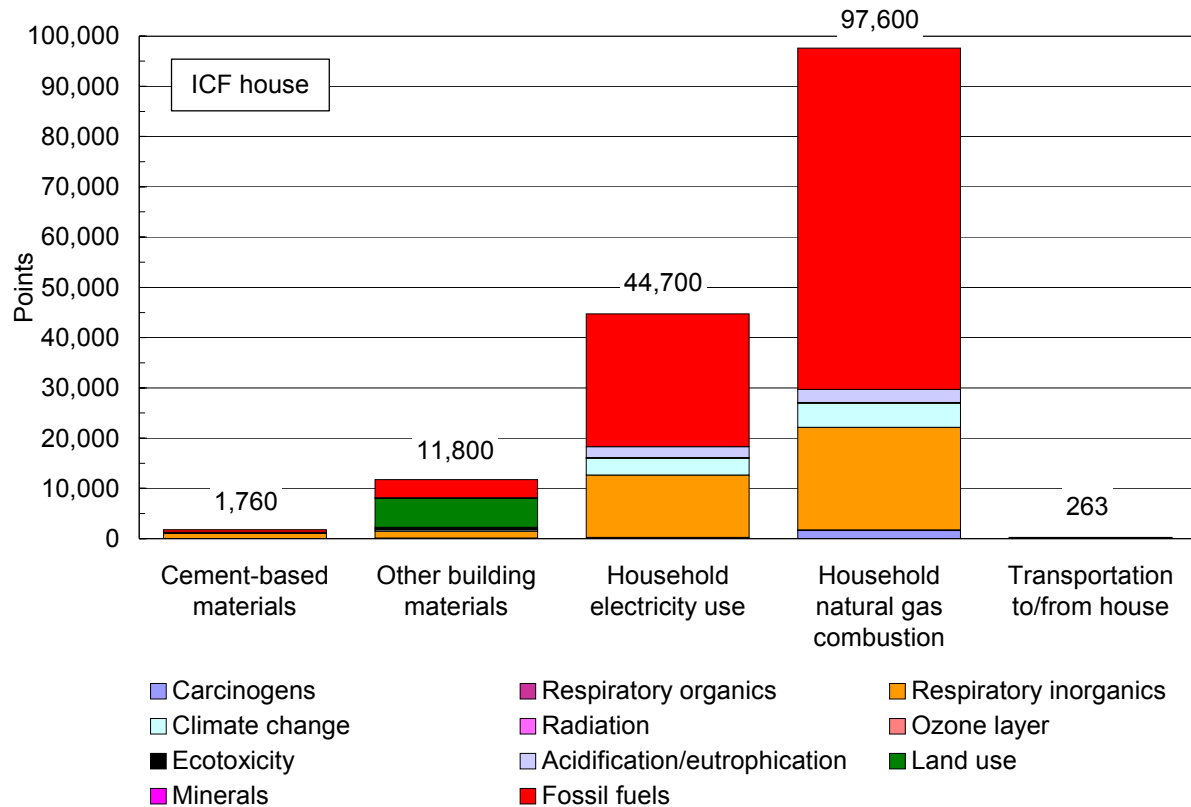


Figure 3. Single-score life cycle inventory assessment of ICF house in Chicago showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

occupancy and maintenance. The system boundary excludes human resources, infrastructure, 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 that in almost cases for all five methods, for a given climate, the impact indicators in each category are greater for the wood house than for the ICF house. Furthermore, in each of the five methods, the ICF house has a lower single score than the wood frame house in almost all impact categories. 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. 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.

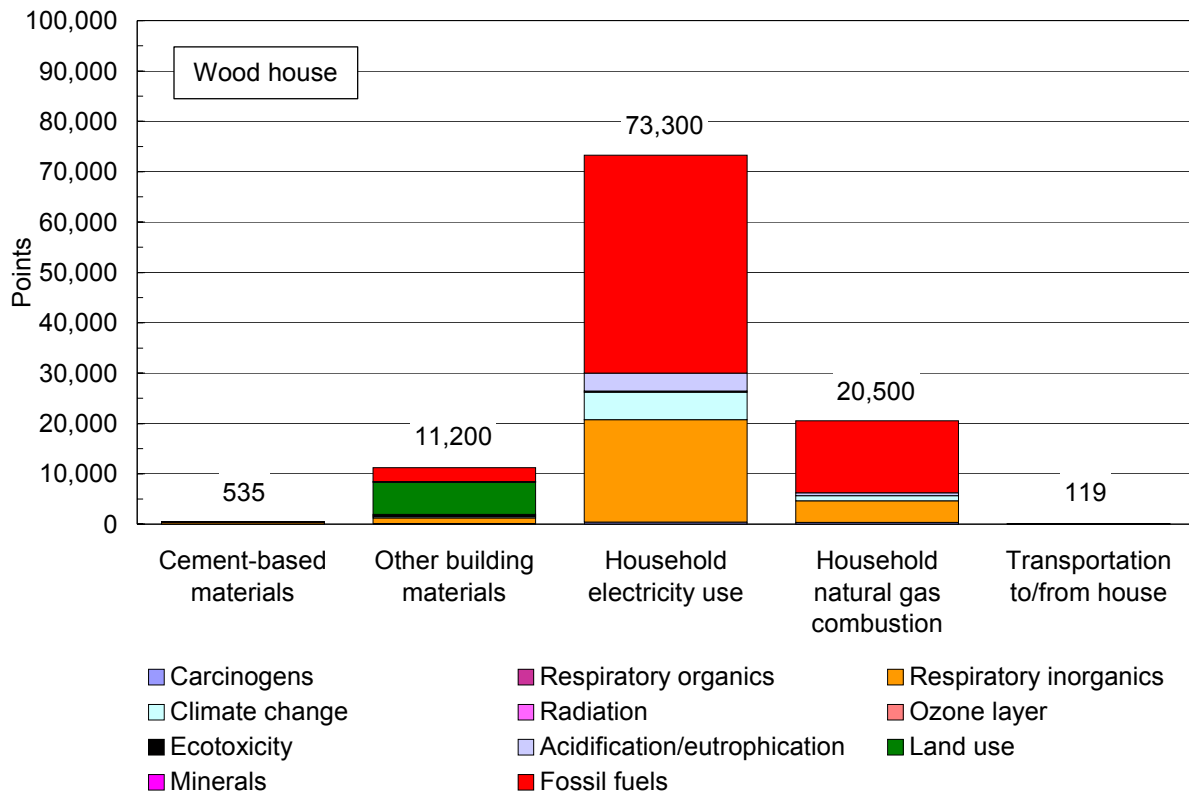


Figure 4. Single-score life cycle inventory assessment of wood frame house in Miami showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

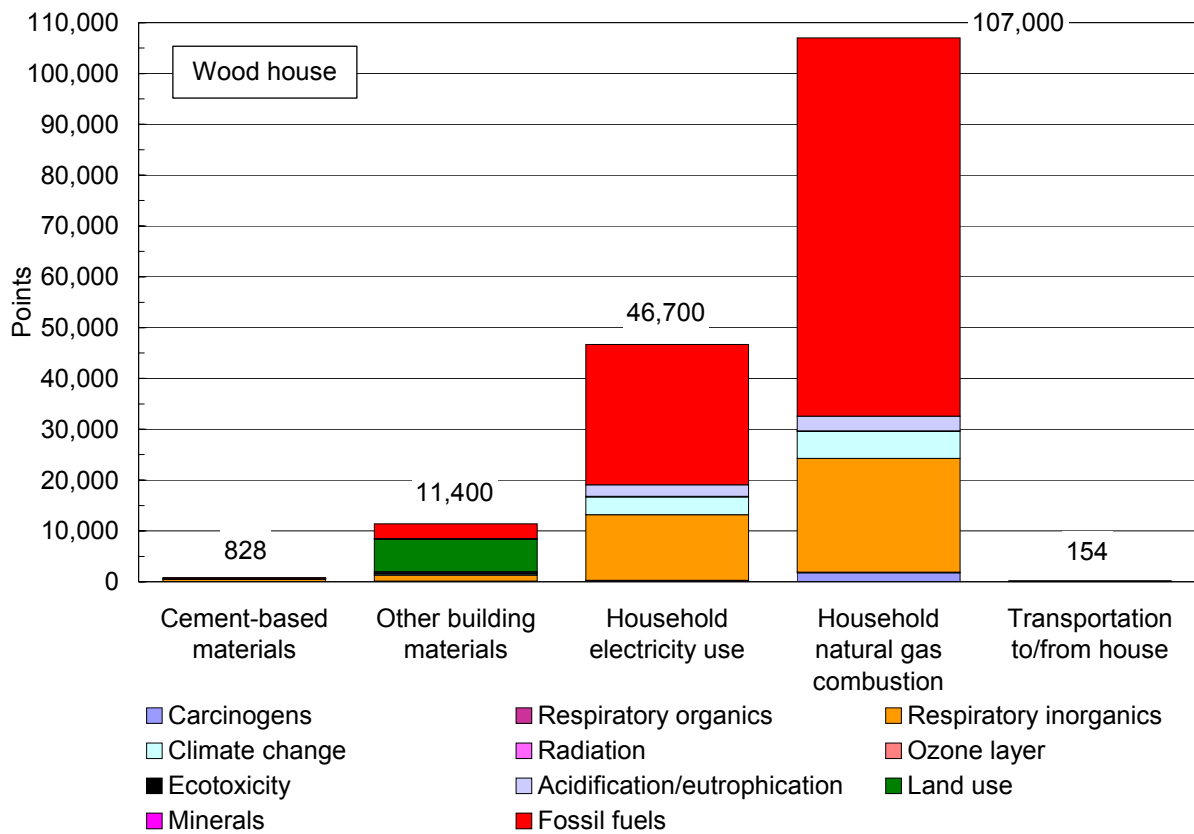


Figure 5. Single-score life cycle inventory assessment of wood frame house in Chicago showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

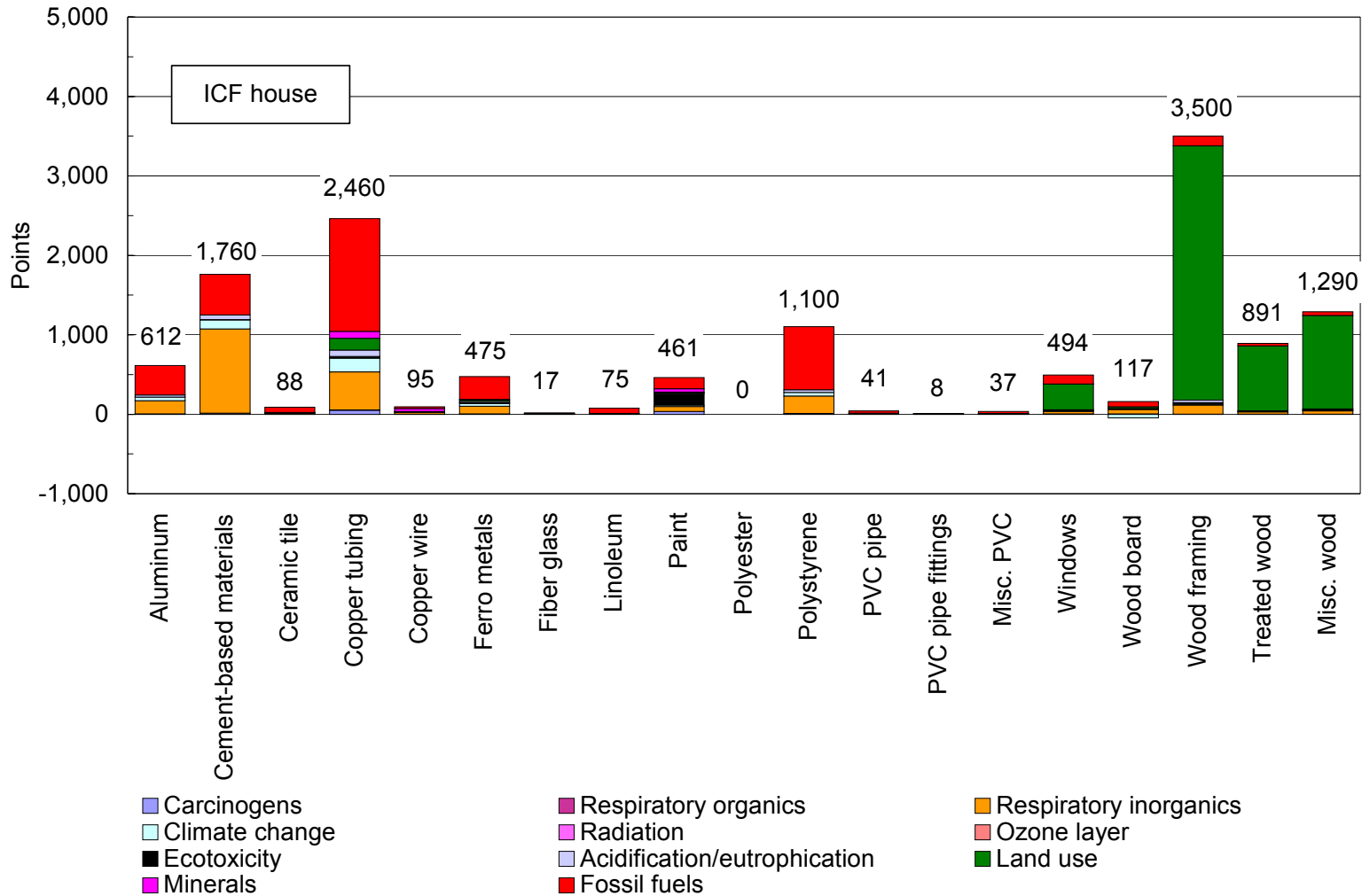


Figure 6. Single-score life cycle inventory assessment for construction materials in the ICF house in Chicago (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

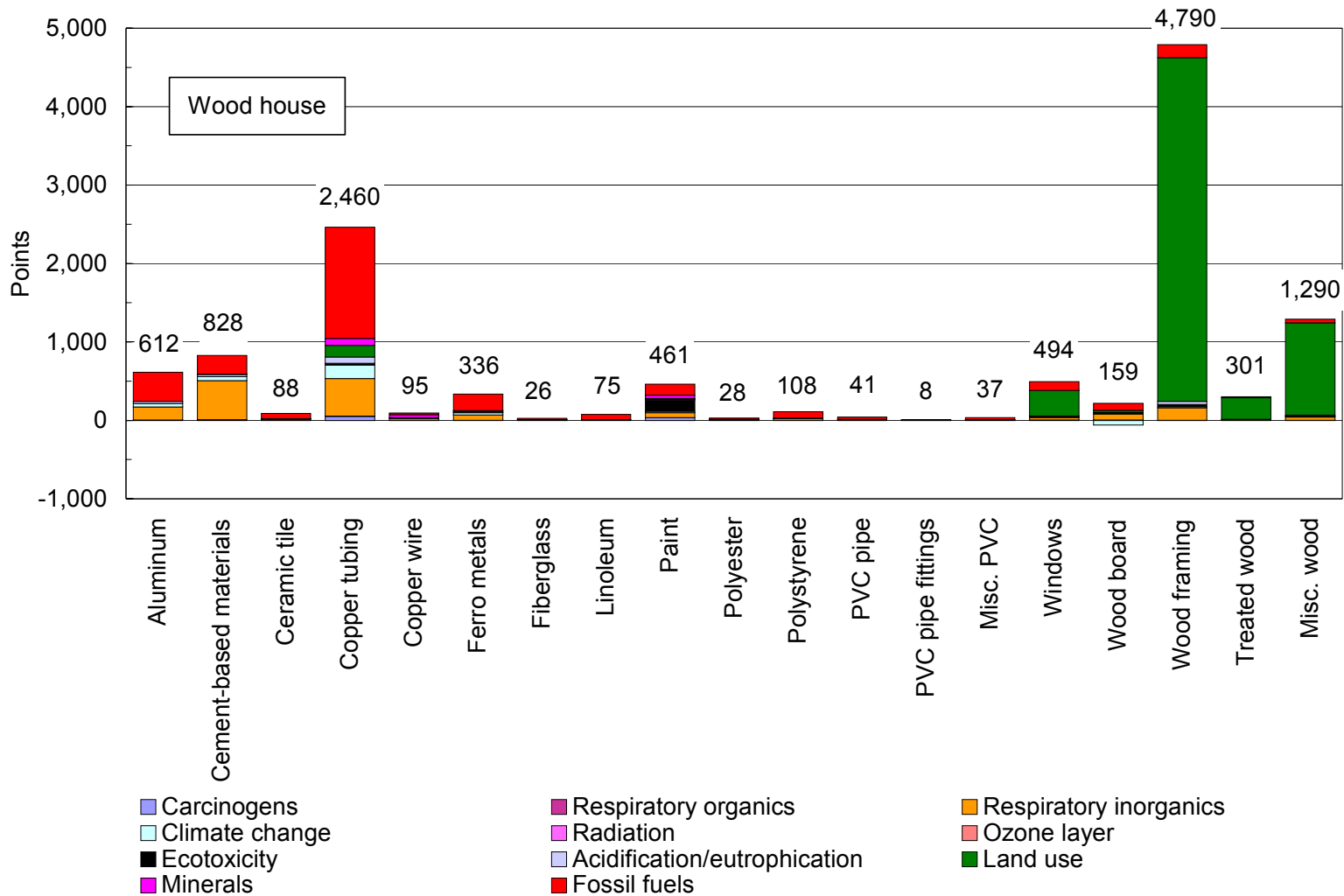


Figure 7. Single-score life cycle inventory assessment for construction materials in the wood frame house in Chicago (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

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

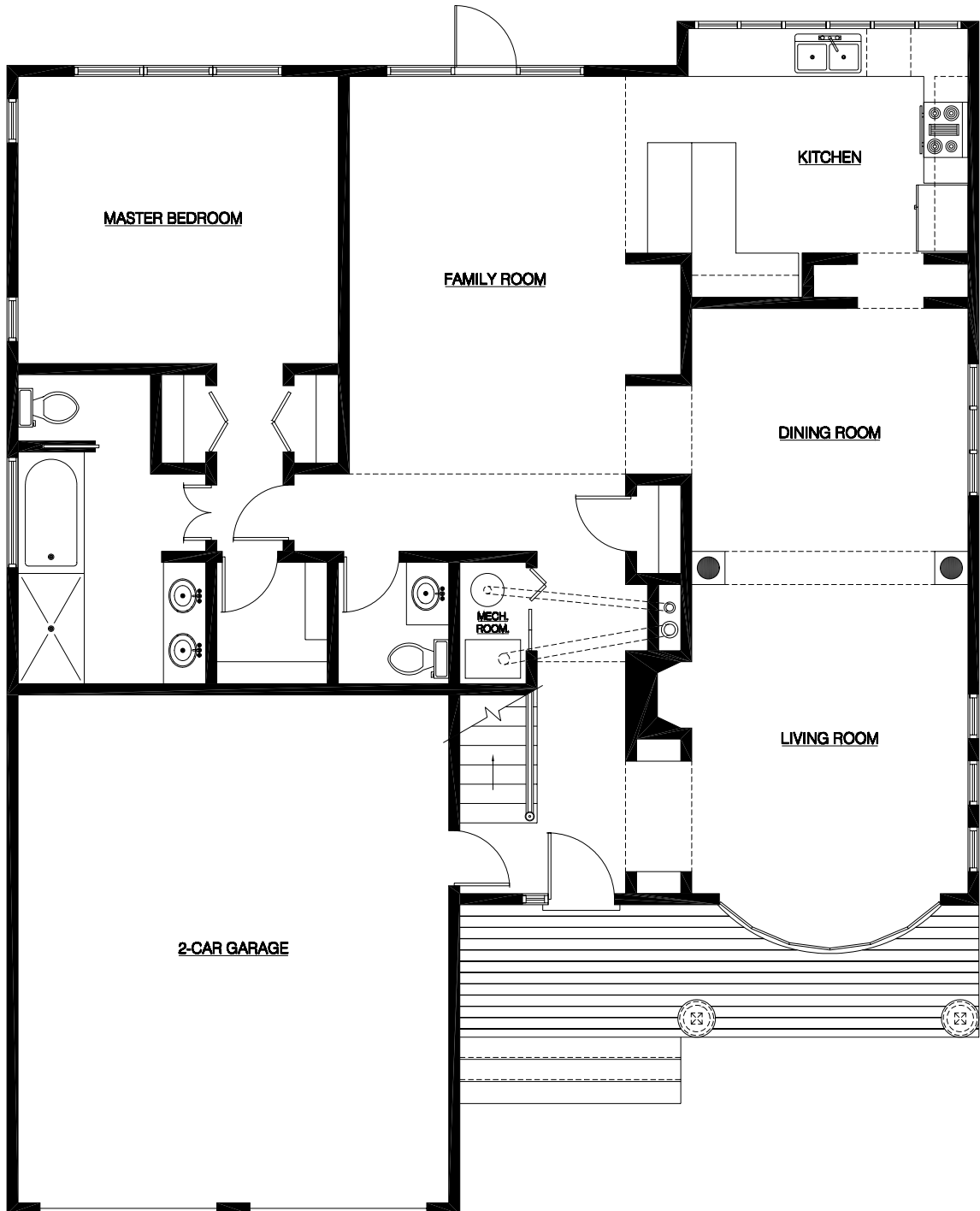


Figure B-1. Floor plan of the lower level.

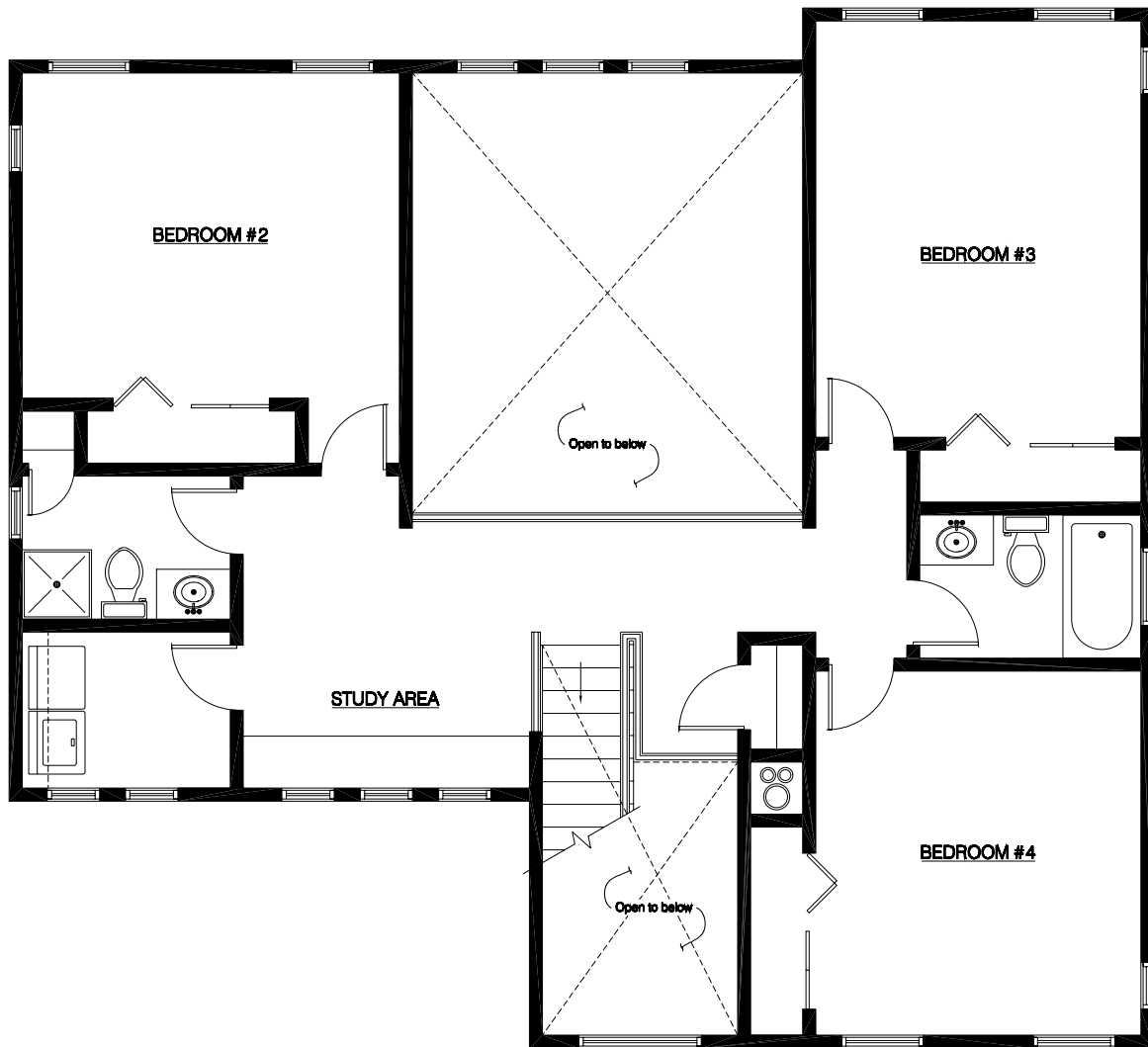


Figure B-2. Floor plan of the upper level.



Figure B-3. Front elevation.



Figure B-4. Rear elevation.

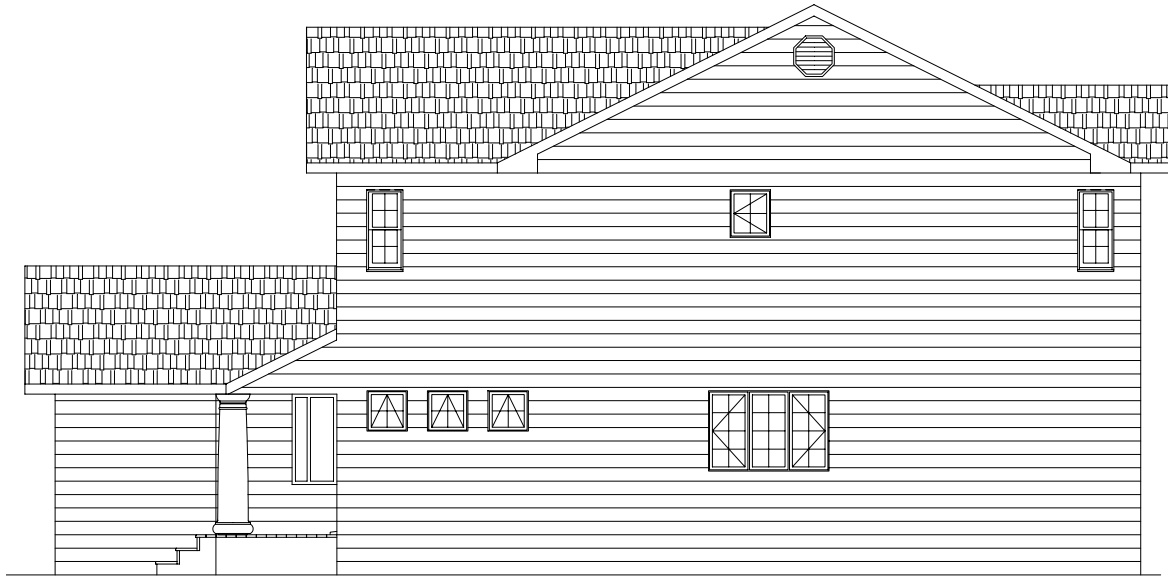


Figure B-5. Right elevation.

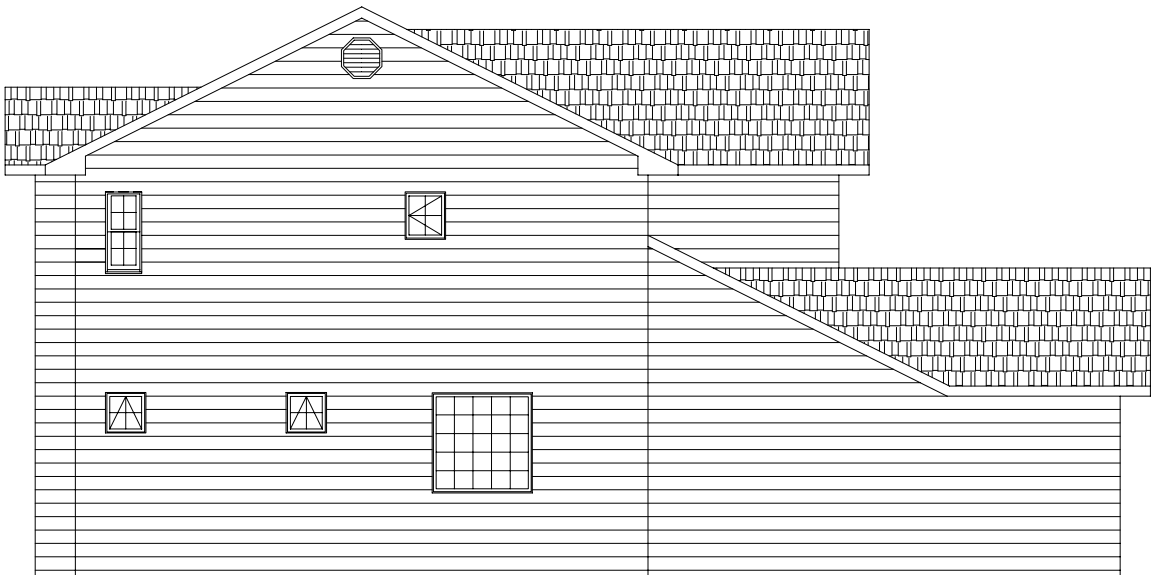


Figure B-6. Left elevation.

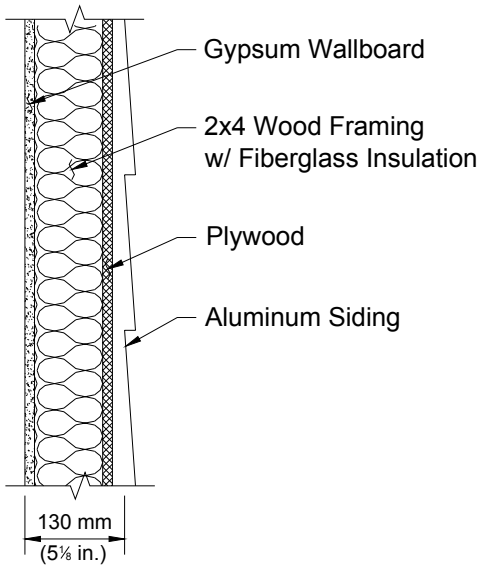


Figure B-7. Wood frame wall cross-section.

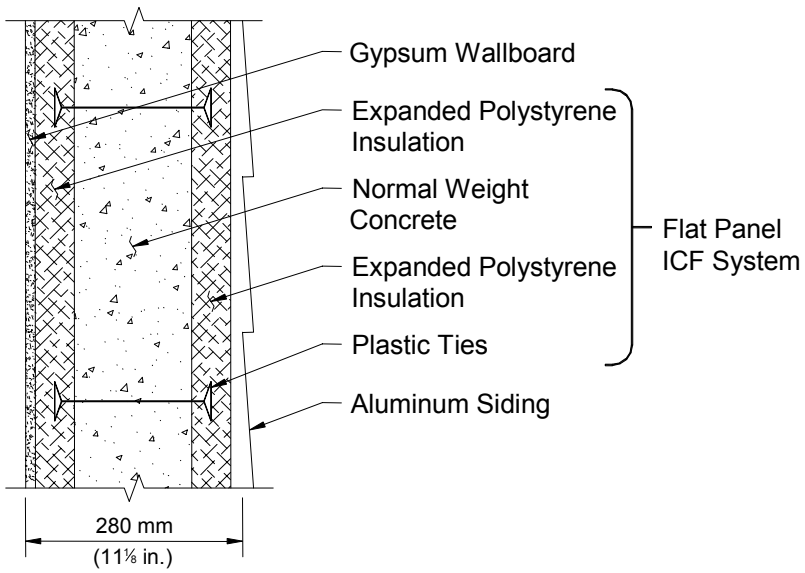


Figure B-8. ICF wall cross-section.

**APPENDIX C – LCI DATA FOR WOOD HOUSES AND ICF 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				
			Miami	Phoenix	Seattle	DC	Chicago
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	9.29	9.29	9.3
chromium (in ore)	Raw	kg	73	73	73	73	73
clay	Raw	kg	907	977	977	1.12E3	1.4E3
clay minerals	Raw	g	6.96	6.96	6.96	6.96	6.96
coal	Raw	kg	397	434	434	508	655
coal ETH	Raw	ton	6.49	6.52	6.52	6.58	6.69
coal FAL	Raw	ton	487	564	271	330	317
cobalt (in ore)	Raw	µg	541	541	541	541	542
copper (in ore)	Raw	kg	98.3	98.3	98.3	98.3	98.3
crude oil	Raw	kg	3.48	4.07	4.07	5.23	7.56
crude oil (feedstock) FAL	Raw	kg	0	29.2	29.2	87.7	205
crude oil ETH	Raw	ton	2.17	2.17	2.17	2.17	2.17
crude oil FAL	Raw	ton	21.9	25.8	17.4	19.5	20.4
crude oil IDEMAT	Raw	ton	9.46	9.47	9.47	9.48	9.51
dolomite	Raw	kg	17.2	21.7	21.7	21.7	25.1
energy (undef.)	Raw	GJ	31.8	31.8	31.8	31.9	31.9
energy from hydro power	Raw	GJ	765	875	450	535	515
energy from uranium	Raw	MJ	8.74	10.2	10.2	13.1	19
feldspar	Raw	kg	17.2	21.7	21.7	21.7	25.1
fluorspar	Raw	g	1.55	1.55	1.55	1.55	1.55
gas from oil production	Raw	m3	57.2	57.3	57.3	57.3	57.3
gravel	Raw	ton	34.8	37.4	37.4	42.8	53.5

*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				
			Miami	Phoenix	Seattle	DC	Chicago
gypsum	Raw	kg	678	731	731	837	1.05E3
iron (in ore)	Raw	kg	486	548	548	672	919
iron (ore)	Raw	ton	2.68	2.68	2.68	2.7	2.73
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	44.5	50.2	33.2	39.1	43.4
manganese (in ore)	Raw	kg	2.65	3.08	3.08	3.93	5.63
manganese (ore)	Raw	g	1.12	1.12	1.12	1.12	1.12
marl	Raw	ton	7.6	7.84	7.84	8.3	9.22
methane (kg)	Raw	kg	31.1	31.2	31.2	31.2	31.2
methane (kg) ETH	Raw	kg	14.5	14.7	14.7	15.2	16.2
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	51.5	65.2	65.2	65.2	75.2
natural gas	Raw	ton	3.72	3.73	3.73	3.74	3.75
natural gas (feedstock) FAL	Raw	kg	0	7.59	7.59	22.8	53.1
natural gas ETH	Raw	m3	1.69E3	1.69E3	1.69E3	1.69E3	1.69E3
natural gas FAL	Raw	ton	184	267	497	472	578
nickel (in ore)	Raw	g	315	315	315	315	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	67.5	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				
			Miami	Phoenix	Seattle	DC	Chicago
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	8.94	8.95	8.95
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	28.4	30.4	30.4	34.4	42.4
scrap, external	Raw	kg	849	849	849	849	849
shale	Raw	kg	721	777	777	889	1.11E3
silicon (in SiO2)	Raw	kg	1.26	1.47	1.47	1.89	2.74
silver	Raw	g	3.47	3.47	3.47	3.47	3.47
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	3.65	3.66
turbine water ETH	Raw	m3	4.6E4	4.6E4	4.6E4	4.6E4	4.61E4
uranium (in ore)	Raw	g	400	400	400	400	400
uranium (in ore) ETH	Raw	g	99.3	99.3	99.3	99.4	99.4
uranium (ore)	Raw	kg	7.04	7.04	7.04	7.04	7.04
uranium FAL	Raw	kg	1.91	2.22	1.06	1.29	1.24
water	Raw	ton	987	988	988	991	996
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	354	431	351	375	410
zeolite	Raw	g	80.8	80.9	80.9	80.9	80.9
zinc (in ore)	Raw	g	7.19	7.19	7.19	7.19	7.2
1,2-dichloroethane	Air	mg	59.6	59.6	59.6	59.7	59.7

*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				
			Miami	Phoenix	Seattle	DC	Chicago
acetaldehyde	Air	g	15.1	15.1	15.1	15.1	15.1
acetic acid	Air	g	50.7	50.7	50.7	50.7	50.8
acetone	Air	g	12.1	12.1	12.1	12.1	12.1
acrolein	Air	g	16.6	19.2	9.18	11.2	10.8
Al	Air	g	358	358	358	359	361
aldehydes	Air	kg	4.41	5.35	5.1	5.32	5.97
alkanes	Air	g	158	158	158	158	158
alkenes	Air	g	168	168	168	168	169
ammonia	Air	kg	5.15	5.84	3.24	3.77	3.67
As	Air	g	102	111	77.1	84.1	82.8
B	Air	g	79.5	79.5	79.5	79.6	79.7
Ba	Air	g	4.67	4.67	4.67	4.68	4.7
Be	Air	g	6.84	7.93	3.85	4.67	4.51
benzaldehyde	Air	µg	611	612	612	612	613
benzene	Air	g	188	191	178	181	181
benzo(a)pyrene	Air	mg	117	130	130	155	206
Br	Air	g	16.4	16.4	16.4	16.4	16.4
butane	Air	g	195	195	195	195	195
butene	Air	g	5.92	5.92	5.92	5.92	5.92
Ca	Air	g	131	131	131	132	132
Cd	Air	g	14.7	16.9	10.8	12.2	12.4
CFC-11	Air	mg	31.3	31.3	31.3	31.3	31.3
CFC-114	Air	mg	828	828	828	829	830
CFC-116	Air	g	2.44	2.44	2.44	2.44	2.44
CFC-12	Air	mg	6.72	6.73	6.73	6.73	6.73
CFC-13	Air	mg	4.22	4.22	4.22	4.22	4.22

*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				
			Miami	Phoenix	Seattle	DC	Chicago
CFC-14	Air	g	21.9	21.9	21.9	21.9	21.9
Cl2	Air	kg	0.328	0.386	0.384	0.481	0.68
CO	Air	ton	1.37	1.8	2.7	2.63	3.13
CO2	Air	ton	254	399	980	909	1.13E3
CO2 (fossil)	Air	ton	1.32E3	1.54E3	833	981	974
CO2 (non-fossil)	Air	kg	485	588	457	493	534
coal dust	Air	mg	259	259	259	259	259
cobalt	Air	g	24.3	27.8	16.4	18.8	18.7
Cr	Air	g	104	119	63	74.3	72.1
Cu	Air	g	10.4	10.5	10.5	10.7	11.1
CxHy	Air	kg	58.2	58.3	58.3	58.5	58.8
CxHy aromatic	Air	g	1.77	1.77	1.77	1.77	1.77
CxHy chloro	Air	g	4.72	5.98	5.98	5.98	6.89
cyanides	Air	mg	45	46.3	46.3	48.7	53.5
dichloroethane	Air	mg	197	197	197	197	197
dichloromethane	Air	g	70.3	81.4	39	47.5	45.7
dioxin (TEQ)	Air	µg	136	157	102	126	151
dust	Air	kg	20.6	29.7	66.5	61.9	76.1
dust (coarse)	Air	kg	21.4	21.4	21.4	21.4	21.5
dust (coarse) process	Air	kg	4	4.02	4.02	4.06	4.15
dust (PM10)	Air	kg	33.2	35.8	35.8	40.9	51.3
dust (PM10) mobile	Air	g	164	164	164	164	164
dust (PM10) stationary	Air	kg	8.71	8.71	8.71	8.72	8.72
dust (SPM)	Air	kg	5.24	5.35	5.35	5.48	5.76
ethane	Air	g	362	363	363	363	365
ethanol	Air	g	24.2	24.2	24.2	24.2	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				
			Miami	Phoenix	Seattle	DC	Chicago
ethene	Air	g	105	106	106	107	110
ethylbenzene	Air	g	64.4	64.4	64.4	64.4	64.5
ethyne	Air	g	1.53	1.55	1.55	1.59	1.68
F2	Air	g	10.4	12.2	12.2	13.3	16.5
Fe	Air	g	182	182	182	183	183
fluoranthene	Air	g	0.216	0.252	0.252	0.324	0.469
fluoride	Air	g	2.43	2.43	2.43	2.43	2.43
formaldehyde	Air	g	195	204	171	178	177
H2	Air	g	225	225	225	225	225
H2S	Air	g	81.2	88.2	88.2	102	130
HALON-1301	Air	mg	665	665	665	665	665
HCFC-21	Air	mg	638	638	638	638	639
HCFC-22	Air	mg	7.45	7.45	7.45	7.45	7.46
HCl	Air	kg	87.1	100	49.8	59.9	57.8
He	Air	g	68	68	68	68	68
heptane	Air	g	37.8	37.8	37.8	37.8	37.9
hexachlorobenzene	Air	µg	12.4	12.4	12.4	12.4	12.4
hexane	Air	g	79.8	79.8	79.8	79.8	79.9
HF	Air	kg	14.6	16.5	9.49	10.9	10.6
HFC-134a	Air	pg	-0.0303	-0.0303	-0.0303	-0.0303	-0.0302
Hg	Air	g	32.8	37.8	18.9	22.7	22
I	Air	g	6.06	6.06	6.06	6.07	6.07
K	Air	g	54.8	54.8	54.8	54.9	55.2
kerosene	Air	g	422	489	233	285	274
La	Air	mg	136	136	136	136	137
metals	Air	g	276	317	263	278	294

*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				
			Miami	Phoenix	Seattle	DC	Chicago
methane	Air	ton	3.56	4.46	4.59	4.71	5.34
methanol	Air	g	24.9	24.9	24.9	24.9	24.9
Mg	Air	g	118	118	118	118	118
Mn	Air	g	199	229	117	140	135
Mo	Air	mg	986	986	986	987	987
MTBE	Air	mg	83.8	83.8	83.8	83.8	83.8
n-nitrodimethylamine	Air	g	3.5	4.05	1.94	2.36	2.27
N2	Air	g	405	405	405	405	405
N2O	Air	kg	24.8	29	33.5	33.4	37.2
Na	Air	g	66.7	66.7	66.7	66.8	66.9
naphthalene	Air	g	7.27	7.45	7.06	7.15	7.19
Ni	Air	g	249	286	178	201	202
NO2	Air	kg	1.5	1.58	1.58	1.75	2.08
non methane VOC	Air	ton	1.88	2.65	4.67	4.46	5.43
NOx	Air	ton	5.27	6.26	4.46	4.9	5.18
NOx (as NO2)	Air	kg	26.4	26.4	26.4	26.5	26.5
organic substances	Air	kg	15	17.1	18.4	19.1	21.9
P	Air	g	2.95	2.95	2.95	2.95	2.95
P-tot	Air	g	1.41	1.41	1.41	1.42	1.43
PAH's	Air	g	3.42	3.42	3.42	3.42	3.42
particulates (PM10)	Air	kg	251	290	138	169	162
particulates (unspecified)	Air	kg	1.28E3	1.48E3	750	898	871
Pb	Air	g	526	536	507	514	517
pentachlorobenzene	Air	µg	33.3	33.3	33.3	33.3	33.3
pentachlorophenol	Air	µg	5.37	5.37	5.37	5.37	5.38
pentane	Air	g	364	364	364	364	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				
			Miami	Phoenix	Seattle	DC	Chicago
phenol	Air	g	49.1	57.6	34	38.9	39.5
phosphate	Air	g	1.18	1.18	1.18	1.18	1.18
propane	Air	g	254	254	254	254	255
propene	Air	g	14.5	14.5	14.5	14.6	14.8
propionic acid	Air	mg	314	316	316	317	320
Pt	Air	µg	675	675	675	675	676
Sb	Air	g	7.61	8.86	4.84	5.68	5.64
Sc	Air	mg	54.7	54.8	54.8	54.9	55.2
Se	Air	g	120	139	68.1	82.3	79.4
silicates	Air	g	697	697	697	698	701
Sn	Air	mg	117	117	117	117	117
SO2	Air	kg	375	377	380	383	391
soot	Air	kg	1.97	1.97	1.97	1.98	2
SOx	Air	ton	13.5	17.4	20.8	20.9	24.3
SOx (as SO2)	Air	kg	44.7	44.7	44.7	44.8	44.8
Sr	Air	g	5.55	5.56	5.56	5.56	5.58
tetrachloroethene	Air	g	15.8	18.3	8.76	10.7	10.3
tetrachloromethane	Air	g	25.9	30	14.9	18	17.5
Th	Air	mg	258	258	258	258	259
Ti	Air	g	16.5	16.5	16.5	16.5	16.6
Tl	Air	mg	21.5	21.5	21.5	21.6	21.6
toluene	Air	g	222	222	222	222	223
trichloroethene	Air	g	15.7	18.1	8.67	10.6	10.2
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				
			Miami	Phoenix	Seattle	DC	Chicago
vinyl chloride	Air	mg	66.1	66.1	66.1	66.1	66.2
VOC	Air	kg	10.7	17.3	44	40.8	51.4
water	Air	ton	20.2	20.2	20.2	20.2	20.2
xylene	Air	g	143	144	144	144	144
Zn	Air	g	224	225	225	226	228
Zr	Air	mg	13.3	14	14	15.3	18
1,1,1-trichloroethane	Water	µg	162	162	162	162	162
acenaphthylene	Water	mg	857	857	857	857	857
Acid as H+	Water	g	114	114	114	114	114
acids (unspecified)	Water	g	3.54	4.81	4.81	7.35	12.4
Ag	Water	mg	71.1	71.2	71.2	71.2	71.2
Al	Water	kg	10.5	10.6	10.6	10.7	10.9
alkanes	Water	g	14.4	14.4	14.4	14.4	14.4
alkenes	Water	g	1.31	1.31	1.31	1.31	1.31
AOX	Water	mg	394	394	394	394	394
As	Water	g	21.3	21.4	21.4	21.6	22
B	Water	kg	44.6	51.7	25	30.3	29.2
Ba	Water	kg	1.1	1.11	1.11	1.11	1.13
baryte	Water	kg	2.47	2.48	2.48	2.48	2.48
Be	Water	mg	8.84	8.84	8.84	8.85	8.85
benzene	Water	g	14.6	14.6	14.6	14.6	14.6
BOD	Water	kg	11.1	15.1	25.4	24.4	29.4
calcium compounds	Water	kg	8.36	8.36	8.36	8.37	8.38
calcium ions	Water	kg	237	237	237	237	237
Cd	Water	kg	0.446	0.645	1.2	1.14	1.4
chlorinated solvents (unspec.)	Water	mg	7.29	7.3	7.3	7.33	7.38

*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				
			Miami	Phoenix	Seattle	DC	Chicago
chlorobenzenes	Water	µg	4.06	4.06	4.06	4.06	4.06
chromate	Water	g	11.3	13.2	7.69	8.88	9
Cl-	Water	kg	1E3	1.2E3	1.76E3	1.7E3	1.95E3
Co	Water	g	20.7	20.8	20.8	21	21.3
COD	Water	kg	113	146	200	196	230
Cr	Water	kg	0.554	0.753	1.31	1.25	1.51
Cr (VI)	Water	mg	24.8	24.8	24.8	24.8	24.8
crude oil	Water	g	278	278	278	278	279
Cs	Water	mg	109	109	109	109	109
Cu	Water	g	54	54.3	54.3	54.8	55.7
CxHy	Water	kg	1.63	1.63	1.63	1.63	1.63
CxHy aromatic	Water	g	67.5	67.5	67.5	67.5	67.6
CxHy chloro	Water	mg	24.6	24.6	24.6	24.6	24.7
cyanide	Water	g	5.72	6.06	6.89	6.87	7.39
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	86.7
dichloroethane	Water	mg	131	131	131	131	131
dichloromethane	Water	mg	663	663	663	663	664
dimethyl p-phthalate	Water	µg	546	546	546	547	547
dissolved organics	Water	kg	1.27	1.27	1.27	1.27	1.27
dissolved solids	Water	ton	9.74	14.1	26.1	24.8	30.4
dissolved substances	Water	kg	4.45	4.47	4.47	4.51	4.58
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	6.74	8.53	8.53	8.53	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				
			Miami	Phoenix	Seattle	DC	Chicago
fats/oils	Water	kg	1.09	1.09	1.09	1.09	1.09
fatty acids as C	Water	g	255	255	255	255	256
Fe	Water	kg	71.7	82.1	42.3	50.4	48.7
fluoride ions	Water	kg	8.55	8.81	7.8	8	7.96
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	262	263	263
H2S	Water	g	0.706	0.74	0.74	0.807	0.942
H2SO4	Water	kg	11.2	12.9	6.24	7.58	7.31
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	93.3	109	153	149	171
HOCL	Water	g	69.6	69.6	69.6	69.7	69.7
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	3.79	3.82	3.88
Kjeldahl-N	Water	g	108	127	127	163	235
metallic ions	Water	kg	1.02	1.1	0.929	0.973	0.995
Mg	Water	kg	8.91	8.95	8.95	9.02	9.17
Mn	Water	kg	38.4	44.4	21.5	26.1	25.1
Mo	Water	g	34.2	34.4	34.4	34.6	35.1
MTBE	Water	mg	9.77	9.77	9.77	9.77	9.77
N-tot	Water	g	266	266	266	266	267
N organically bound	Water	g	10.9	10.9	10.9	10.9	10.9
Na	Water	kg	135	135	135	135	135
NH3	Water	g	852	975	545	633	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				
			Miami	Phoenix	Seattle	DC	Chicago
NH3 (as N)	Water	g	408	408	408	409	410
NH4+	Water	g	3.09	3.09	3.09	3.09	3.09
Ni	Water	g	54	54.3	54.3	54.7	55.7
nitrate	Water	g	462	488	392	411	408
nitrite	Water	g	3.93	3.93	3.93	3.93	3.94
nitrogen	Water	g	7.54	7.54	7.54	7.54	7.54
non methane VOC	Water	g	0	2.99	2.99	8.97	20.9
OCI-	Water	g	15.9	15.9	15.9	15.9	15.9
oil	Water	kg	175	252	466	443	542
other organics	Water	kg	36.5	50.4	80.1	77.4	93.2
P-compounds	Water	mg	46.5	46.9	46.9	47.7	49.4
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	2.59	2.6	2.6
Pb	Water	g	63.9	64.2	64.2	64.6	65.6
pesticides	Water	ng	751	751	751	751	751
phenol	Water	g	14.7	15	14.4	14.6	14.6
phenols	Water	g	7	7	7	7	7.01
phosphate	Water	kg	11.7	12.5	9.2	9.88	9.75
Ru	Water	mg	497	498	498	498	498
S	Water	g	1.82	1.82	1.82	1.82	1.83
salt	Water	g	389	389	389	390	390
salts	Water	kg	4.99	5	5	5.02	5.06
Sb	Water	mg	158	158	158	158	158
Se	Water	g	52.8	53.1	53.1	53.5	54.5
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				
			Miami	Phoenix	Seattle	DC	Chicago
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	781	782	784
sulphate	Water	kg	589	778	1.09E3	1.07E3	1.26E3
sulphates	Water	kg	64.6	64.6	64.6	64.7	64.7
sulphide	Water	g	1.63	2.23	2.23	3.42	5.81
suspended solids	Water	kg	855	991	515	613	600
suspended substances	Water	kg	4.63	4.64	4.64	4.64	4.64
tetrachloroethene	Water	µg	267	267	267	267	267
tetrachloromethane	Water	µg	407	407	407	407	407
Ti	Water	g	622	625	625	630	641
TOC	Water	kg	2.56	2.56	2.56	2.56	2.57
toluene	Water	g	12.7	12.7	12.7	12.7	12.7
tributyltin	Water	mg	398	398	398	398	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	56.5	57.4
vinyl chloride	Water	µg	75.7	75.7	75.7	75.7	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	265	334	525	505	595
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				
			Miami	Phoenix	Seattle	DC	Chicago
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	140	180	260
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	4.64
mineral waste	Solid	kg	56.4	56.4	56.4	56.4	56.4
oil	Solid	kg	15.5	15.6	15.6	15.8	16
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	9.5	9.51	9.51
slags/ash	Solid	kg	1.87	1.87	1.87	1.87	1.87
solid waste	Solid	ton	242	284	176	200	204
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	1.44	1.44	1.45
Co (ind.)	Soil	mg	1.34	1.34	1.34	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	6.72

*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				
			Miami	Phoenix	Seattle	DC	Chicago
Fe (ind.)	Soil	g	175	175	175	175	175
Hg (ind.)	Soil	µg	218	220	220	224	231
Mn (ind.)	Soil	g	3.49	3.49	3.49	3.49	3.49
N	Soil	mg	86.4	88.3	88.3	92.2	100
Ni (ind.)	Soil	mg	10.1	10.1	10.1	10.1	10.1
oil (ind.)	Soil	g	309	309	309	309	309
oil biodegradable	Soil	g	167	167	167	167	167
P-tot	Soil	g	4.61	4.62	4.62	4.64	4.68
Pb (ind.)	Soil	mg	30.7	30.7	30.7	30.7	30.7
S (ind.)	Soil	g	52.4	52.4	52.4	52.4	52.4
Zn (ind.)	Soil	g	1.37	1.37	1.37	1.37	1.38
Ag110m to air	Non mat.	mBq	39.8	39.8	39.8	39.8	39.8
Ag110m to water	Non mat.	Bq	272	272	272	272	272
alpha radiation (unspecified) to water	Non mat.	mBq	32	32	32	32	32.1
Am241 to air	Non mat.	mBq	765	765	765	766	766
Am241 to water	Non mat.	Bq	101	101	101	101	101
Ar41 to air	Non mat.	kBq	86.2	86.2	86.2	86.2	86.3
Ba140 to air	Non mat.	mBq	181	181	181	181	182
Ba140 to water	Non mat.	mBq	932	932	932	933	933
beta radiation (unspecified) to air	Non mat.	mBq	8.41	8.41	8.41	8.42	8.42
C14 to air	Non mat.	kBq	62.6	62.6	62.6	62.6	62.7
C14 to water	Non mat.	kBq	5.08	5.08	5.08	5.09	5.09
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	3.72	3.73
Ce141 to water	Non mat.	mBq	140	140	140	140	140
Ce144 to air	Non mat.	Bq	8.14	8.14	8.14	8.14	8.15

*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				
			Miami	Phoenix	Seattle	DC	Chicago
Ce144 to water	Non mat.	kBq	2.3	2.3	2.3	2.31	2.31
Cm (alpha) to air	Non mat.	Bq	1.21	1.21	1.21	1.21	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	3.89	3.9
Cm244 to air	Non mat.	µBq	35.3	35.3	35.3	35.4	35.4
Co57 to air	Non mat.	µBq	67.8	67.8	67.8	67.9	67.9
Co57 to water	Non mat.	mBq	960	960	960	960	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	586
Co60 to air	Non mat.	Bq	1.71	1.71	1.71	1.71	1.71
Co60 to water	Non mat.	kBq	22.5	22.5	22.5	22.6	22.6
Conv. to continuous urban land	Non mat.	m2	1.72	1.73	1.73	1.75	1.79
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	29.1
Cs134 to water	Non mat.	kBq	5.14	5.14	5.14	5.15	5.15
Cs136 to water	Non mat.	mBq	5.02	5.02	5.02	5.02	5.02
Cs137 to air	Non mat.	Bq	56	56.1	56.1	56.1	56.1
Cs137 to water	Non mat.	kBq	47.5	47.5	47.5	47.5	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	16.5
Fission and activation products (RA) to water	Non mat.	Bq	291	291	291	291	291
H3 to air	Non mat.	kBq	620	620	620	621	621
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	219	222	230

*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				
			Miami	Phoenix	Seattle	DC	Chicago
heat losses to soil	Non mat.	MJ	91.9	92	92	92	92.1
heat losses to water	Non mat.	GJ	-12.3	-12.3	-12.3	-12.2	-12.2
I129 to air	Non mat.	Bq	218	218	218	219	219
I129 to water	Non mat.	kBq	14.5	14.5	14.5	14.5	14.6
I131 to air	Non mat.	Bq	31.3	31.3	31.3	31.3	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	4.28
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	143
K40 to water	Non mat.	Bq	387	387	387	387	388
Kr85 to air	Non mat.	kBq	3.76E6	3.76E6	3.76E6	3.76E6	3.77E6
Kr85m to air	Non mat.	kBq	6.79	6.79	6.79	6.79	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	172	173
Kr89 to air	Non mat.	kBq	2.14	2.14	2.14	2.14	2.14
La140 to air	Non mat.	mBq	102	102	102	102	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	390	391	391
land use II-IV	Non mat.	m2a	215	215	215	215	215
land use III-IV	Non mat.	m2a	24.6	24.6	24.6	24.7	24.7
land use IV-IV	Non mat.	m2a	0.243	0.243	0.243	0.243	0.243
Mn54 to air	Non mat.	mBq	40.6	40.6	40.6	40.6	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				
			Miami	Phoenix	Seattle	DC	Chicago
Mo99 to water	Non mat.	mBq	65.4	65.4	65.4	65.4	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	7.23	7.24
Nb95 to water	Non mat.	mBq	531	531	531	531	531
Np237 to air	Non mat.	μBq	40	40	40	40.1	40.1
Np237 to water	Non mat.	Bq	6.44	6.44	6.44	6.44	6.45
Occup. as contin. urban land	Non mat.	m2a	13.9	14.8	14.8	16.4	19.6
Occup. as convent. arable land	Non mat.	m2a	1.26E3	1.26E3	1.26E3	1.27E3	1.27E3
Occup. as forest land	Non mat.	cm2a	476	476	476	476	477
Occup. as industrial area	Non mat.	m2a	924	930	930	938	955
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	24.2	24.3	24.3
Pa234m to water	Non mat.	Bq	449	449	449	449	450
Pb210 to air	Non mat.	Bq	775	775	775	775	776
Pb210 to water	Non mat.	Bq	308	308	308	308	308
Pm147 to air	Non mat.	Bq	20.6	20.6	20.6	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	308
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	400	401	401
Pu238 to air	Non mat.	μBq	87.7	87.7	87.7	87.7	87.8
Pu241 beta	Non mat.	kBq	9.95	9.95	9.95	9.95	9.96
Pu241 Beta to air	Non mat.	Bq	66.8	66.8	66.8	66.8	66.9
Ra224 to water	Non mat.	kBq	2.47	2.47	2.47	2.47	2.48
Ra226 to air	Non mat.	Bq	890	891	891	891	892
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				
			Miami	Phoenix	Seattle	DC	Chicago
Ra228 to air	Non mat.	Bq	70.4	70.4	70.4	70.4	70.5
Ra228 to water	Non mat.	kBq	4.94	4.94	4.94	4.94	4.94
radio active noble gases to air	Non mat.	kBq	9.87	9.88	9.88	9.88	9.88
radioactive substance to air	Non mat.	kBq	5.81E7	6.17E7	4.77E7	5.06E7	5E7
radioactive substance to water	Non mat.	kBq	3.2E5	3.2E5	3.2E5	3.2E5	3.2E5
radionuclides (mixed) to water	Non mat.	mBq	227	227	227	227	227
Rn220 to air	Non mat.	kBq	5.82	5.82	5.82	5.82	5.83
Rn222 (long term) to air	Non mat.	kBq	5.4E6	5.4E6	5.4E6	5.4E6	5.41E6
Rn222 to air	Non mat.	kBq	5.86E4	5.86E4	5.86E4	5.86E4	5.86E4
Ru103 to air	Non mat.	µBq	441	441	441	441	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	932	933	933
Sb124 to air	Non mat.	mBq	11	11	11	11.1	11.1
Sb124 to water	Non mat.	Bq	76.1	76.2	76.2	76.2	76.2
Sb125 to air	Non mat.	mBq	2	2	2	2	2
Sb125 to water	Non mat.	Bq	7.62	7.62	7.62	7.63	7.63
Sr89 to air	Non mat.	mBq	71.1	71.1	71.1	71.1	71.2
Sr89 to water	Non mat.	Bq	2.11	2.11	2.11	2.11	2.11
Sr90 to air	Non mat.	Bq	40	40	40	40.1	40.1
Sr90 to water	Non mat.	kBq	4.85	4.85	4.85	4.86	4.86
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				
			Miami	Phoenix	Seattle	DC	Chicago
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	59.6	59.6	59.7
Th228 to water	Non mat.	kBq	9.9	9.9	9.9	9.9	9.9
Th230 to air	Non mat.	Bq	270	270	270	270	271
Th230 to water	Non mat.	kBq	70.2	70.2	70.2	70.2	70.3
Th232 to air	Non mat.	Bq	37.8	37.8	37.8	37.9	37.9
Th232 to water	Non mat.	Bq	72.1	72.1	72.1	72.1	72.2
Th234 to air	Non mat.	Bq	24.2	24.2	24.2	24.3	24.3
Th234 to water	Non mat.	Bq	453	453	453	453	454
U alpha to air	Non mat.	Bq	868	868	868	869	870
U alpha to water	Non mat.	kBq	29.3	29.3	29.3	29.4	29.4
U234 to air	Non mat.	Bq	291	291	291	291	291
U234 to water	Non mat.	Bq	600	600	600	600	601
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	896	897
U238 to air	Non mat.	Bq	395	395	395	395	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	-4.16E4	-4.14E4	-4.11E4
waste heat to soil	Non mat.	MJ	376	376	376	376	376
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	2.68E3	2.68E3	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	496	497	497
Xe135m to air	Non mat.	kBq	67.3	67.3	67.3	67.3	67.3

*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				
			Miami	Phoenix	Seattle	DC	Chicago
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	60.9
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 ICF Houses – SI Units*

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
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	9.11	9.11	9.11	9.12	9.13
chromium (in ore)	Raw	kg	73	73	73	73	73
clay	Raw	kg	2.47E3	2.54E3	2.54E3	2.68E3	2.96E3
clay minerals	Raw	g	6.96	6.96	6.96	6.96	6.96
coal	Raw	kg	1.2E3	1.24E3	1.24E3	1.31E3	1.46E3
coal ETH	Raw	ton	6.99	7.02	7.02	7.08	7.19
coal FAL	Raw	ton	460	528	268	318	308
cobalt (in ore)	Raw	µg	485	485	485	485	486
copper (in ore)	Raw	kg	98.1	98.1	98.1	98.1	98.1
crude oil	Raw	kg	16.2	16.8	16.8	18	20.3
crude oil (feedstock) FAL	Raw	kg	1.88E3	1.91E3	1.91E3	1.97E3	2.08E3
crude oil ETH	Raw	ton	2.09	2.09	2.09	2.09	2.09
crude oil FAL	Raw	ton	22	25.4	18	19.8	20.7
crude oil IDEMAT	Raw	ton	9.29	9.31	9.31	9.32	9.35
dolomite	Raw	kg	8.46	13	13	13	16.4
energy (undef.)	Raw	GJ	31.5	31.5	31.5	31.5	31.6
energy from hydro power	Raw	GJ	724	820	444	517	499
energy from uranium	Raw	MJ	40.7	42.2	42.2	45.1	50.9
feldspar	Raw	kg	8.46	13	13	13	16.4
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	94.5	97.1	97.1	102	113

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
gypsum	Raw	kg	1.86E3	1.91E3	1.91E3	2.02E3	2.23E3
iron (in ore)	Raw	kg	1.83E3	1.9E3	1.9E3	2.02E3	2.27E3
iron (ore)	Raw	ton	2.85	2.86	2.86	2.87	2.9
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	1.33	1.33	1.33	1.34	1.34
limestone	Raw	ton	70.7	75.8	60.8	66.3	70.6
manganese (in ore)	Raw	kg	12	12.4	12.4	13.2	14.9
manganese (ore)	Raw	g	x	x	x	x	x
marl	Raw	ton	12.8	13	13	13.5	14.4
methane (kg)	Raw	kg	31.2	31.2	31.2	31.2	31.2
methane (kg) ETH	Raw	kg	19.2	19.5	19.5	19.9	20.9
molybdene (in ore)	Raw	mg	1.04	1.04	1.04	1.04	1.04
NaCl	Raw	kg	605	605	605	605	605
NaOH	Raw	kg	25.4	39.1	39.1	39.1	49.1
natural gas	Raw	ton	3.66	3.68	3.68	3.68	3.7
natural gas (feedstock) FAL	Raw	kg	488	496	496	511	541
natural gas ETH	Raw	m3	1.61E3	1.62E3	1.62E3	1.62E3	1.62E3
natural gas FAL	Raw	ton	178	248	453	437	532
nickel (in ore)	Raw	g	307	307	307	307	308
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	62	62	62.1	62.1
phosphate (ore)	Raw	mg	x	x	x	x	x

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
platinum (in ore)	Raw	mg	1.83	1.83	1.83	1.83	1.83
potential energy water ETH	Raw	GJ	8.18	8.18	8.18	8.18	8.19
reservoir content ETH	Raw	m3y	175	175	175	175	175
rhenium (in ore)	Raw	mg	1.55	1.55	1.55	1.55	1.55
rhodium (in ore)	Raw	mg	1.72	1.72	1.72	1.72	1.72
rock salt	Raw	kg	659	659	659	659	659
sand	Raw	ton	72.6	74.6	74.6	78.6	86.5
scrap, external	Raw	kg	853	853	853	853	853
shale	Raw	kg	1.98E3	2.03E3	2.03E3	2.14E3	2.37E3
silicon (in SiO2)	Raw	kg	5.87	6.08	6.08	6.5	7.35
silver	Raw	g	3.47	3.47	3.47	3.47	3.48
silver (in ore)	Raw	g	2.85	2.85	2.85	2.85	2.85
sulphur	Raw	kg	11.6	11.6	11.6	11.6	11.6
tin (in ore)	Raw	g	3.51	3.51	3.51	3.51	3.52
turbine water ETH	Raw	m3	4.22E4	4.22E4	4.22E4	4.22E4	4.23E4
uranium (in ore)	Raw	g	400	400	400	400	400
uranium (in ore) ETH	Raw	g	90.2	90.2	90.2	90.2	90.3
uranium (ore)	Raw	kg	7.03	7.03	7.03	7.03	7.03
uranium FAL	Raw	kg	1.8	2.07	1.04	1.24	1.2
water	Raw	ton	993	995	995	998	1E3
wood	Raw	ton	20.4	20.4	20.4	20.4	20.4
wood (dry matter) ETH	Raw	ton	9.36	9.36	9.36	9.36	9.36
wood/wood wastes FAL	Raw	kg	336	403	332	355	386
zeolite	Raw	g	80.9	80.9	80.9	80.9	80.9
zinc (in ore)	Raw	g	6.66	6.67	6.67	6.67	6.68
1,2-dichloroethane	Air	mg	59.6	59.7	59.7	59.7	59.8

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
acetaldehyde	Air	g	14.1	14.1	14.1	14.1	14.1
acetic acid	Air	g	49.9	49.9	49.9	49.9	50
acetone	Air	g	11.9	11.9	11.9	11.9	11.9
acrolein	Air	g	15.6	17.9	9.03	10.8	10.4
Al	Air	g	359	360	360	361	362
aldehydes	Air	kg	4.81	5.62	5.41	5.63	6.23
alkanes	Air	g	143	143	143	143	143
alkenes	Air	g	130	130	130	130	131
ammonia	Air	kg	4.79	5.4	3.09	3.54	3.46
As	Air	g	98.9	107	76.7	82.6	81.6
B	Air	g	74.9	75	75	75	75.1
Ba	Air	g	4.64	4.64	4.64	4.65	4.67
Be	Air	g	6.45	7.4	3.79	4.5	4.35
benzaldehyde	Air	µg	587	587	587	588	588
benzene	Air	g	162	165	153	155	156
benzo(a)pyrene	Air	mg	389	402	402	428	479
Br	Air	g	15.9	15.9	15.9	16	16
butane	Air	g	187	187	187	188	188
butene	Air	g	5.48	5.48	5.48	5.48	5.48
Ca	Air	g	125	125	125	125	125
Cd	Air	g	14.4	16.4	11	12.2	12.4
CFC-11	Air	mg	28.4	28.4	28.4	28.4	28.5
CFC-114	Air	mg	752	752	752	753	753
CFC-116	Air	g	2.44	2.44	2.44	2.44	2.44
CFC-12	Air	mg	6.11	6.11	6.11	6.12	6.12
CFC-13	Air	mg	3.83	3.83	3.83	3.84	3.84

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
CFC-14	Air	g	21.9	21.9	21.9	21.9	21.9
Cl2	Air	kg	1.37	1.42	1.42	1.52	1.72
CO	Air	ton	1.4	1.76	2.57	2.53	2.98
CO2	Air	ton	263	385	901	852	1.06E3
CO2 (fossil)	Air	ton	1.25E3	1.44E3	817	945	940
CO2 (non-fossil)	Air	kg	460	549	433	467	504
coal dust	Air	mg	259	259	259	259	259
cobalt	Air	g	23.1	26.2	16.1	18.2	18.1
Cr	Air	g	96.8	110	60.2	70	68.1
Cu	Air	g	12.1	12.2	12.2	12.4	12.8
CxHy	Air	kg	56.9	57	57	57.1	57.4
CxHy aromatic	Air	g	1.68	1.68	1.68	1.68	1.68
CxHy chloro	Air	g	2.33	3.58	3.58	3.58	4.5
cyanides	Air	mg	69.3	70.5	70.5	72.9	77.7
dichloroethane	Air	mg	163	163	163	163	163
dichloromethane	Air	g	66.2	75.9	38.3	45.6	44.1
dioxin (TEQ)	Air	µg	276	295	246	269	294
dust	Air	kg	20.1	27.8	60.5	57.3	70
dust (coarse)	Air	kg	21.4	21.4	21.4	21.5	21.5
dust (coarse) process	Air	kg	4.25	4.27	4.27	4.31	4.4
dust (PM10)	Air	kg	91	93.5	93.5	98.7	109
dust (PM10) mobile	Air	g	150	151	151	151	151
dust (PM10) stationary	Air	kg	7.1	7.1	7.1	7.11	7.11
dust (SPM)	Air	kg	5.91	6.03	6.03	6.15	6.43
ethane	Air	g	352	353	353	353	355
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 ICF Houses – SI Units (Continued)*

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
ethene	Air	g	107	108	108	109	112
ethylbenzene	Air	g	59.2	59.3	59.3	59.3	59.3
ethyne	Air	g	2	2.02	2.02	2.07	2.15
F2	Air	g	18.2	20	20	21.1	24.3
Fe	Air	g	180	180	180	181	181
fluoranthene	Air	g	1.01	1.04	1.04	1.11	1.26
fluoride	Air	g	2.43	2.43	2.43	2.43	2.43
formaldehyde	Air	g	186	194	165	171	170
H2	Air	g	224	224	224	224	224
H2S	Air	g	233	240	240	254	282
HALON-1301	Air	mg	633	634	634	634	634
HCFC-21	Air	mg	557	557	557	558	558
HCFC-22	Air	mg	6.76	6.77	6.77	6.77	6.78
HCl	Air	kg	82.1	93.7	48.9	57.6	55.7
He	Air	g	62.5	62.5	62.5	62.5	62.5
heptane	Air	g	36.4	36.4	36.4	36.4	36.4
hexachlorobenzene	Air	µg	10.1	10.1	10.1	10.1	10.1
hexane	Air	g	76.7	76.7	76.7	76.7	76.8
HF	Air	kg	14	15.6	9.38	10.6	10.3
HFC-134a	Air	pg	-0.0301	-0.0301	-0.0301	-0.03	-0.03
Hg	Air	g	31	35.4	18.7	22	21.3
I	Air	g	5.85	5.85	5.85	5.85	5.86
K	Air	g	54	54.1	54.1	54.2	54.4
kerosene	Air	g	397	456	229	273	264
La	Air	mg	136	136	136	137	137
metals	Air	g	266	301	253	267	282

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
methane	Air	ton	3.4	4.17	4.29	4.43	5
methanol	Air	g	24.5	24.5	24.5	24.5	24.5
Mg	Air	g	117	118	118	118	118
Mn	Air	g	186	212	113	132	128
Mo	Air	mg	964	964	964	964	965
MTBE	Air	mg	62.9	62.9	62.9	63	63
n-nitrodimethylamine	Air	g	3.29	3.78	1.91	2.27	2.19
N2	Air	g	386	386	386	386	386
N2O	Air	kg	24	27.7	31.6	31.7	35.2
Na	Air	g	65.6	65.6	65.6	65.7	65.8
naphthalene	Air	g	6.51	6.67	6.32	6.41	6.44
Ni	Air	g	238	270	174	194	196
NO2	Air	kg	2.77	2.85	2.85	3.01	3.34
non methane VOC	Air	ton	1.89	2.55	4.34	4.21	5.09
NOx	Air	ton	5.05	5.91	4.32	4.72	4.98
NOx (as NO2)	Air	kg	23.8	23.8	23.8	23.8	23.9
organic substances	Air	kg	23.1	25	26.1	26.9	29.6
P	Air	g	2.95	2.95	2.95	2.95	2.96
P-tot	Air	g	1.35	1.35	1.35	1.35	1.36
PAH's	Air	g	3.38	3.38	3.38	3.38	3.38
particulates (PM10)	Air	kg	239	274	139	165	160
particulates (unspecified)	Air	kg	1.22E3	1.39E3	741	868	845
Pb	Air	g	535	544	518	524	527
pentachlorobenzene	Air	µg	27	27	27	27	27
pentachlorophenol	Air	µg	4.36	4.36	4.36	4.36	4.36
pentane	Air	g	341	341	341	341	342

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
phenol	Air	g	44.3	51.9	31	35.2	35.9
phosphate	Air	g	1.18	1.18	1.18	1.18	1.18
propane	Air	g	246	247	247	247	248
propene	Air	g	14.2	14.3	14.3	14.4	14.5
propionic acid	Air	mg	303	305	305	306	308
Pt	Air	µg	580	580	580	580	580
Sb	Air	g	7.21	8.31	4.74	5.47	5.44
Sc	Air	mg	55	55.1	55.1	55.2	55.5
Se	Air	g	113	129	67	79.1	76.6
silicates	Air	g	683	683	683	684	687
Sn	Air	mg	115	115	115	115	116
SO2	Air	kg	405	408	410	413	421
soot	Air	kg	1.83	1.83	1.83	1.84	1.86
SOx	Air	ton	12.9	16.2	19.3	19.5	22.6
SOx (as SO2)	Air	kg	41.7	41.8	41.8	41.8	41.8
Sr	Air	g	5.52	5.53	5.53	5.54	5.56
tetrachloroethene	Air	g	14.9	17.1	8.61	10.3	9.9
tetrachloromethane	Air	g	24.4	28	14.6	17.2	16.8
Th	Air	mg	257	257	257	258	258
Ti	Air	g	16.4	16.4	16.4	16.4	16.5
Tl	Air	mg	21.1	21.2	21.2	21.2	21.3
toluene	Air	g	196	197	197	197	197
trichloroethene	Air	g	14.7	16.9	8.53	10.2	9.8
trichloromethane	Air	mg	4.32	4.32	4.32	4.32	4.32
U	Air	mg	132	132	132	132	133
V	Air	g	123	123	123	124	124

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
vinyl chloride	Air	mg	60.7	60.7	60.7	60.7	60.8
VOC	Air	kg	12	17.6	41.3	39.1	48.6
water	Air	ton	18	18	18	18	18
xylene	Air	g	133	133	133	133	133
Zn	Air	g	210	211	211	211	213
Zr	Air	mg	28	28.7	28.7	30	32.7
1,1,1-trichloroethane	Water	µg	138	138	138	138	138
acenaphthylene	Water	mg	788	788	788	788	788
Acid as H+	Water	g	38.5	38.5	38.5	38.5	38.5
acids (unspecified)	Water	g	78.3	79.6	79.6	82.1	87.2
Ag	Water	mg	68.4	68.5	68.5	68.5	68.5
Al	Water	kg	11.3	11.4	11.4	11.5	11.7
alkanes	Water	g	13.8	13.8	13.8	13.8	13.8
alkenes	Water	g	1.26	1.26	1.26	1.26	1.27
AOX	Water	mg	378	378	378	379	379
As	Water	g	22.9	23	23	23.2	23.6
B	Water	kg	42	48.3	24.5	29.2	28.2
Ba	Water	kg	1.16	1.16	1.16	1.17	1.18
baryte	Water	kg	2.38	2.38	2.38	2.38	2.39
Be	Water	mg	8.54	8.54	8.54	8.54	8.55
benzene	Water	g	14	14	14	14	14
BOD	Water	kg	11.9	15.2	24.4	23.8	28.3
calcium compounds	Water	kg	8.36	8.37	8.37	8.37	8.38
calcium ions	Water	kg	237	237	237	237	237
Cd	Water	kg	0.431	0.6	1.09	1.06	1.29
chlorinated solvents (unspec.)	Water	mg	6.81	6.82	6.82	6.85	6.9

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
chlorobenzenes	Water	µg	3.06	3.06	3.06	3.06	3.06
chromate	Water	g	10.7	12.5	7.53	8.58	8.69
Cl-	Water	kg	990	1.16E3	1.65E3	1.61E3	1.85E3
Co	Water	g	22.3	22.4	22.4	22.6	23
COD	Water	kg	112	140	188	186	217
Cr	Water	kg	0.548	0.718	1.21	1.17	1.41
Cr (VI)	Water	mg	24.5	24.5	24.5	24.5	24.5
crude oil	Water	g	277	277	277	277	278
Cs	Water	mg	105	105	105	105	105
Cu	Water	g	58.3	58.5	58.5	59	60
CxHy	Water	kg	1.62	1.62	1.62	1.62	1.62
CxHy aromatic	Water	g	65	65	65	65	65.1
CxHy chloro	Water	mg	24.6	24.6	24.6	24.6	24.7
cyanide	Water	g	6.42	6.71	7.45	7.47	7.95
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	8.49	8.49
dibutyl p-phthalate	Water	µg	79.7	79.7	79.7	79.7	79.8
dichloroethane	Water	mg	114	114	114	114	114
dichloromethane	Water	mg	621	621	621	621	621
dimethyl p-phthalate	Water	µg	502	502	502	503	503
dissolved organics	Water	kg	1.24	1.24	1.24	1.24	1.24
dissolved solids	Water	ton	9.44	13.1	23.8	23	28
dissolved substances	Water	kg	4.76	4.78	4.78	4.82	4.89
DOC	Water	g	21.8	21.8	21.8	21.8	21.8
ethyl benzene	Water	g	2.51	2.51	2.51	2.51	2.51
F2	Water	g	3.32	5.12	5.12	5.12	6.42

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
fats/oils	Water	kg	0.975	0.975	0.975	0.975	0.975
fatty acids as C	Water	g	235	235	235	235	235
Fe	Water	kg	68	77.2	41.9	48.8	47.4
fluoride ions	Water	kg	8.45	8.68	7.78	7.95	7.92
formaldehyde	Water	g	5.29	5.29	5.29	5.29	5.29
glutaraldehyde	Water	mg	294	294	294	294	295
H2	Water	g	258	259	259	259	260
H2S	Water	g	1.44	1.47	1.47	1.54	1.68
H2SO4	Water	kg	10.5	12.1	6.13	7.29	7.05
herbicides	Water	µg	x	x	x	x	x
hexachloroethane	Water	µg	1.87	1.87	1.87	1.87	1.87
Hg	Water	mg	100	114	153	151	171
HOCL	Water	g	68.3	68.3	68.3	68.3	68.4
I	Water	g	10.4	10.4	10.4	10.4	10.4
inorganic general	Water	kg	267	267	267	267	267
K	Water	kg	4	4.02	4.02	4.04	4.1
Kjeldahl-N	Water	g	505	523	523	559	632
metallic ions	Water	kg	1.06	1.13	0.972	1.01	1.03
Mg	Water	kg	9.54	9.58	9.58	9.66	9.8
Mn	Water	kg	36.3	41.6	21.2	25.2	24.3
Mo	Water	g	36.1	36.2	36.2	36.4	36.9
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	9.82	9.82	9.82	9.82	9.83
Na	Water	kg	134	135	134	134	135
NH3	Water	g	816	924	543	619	609

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
NH3 (as N)	Water	g	398	399	399	399	400
NH4+	Water	g	3.09	3.09	3.09	3.09	3.09
Ni	Water	g	58.1	58.3	58.3	58.8	59.7
nitrate	Water	g	447	469	384	401	398
nitrite	Water	g	3.58	3.58	3.58	3.59	3.59
nitrogen	Water	g	7.54	7.54	7.54	7.54	7.54
non methane VOC	Water	g	192	195	195	201	213
OCI-	Water	g	14.6	14.6	14.6	14.6	14.6
oil	Water	kg	170	235	425	411	500
other organics	Water	kg	35.1	46.9	73.3	71.8	86.1
P-compounds	Water	mg	52.8	53.2	53.2	54	55.7
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	2.54	2.55	2.55	2.55	2.55
Pb	Water	g	68	68.3	68.2	68.7	69.7
pesticides	Water	ng	x	x	x	x	x
phenol	Water	g	14.5	14.8	14.3	14.4	14.5
phenols	Water	g	6.44	6.44	6.44	6.45	6.45
phosphate	Water	kg	11.4	12.2	9.2	9.78	9.68
Ru	Water	mg	457	457	457	457	457
S	Water	g	1.82	1.82	1.82	1.82	1.83
salt	Water	g	389	390	390	390	391
salts	Water	kg	4.77	4.78	4.78	4.8	4.84
Sb	Water	mg	155	156	156	156	156
Se	Water	g	56.8	57.1	57.1	57.6	58.5
Si	Water	g	1.41	1.41	1.41	1.42	1.42

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
Sn	Water	mg	123	123	123	123	124
SO3	Water	g	9.55	9.55	9.55	9.55	9.56
Sr	Water	g	765	766	766	767	769
sulphate	Water	kg	568	730	1E3	997	1.17E3
sulphates	Water	kg	64.6	64.6	64.6	64.6	64.7
sulphide	Water	g	39.9	40.5	40.5	41.7	44.1
suspended solids	Water	kg	811	930	509	593	582
suspended substances	Water	kg	4.64	4.64	4.64	4.64	4.65
tetrachloroethene	Water	µg	221	221	221	221	221
tetrachloromethane	Water	µg	338	338	338	338	338
Ti	Water	g	670	673	673	679	690
TOC	Water	kg	2.4	2.4	2.4	2.4	2.41
toluene	Water	g	12.2	12.2	12.2	12.2	12.2
tributyltin	Water	mg	392	392	392	392	392
trichloroethene	Water	mg	19.1	19.1	19.1	19.1	19.1
trichloromethane	Water	mg	51.8	51.8	51.8	51.8	51.8
triethylene glycol	Water	g	21.8	21.8	21.8	21.8	21.8
undissolved substances	Water	kg	58.4	58.4	58.4	58.4	58.4
V	Water	g	59.7	60	60	60.4	61.4
vinyl chloride	Water	µg	62.9	62.9	62.9	62.9	62.9
VOC as C	Water	g	15.9	15.9	15.9	15.9	15.9
W	Water	mg	192	192	192	192	192
xylene	Water	g	10.1	10.1	10.1	10.1	10.1
Zn	Water	g	270	329	498	486	567
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 ICF Houses – SI Units (Continued)*

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
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	559	579	579	619	699
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	3.51	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	4.64	4.64	4.64	4.64	4.64
mineral waste	Solid	kg	55.7	55.7	55.7	55.7	55.7
oil	Solid	kg	15.4	15.4	15.4	15.6	15.9
plastic production waste	Solid	g	340	340	340	340	340
produc. waste (not inert)	Solid	kg	121	121	121	121	121
slag	Solid	kg	9.4	9.4	9.4	9.41	9.41
slags/ash	Solid	kg	1.66	1.66	1.66	1.66	1.66
solid waste	Solid	ton	229	266	170	191	195
unspecified	Solid	g	6.96	6.96	6.96	6.96	6.96
wood (sawdust)	Solid	ton	1.35	1.35	1.35	1.35	1.35
Al (ind.)	Soil	g	81.1	81.1	81.1	81.1	81.2
As (ind.)	Soil	mg	32.5	32.5	32.5	32.5	32.5
C (ind.)	Soil	g	249	249	249	249	249
Ca (ind.)	Soil	g	325	325	325	325	325
Cd (ind.)	Soil	mg	1.38	1.38	1.38	1.39	1.4
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	6.17	6.18	6.18	6.18	6.18

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
Fe (ind.)	Soil	g	163	163	163	163	163
Hg (ind.)	Soil	µg	243	245	245	249	256
Mn (ind.)	Soil	g	3.25	3.25	3.25	3.25	3.25
N	Soil	mg	125	127	127	131	139
Ni (ind.)	Soil	mg	9.25	9.26	9.26	9.26	9.26
oil (ind.)	Soil	g	235	235	235	235	235
oil biodegradable	Soil	g	122	122	122	122	122
P-tot	Soil	g	4.53	4.54	4.54	4.57	4.61
Pb (ind.)	Soil	mg	28.3	28.3	28.3	28.3	28.3
S (ind.)	Soil	g	48.7	48.7	48.7	48.7	48.8
Zn (ind.)	Soil	g	1.28	1.28	1.28	1.28	1.28
Ag110m to air	Non mat.	mBq	36.3	36.3	36.3	36.3	36.4
Ag110m to water	Non mat.	Bq	248	248	248	248	249
alpha radiation (unspecified) to water	Non mat.	mBq	29.3	29.3	29.3	29.3	29.3
Am241 to air	Non mat.	mBq	695	695	695	695	696
Am241 to water	Non mat.	Bq	91.3	91.3	91.3	91.3	91.4
Ar41 to air	Non mat.	kBq	78.8	78.8	78.8	78.8	78.9
Ba140 to air	Non mat.	mBq	161	161	161	161	161
Ba140 to water	Non mat.	mBq	771	771	771	772	772
beta radiation (unspecified) to air	Non mat.	mBq	7.07	7.07	7.07	7.07	7.08
C14 to air	Non mat.	kBq	56.6	56.6	56.6	56.6	56.7
C14 to water	Non mat.	kBq	4.61	4.61	4.61	4.62	4.62
Cd109 to water	Non mat.	mBq	4.47	4.47	4.47	4.47	4.48
Ce141 to air	Non mat.	mBq	3.39	3.39	3.39	3.4	3.4
Ce141 to water	Non mat.	mBq	115	115	115	115	116
Ce144 to air	Non mat.	Bq	7.39	7.39	7.39	7.39	7.4

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
Ce144 to water	Non mat.	kBq	2.09	2.09	2.09	2.09	2.1
Cm (alpha) to air	Non mat.	Bq	1.1	1.1	1.1	1.1	1.1
Cm (alpha) to water	Non mat.	Bq	121	121	121	121	121
Cm242 to air	Non mat.	µBq	3.56	3.56	3.56	3.56	3.56
Cm244 to air	Non mat.	µBq	32.3	32.3	32.3	32.3	32.3
Co57 to air	Non mat.	µBq	62	62	62	62	62.1
Co57 to water	Non mat.	mBq	794	794	794	794	795
Co58 to air	Non mat.	Bq	1.03	1.03	1.03	1.03	1.03
Co58 to water	Non mat.	Bq	506	506	506	506	506
Co60 to air	Non mat.	Bq	1.56	1.56	1.56	1.56	1.56
Co60 to water	Non mat.	kBq	20.4	20.4	20.4	20.4	20.5
Conv. to continuous urban land	Non mat.	m2	1.95	1.96	1.96	1.98	2.02
Conv. to industrial area	Non mat.	m2	1.19	1.19	1.19	1.19	1.19
Cr51 to air	Non mat.	mBq	130	130	130	130	130
Cr51 to water	Non mat.	Bq	17	17	17	17.1	17.1
Cs134 to air	Non mat.	Bq	26.3	26.3	26.3	26.4	26.4
Cs134 to water	Non mat.	kBq	4.67	4.67	4.67	4.67	4.68
Cs136 to water	Non mat.	mBq	4.15	4.15	4.15	4.15	4.16
Cs137 to air	Non mat.	Bq	50.9	50.9	50.9	50.9	51
Cs137 to water	Non mat.	kBq	43.1	43.1	43.1	43.1	43.2
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	266	266
H3 to air	Non mat.	kBq	565	566	566	566	567
H3 to water	Non mat.	kBq	1.37E5	1.37E5	1.37E5	1.37E5	1.37E5
heat losses to air	Non mat.	GJ	259	261	261	265	272

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
heat losses to soil	Non mat.	MJ	91.9	92	92	92	92.1
heat losses to water	Non mat.	GJ	-12.3	-12.2	-12.2	-12.2	-12.2
I129 to air	Non mat.	Bq	198	198	198	198	199
I129 to water	Non mat.	kBq	13.2	13.2	13.2	13.2	13.2
I131 to air	Non mat.	Bq	27.2	27.2	27.2	27.2	27.2
I131 to water	Non mat.	Bq	9.9	9.9	9.9	9.91	9.92
I133 to air	Non mat.	Bq	12.1	12.1	12.1	12.1	12.1
I133 to water	Non mat.	Bq	3.54	3.54	3.54	3.54	3.54
I135 to air	Non mat.	Bq	18	18	18	18	18
K40 to air	Non mat.	Bq	134	134	134	134	134
K40 to water	Non mat.	Bq	357	357	357	357	357
Kr85 to air	Non mat.	kBq	3.42E6	3.42E6	3.42E6	3.42E6	3.42E6
Kr85m to air	Non mat.	kBq	5.75	5.75	5.75	5.76	5.76
Kr87 to air	Non mat.	kBq	2.3	2.3	2.3	2.3	2.3
Kr88 to air	Non mat.	kBq	157	157	157	157	158
Kr89 to air	Non mat.	kBq	1.81	1.81	1.81	1.81	1.82
La140 to air	Non mat.	mBq	92.8	92.8	92.8	92.9	93
La140 to water	Non mat.	mBq	160	160	160	160	160
land use (sea floor) II-III	Non mat.	m2a	100	100	100	100	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	358	358	358	358	359
land use II-IV	Non mat.	m2a	162	162	162	162	162
land use III-IV	Non mat.	m2a	22.2	22.2	22.2	22.2	22.3
land use IV-IV	Non mat.	m2a	0.239	0.239	0.239	0.239	0.239
Mn54 to air	Non mat.	mBq	37.1	37.1	37.1	37.1	37.1
Mn54 to water	Non mat.	kBq	3.11	3.11	3.11	3.11	3.11

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
Mo99 to water	Non mat.	mBq	54.1	54.1	54.1	54.2	54.2
Na24 to water	Non mat.	Bq	23.8	23.8	23.8	23.8	23.8
Nb95 to air	Non mat.	mBq	6.58	6.59	6.59	6.59	6.6
Nb95 to water	Non mat.	mBq	439	439	439	439	440
Np237 to air	Non mat.	µBq	36.3	36.3	36.3	36.4	36.4
Np237 to water	Non mat.	Bq	5.84	5.84	5.84	5.85	5.85
Occup. as contin. urban land	Non mat.	m2a	31.5	32.3	32.3	33.9	37.2
Occup. as convent. arable land	Non mat.	m2a	1.26E3	1.27E3	1.27E3	1.27E3	1.27E3
Occup. as forest land	Non mat.	cm2a	476	476	476	476	477
Occup. as industrial area	Non mat.	m2a	920	925	925	934	951
Occup. as rail/road area	Non mat.	m2a	6.66E4	6.66E4	6.66E4	6.66E4	6.66E4
Pa234m to air	Non mat.	Bq	22	22	22	22	22.1
Pa234m to water	Non mat.	Bq	408	408	408	408	409
Pb210 to air	Non mat.	Bq	718	718	718	719	720
Pb210 to water	Non mat.	Bq	284	284	284	284	284
Pm147 to air	Non mat.	Bq	18.7	18.7	18.7	18.7	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	284	284	284
Pu alpha to air	Non mat.	Bq	2.2	2.2	2.2	2.2	2.21
Pu alpha to water	Non mat.	Bq	363	363	363	364	364
Pu238 to air	Non mat.	µBq	80.1	80.1	80.1	80.2	80.3
Pu241 beta	Non mat.	kBq	9.03	9.03	9.03	9.04	9.05
Pu241 Beta to air	Non mat.	Bq	60.6	60.6	60.6	60.7	60.7
Ra224 to water	Non mat.	kBq	2.27	2.27	2.27	2.27	2.27
Ra226 to air	Non mat.	Bq	812	812	812	813	814
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 ICF Houses – SI Units (Continued)*

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
Ra228 to air	Non mat.	Bq	65.9	66	66	66	66.1
Ra228 to water	Non mat.	kBq	4.54	4.54	4.54	4.54	4.54
radio active noble gases to air	Non mat.	kBq	8.17	8.17	8.17	8.17	8.18
radioactive substance to air	Non mat.	kBq	5.67E7	5.99E7	4.75E7	4.99E7	4.94E7
radioactive substance to water	Non mat.	kBq	3.2E5	3.2E5	3.2E5	3.2E5	3.2E5
radionuclides (mixed) to water	Non mat.	mBq	204	204	204	205	205
Rn220 to air	Non mat.	kBq	5.39	5.39	5.39	5.39	5.4
Rn222 (long term) to air	Non mat.	kBq	4.91E6	4.91E6	4.91E6	4.91E6	4.91E6
Rn222 to air	Non mat.	kBq	5.32E4	5.32E4	5.32E4	5.32E4	5.33E4
Ru103 to air	Non mat.	µBq	396	396	396	396	397
Ru103 to water	Non mat.	mBq	259	259	259	260	260
Ru106 to air	Non mat.	Bq	220	220	220	220	221
Ru106 to water	Non mat.	kBq	22	22	22	22	22.1
Sb122 to water	Non mat.	mBq	771	771	771	772	772
Sb124 to air	Non mat.	mBq	10.1	10.1	10.1	10.1	10.1
Sb124 to water	Non mat.	Bq	68.4	68.4	68.4	68.5	68.5
Sb125 to air	Non mat.	mBq	1.71	1.71	1.71	1.71	1.72
Sb125 to water	Non mat.	Bq	6.31	6.31	6.31	6.31	6.31
Sr89 to air	Non mat.	mBq	64.8	64.8	64.8	64.9	64.9
Sr89 to water	Non mat.	Bq	1.75	1.75	1.75	1.75	1.75
Sr90 to air	Non mat.	Bq	36.3	36.3	36.3	36.4	36.4
Sr90 to water	Non mat.	kBq	4.4	4.41	4.41	4.41	4.41
Tc99 to air	Non mat.	mBq	1.54	1.54	1.54	1.54	1.54
Tc99 to water	Non mat.	kBq	2.31	2.31	2.31	2.31	2.32
Tc99m to water	Non mat.	mBq	365	365	365	365	366
Te123m to air	Non mat.	mBq	162	162	162	162	162

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
Te123m to water	Non mat.	mBq	32.6	32.6	32.6	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	55.8	55.9	55.9	55.9	56
Th228 to water	Non mat.	kBq	9.09	9.09	9.09	9.09	9.1
Th230 to air	Non mat.	Bq	245	245	245	245	246
Th230 to water	Non mat.	kBq	63.7	63.7	63.7	63.8	63.8
Th232 to air	Non mat.	Bq	35.4	35.5	35.5	35.5	35.5
Th232 to water	Non mat.	Bq	66.4	66.4	66.4	66.5	66.5
Th234 to air	Non mat.	Bq	22	22	22	22	22.1
Th234 to water	Non mat.	Bq	411	411	411	412	412
U alpha to air	Non mat.	Bq	788	788	788	789	790
U alpha to water	Non mat.	kBq	26.6	26.7	26.7	26.7	26.7
U234 to air	Non mat.	Bq	264	264	264	264	264
U234 to water	Non mat.	Bq	545	545	545	545	546
U235 to air	Non mat.	Bq	12.8	12.8	12.8	12.8	12.8
U235 to water	Non mat.	Bq	813	813	813	814	815
U238 to air	Non mat.	Bq	362	362	362	362	363
U238 to water	Non mat.	kBq	1.39	1.39	1.39	1.39	1.39
waste heat to air	Non mat.	MJ	-70.1	4.26	4.26	153	450
waste heat to soil	Non mat.	MJ	328	328	328	328	328
waste heat to water	Non mat.	GJ	6.68	6.68	6.68	6.68	6.68
Xe131m to air	Non mat.	kBq	10.6	10.6	10.6	10.6	10.6
Xe133 to air	Non mat.	kBq	2.44E3	2.44E3	2.44E3	2.44E3	2.44E3
Xe133m to air	Non mat.	kBq	1.2	1.2	1.2	1.2	1.2
Xe135 to air	Non mat.	kBq	444	444	444	445	445
Xe135m to air	Non mat.	kBq	57.3	57.3	57.3	57.3	57.3

*An x means there are no data.

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

Substance	Compartment	Unit	ICF house				
			Miami	Phoenix	Seattle	DC	Chicago
Xe137 to air	Non mat.	kBq	1.34	1.34	1.34	1.34	1.34
Xe138 to air	Non mat.	kBq	15.6	15.6	15.6	15.6	15.7
Y90 to water	Non mat.	mBq	89.5	89.6	89.6	89.6	89.6
Zn65 to air	Non mat.	mBq	167	167	167	168	168
Zn65 to water	Non mat.	Bq	50.4	50.4	50.4	50.4	50.4
Zr95 to air	Non mat.	mBq	2.35	2.35	2.35	2.36	2.36
Zr95 to water	Non mat.	Bq	187	188	188	188	188

*An x means there are no data.

**APPENDIX D – LCI DATA FOR WOOD HOUSES AND ICF 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				
			Miami	Phoenix	Seattle	DC	Chicago
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	431
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	2.15E3	2.46E3	3.08E3
clay minerals	Raw	oz	0.246	0.246	0.246	0.246	0.246
coal	Raw	lb	875	956	956	1.12E3	1.44E3
coal ETH	Raw	tn.lg	6.39	6.42	6.42	6.47	6.58
coal FAL	Raw	tn.lg	480	555	267	325	312
cobalt (in ore)	Raw	oz	1.91E-5	1.91E-5	1.91E-5	1.91E-5	1.91E-5
copper (in ore)	Raw	lb	217	217	217	217	217
crude oil	Raw	oz	123	143	143	184	267
crude oil (feedstock) FAL	Raw	lb	0	64.5	64.5	193	451
crude oil ETH	Raw	tn.lg	2.13	2.13	2.13	2.13	2.13
crude oil FAL	Raw	tn.lg	21.6	25.4	17.2	19.1	20.1
crude oil IDEMAT	Raw	tn.lg	9.31	9.32	9.32	9.33	9.36
dolomite	Raw	oz	605	767	767	767	884
energy (undef.)	Raw	MWh	8.84	8.84	8.84	8.85	8.86
energy from hydro power	Raw	MWh	213	243	125	149	143
energy from uranium	Raw	kWh	2.43	2.83	2.83	3.64	5.27
feldspar	Raw	oz	605	767	767	767	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	74.9
gravel	Raw	tn.lg	34.2	36.8	36.8	42.1	52.6

*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				
			Miami	Phoenix	Seattle	DC	Chicago
gypsum	Raw	lb	1.5E3	1.61E3	1.61E3	1.85E3	2.31E3
iron (in ore)	Raw	lb	1.07E3	1.21E3	1.21E3	1.48E3	2.03E3
iron (ore)	Raw	tn.lg	2.63	2.64	2.64	2.65	2.68
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	1.43	1.44
limestone	Raw	tn.lg	43.8	49.4	32.7	38.5	42.7
manganese (in ore)	Raw	oz	93.6	109	109	139	199
manganese (ore)	Raw	oz	0.0394	0.0394	0.0394	0.0394	0.0394
marl	Raw	tn.lg	7.48	7.71	7.71	8.17	9.08
methane (kg)	Raw	lb	68.6	68.7	68.7	68.7	68.8
methane (kg) ETH	Raw	oz	512	520	520	537	572
molybdene (in ore)	Raw	oz	4.06E-5	4.06E-5	4.06E-5	4.06E-5	4.06E-5
NaCl	Raw	lb	1.33E3	1.33E3	1.33E3	1.33E3	1.33E3
NaOH	Raw	lb	114	144	144	144	166
natural gas	Raw	tn.lg	3.66	3.68	3.68	3.68	3.69
natural gas (feedstock) FAL	Raw	lb	0	16.7	16.7	50.2	117
natural gas ETH	Raw	cu.yd	2.2E3	2.21E3	2.21E3	2.21E3	2.21E3
natural gas FAL	Raw	tn.lg	181	263	489	465	569
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-5	6.81E-5	6.81E-5
petroleum gas ETH	Raw	cu.yd	88.3	88.3	88.3	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				
			Miami	Phoenix	Seattle	DC	Chicago
platinum (in ore)	Raw	oz	7.69E-5	7.69E-5	7.69E-5	7.69E-5	7.69E-5
potential energy water ETH	Raw	MWh	2.48	2.48	2.48	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-5	6.41E-5	6.41E-5
rhodium (in ore)	Raw	oz	7.23E-5	7.23E-5	7.23E-5	7.23E-5	7.23E-5
rock salt	Raw	lb	1.45E3	1.45E3	1.45E3	1.45E3	1.45E3
sand	Raw	tn.lg	27.9	30	30	33.9	41.7
scrap, external	Raw	lb	1.87E3	1.87E3	1.87E3	1.87E3	1.87E3
shale	Raw	lb	1.59E3	1.71E3	1.71E3	1.96E3	2.46E3
silicon (in SiO2)	Raw	oz	44.5	51.9	51.9	66.8	96.5
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	6.02E4	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	3.5	3.5	3.51
uranium (ore)	Raw	oz	248	248	248	248	248
uranium FAL	Raw	oz	67.5	78.2	37.3	45.5	43.7
water	Raw	tn.lg	971	973	973	975	981
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	780	950	774	827	903
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	0.0021	0.0021	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				
			Miami	Phoenix	Seattle	DC	Chicago
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	0.426	0.427
acrolein	Air	oz	0.585	0.677	0.324	0.395	0.38
Al	Air	oz	12.6	12.6	12.6	12.7	12.7
aldehydes	Air	oz	155	189	180	188	210
alkanes	Air	oz	5.57	5.57	5.57	5.57	5.58
alkenes	Air	oz	5.94	5.94	5.94	5.94	5.95
ammonia	Air	oz	182	206	114	133	129
As	Air	oz	3.6	3.93	2.72	2.97	2.92
B	Air	oz	2.8	2.81	2.81	2.81	2.81
Ba	Air	oz	0.165	0.165	0.165	0.165	0.166
Be	Air	oz	0.241	0.28	0.136	0.165	0.159
benzaldehyde	Air	oz	2.16E-5	2.16E-5	2.16E-5	2.16E-5	2.16E-5
benzene	Air	oz	6.62	6.75	6.26	6.37	6.38
benzo(a)pyrene	Air	oz	0.00413	0.00458	0.00458	0.00548	0.00728
Br	Air	oz	0.578	0.579	0.579	0.579	0.58
butane	Air	oz	6.88	6.88	6.88	6.89	6.89
butene	Air	oz	0.209	0.209	0.209	0.209	0.209
Ca	Air	oz	4.63	4.64	4.64	4.64	4.65
Cd	Air	oz	0.517	0.596	0.381	0.429	0.438
CFC-11	Air	oz	0.0011	0.0011	0.0011	0.0011	0.0011
CFC-114	Air	oz	0.0292	0.0292	0.0292	0.0292	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	0.000237	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				
			Miami	Phoenix	Seattle	DC	Chicago
CFC-14	Air	oz	0.773	0.773	0.773	0.773	0.773
Cl2	Air	oz	11.6	13.6	13.5	17	24
CO	Air	tn.lg	1.34	1.77	2.66	2.59	3.08
CO2	Air	tn.lg	250	392	965	894	1.12E3
CO2 (fossil)	Air	tn.lg	1.3E3	1.52E3	820	965	959
CO2 (non-fossil)	Air	lb	1.07E3	1.3E3	1.01E3	1.09E3	1.18E3
coal dust	Air	oz	0.00913	0.00913	0.00913	0.00913	0.00913
cobalt	Air	oz	0.857	0.982	0.58	0.664	0.66
Cr	Air	oz	3.67	4.2	2.22	2.62	2.54
Cu	Air	oz	0.367	0.37	0.37	0.378	0.392
CxHy	Air	lb	128	129	129	129	130
CxHy aromatic	Air	oz	0.0623	0.0623	0.0623	0.0623	0.0624
CxHy chloro	Air	oz	0.166	0.211	0.211	0.211	0.243
cyanides	Air	oz	0.00159	0.00163	0.00163	0.00172	0.00189
dichloroethane	Air	oz	0.00693	0.00693	0.00693	0.00693	0.00693
dichloromethane	Air	oz	2.48	2.87	1.38	1.68	1.61
dioxin (TEQ)	Air	oz	4.79E-6	5.53E-6	3.6E-6	4.46E-6	5.32E-6
dust	Air	lb	45.4	65.5	147	137	168
dust (coarse)	Air	oz	756	756	756	756	757
dust (coarse) process	Air	oz	141	142	142	143	146
dust (PM10)	Air	lb	73.1	78.8	78.8	90.2	113
dust (PM10) mobile	Air	oz	5.79	5.8	5.8	5.8	5.8
dust (PM10) stationary	Air	oz	307	307	307	307	307
dust (SPM)	Air	oz	185	189	189	193	203
ethane	Air	oz	12.8	12.8	12.8	12.8	12.9
ethanol	Air	oz	0.855	0.855	0.855	0.855	0.855

*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				
			Miami	Phoenix	Seattle	DC	Chicago
ethene	Air	oz	3.71	3.73	3.73	3.78	3.87
ethylbenzene	Air	oz	2.27	2.27	2.27	2.27	2.27
ethyne	Air	oz	0.0538	0.0546	0.0546	0.0561	0.0592
F2	Air	oz	0.365	0.43	0.43	0.47	0.582
Fe	Air	oz	6.43	6.43	6.43	6.44	6.47
fluoranthene	Air	oz	0.00762	0.0089	0.0089	0.0114	0.0165
fluoride	Air	oz	0.0857	0.0857	0.0857	0.0857	0.0857
formaldehyde	Air	oz	6.87	7.19	6.02	6.26	6.23
H2	Air	oz	7.92	7.92	7.92	7.92	7.92
H2S	Air	oz	2.86	3.11	3.11	3.61	4.6
HALON-1301	Air	oz	0.0234	0.0234	0.0234	0.0235	0.0235
HCFC-21	Air	oz	0.0225	0.0225	0.0225	0.0225	0.0225
HCFC-22	Air	oz	0.000263	0.000263	0.000263	0.000263	0.000263
HCl	Air	lb	192	221	110	132	127
He	Air	oz	2.4	2.4	2.4	2.4	2.4
heptane	Air	oz	1.33	1.33	1.33	1.33	1.34
hexachlorobenzene	Air	oz	4.39E-7	4.39E-7	4.39E-7	4.39E-7	4.39E-7
hexane	Air	oz	2.82	2.82	2.82	2.82	2.82
HF	Air	oz	517	581	335	384	374
HFC-134a	Air	oz	-1.07E-15	-1.07E-15	-1.07E-15	-1.07E-15	-1.07E-15
Hg	Air	oz	1.16	1.33	0.667	0.802	0.776
I	Air	oz	0.214	0.214	0.214	0.214	0.214
K	Air	oz	1.93	1.93	1.93	1.94	1.95
kerosene	Air	oz	14.9	17.3	8.23	10	9.65
La	Air	oz	0.00479	0.0048	0.0048	0.00481	0.00484
metals	Air	oz	9.75	11.2	9.27	9.8	10.4

*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				
			Miami	Phoenix	Seattle	DC	Chicago
methane	Air	tn.lg	3.5	4.39	4.52	4.63	5.26
methanol	Air	oz	0.878	0.878	0.878	0.878	0.878
Mg	Air	oz	4.15	4.15	4.15	4.16	4.18
Mn	Air	oz	7.02	8.07	4.13	4.92	4.76
Mo	Air	oz	0.0348	0.0348	0.0348	0.0348	0.0348
MTBE	Air	oz	0.00296	0.00296	0.00296	0.00296	0.00296
n-nitrodimethylamine	Air	oz	0.123	0.143	0.0684	0.0834	0.0802
N2	Air	oz	14.3	14.3	14.3	14.3	14.3
N2O	Air	lb	54.6	64	73.8	73.6	82
Na	Air	oz	2.35	2.35	2.35	2.35	2.36
naphthalene	Air	oz	0.256	0.263	0.249	0.252	0.254
Ni	Air	oz	8.78	10.1	6.27	7.09	7.14
NO2	Air	oz	53	55.9	55.9	61.7	73.2
non methane VOC	Air	tn.lg	1.85	2.61	4.6	4.39	5.35
NOx	Air	tn.lg	5.19	6.16	4.39	4.83	5.1
NOx (as NO2)	Air	oz	932	932	932	933	935
organic substances	Air	lb	33	37.7	40.5	42.1	48.4
P	Air	oz	0.104	0.104	0.104	0.104	0.104
P-tot	Air	oz	0.0498	0.0499	0.0499	0.05	0.0503
PAH's	Air	oz	0.121	0.121	0.121	0.121	0.121
particulates (PM10)	Air	lb	553	639	305	372	358
particulates (unspecified)	Air	lb	2.83E3	3.27E3	1.65E3	1.98E3	1.92E3
Pb	Air	oz	18.5	18.9	17.9	18.1	18.2
pentachlorobenzene	Air	oz	1.17E-6	1.17E-6	1.17E-6	1.17E-6	1.18E-6
pentachlorophenol	Air	oz	1.9E-7	1.9E-7	1.9E-7	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				
			Miami	Phoenix	Seattle	DC	Chicago
phenol	Air	oz	1.73	2.03	1.2	1.37	1.39
phosphate	Air	oz	0.0416	0.0416	0.0416	0.0416	0.0416
propane	Air	oz	8.96	8.97	8.97	8.98	9
propene	Air	oz	0.51	0.512	0.512	0.515	0.521
propionic acid	Air	oz	0.0111	0.0111	0.0111	0.0112	0.0113
Pt	Air	oz	2.38E-5	2.38E-5	2.38E-5	2.38E-5	2.38E-5
Sb	Air	oz	0.268	0.313	0.171	0.2	0.199
Sc	Air	oz	0.00193	0.00193	0.00193	0.00194	0.00195
Se	Air	oz	4.23	4.89	2.4	2.9	2.8
silicates	Air	oz	24.6	24.6	24.6	24.6	24.7
Sn	Air	oz	0.00412	0.00412	0.00412	0.00412	0.00413
SO2	Air	lb	827	832	838	845	862
soot	Air	oz	69.4	69.6	69.6	69.9	70.4
SOx	Air	tn.lg	13.3	17.1	20.5	20.5	23.9
SOx (as SO2)	Air	lb	98.6	98.6	98.6	98.7	98.8
Sr	Air	oz	0.196	0.196	0.196	0.196	0.197
tetrachloroethene	Air	oz	0.557	0.645	0.309	0.376	0.362
tetrachloromethane	Air	oz	0.913	1.06	0.526	0.634	0.616
Th	Air	oz	0.00909	0.00909	0.00909	0.0091	0.00912
Ti	Air	oz	0.58	0.581	0.581	0.582	0.584
Tl	Air	oz	0.000758	0.000759	0.000759	0.000761	0.000764
toluene	Air	oz	7.83	7.84	7.84	7.84	7.86
trichloroethene	Air	oz	0.552	0.64	0.306	0.373	0.358
trichloromethane	Air	oz	0.000183	0.000183	0.000183	0.000183	0.000183
U	Air	oz	0.0047	0.00471	0.00471	0.00471	0.00472
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				
			Miami	Phoenix	Seattle	DC	Chicago
vinyl chloride	Air	oz	0.00233	0.00233	0.00233	0.00233	0.00233
VOC	Air	lb	23.6	38.2	97	90	113
water	Air	tn.lg	19.9	19.9	19.9	19.9	19.9
xylene	Air	oz	5.06	5.06	5.06	5.06	5.07
Zn	Air	oz	7.91	7.95	7.95	7.97	8.03
Zr	Air	oz	0.000469	0.000493	0.000493	0.00054	0.000635
1,1,1-trichloroethane	Water	oz	5.72E-6	5.72E-6	5.72E-6	5.72E-6	5.72E-6
acenaphthylene	Water	oz	0.0302	0.0302	0.0302	0.0302	0.0302
Acid as H+	Water	oz	4.02	4.02	4.02	4.02	4.02
acids (unspecified)	Water	oz	0.125	0.17	0.17	0.259	0.439
Ag	Water	oz	0.00251	0.00251	0.00251	0.00251	0.00251
Al	Water	oz	372	374	374	377	383
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	0.756	0.762	0.776
B	Water	lb	98.4	114	55	66.9	64.5
Ba	Water	oz	38.9	39	39	39.3	39.8
baryte	Water	oz	87.3	87.3	87.3	87.3	87.4
Be	Water	oz	0.000312	0.000312	0.000312	0.000312	0.000312
benzene	Water	oz	0.513	0.514	0.514	0.514	0.514
BOD	Water	lb	24.5	33.2	56	53.7	64.7
calcium compounds	Water	oz	295	295	295	295	296
calcium ions	Water	lb	523	523	522	523	523
Cd	Water	oz	15.7	22.8	42.4	40.3	49.3
chlorinated solvents (unspec.)	Water	oz	0.000257	0.000258	0.000258	0.000258	0.00026

*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				
			Miami	Phoenix	Seattle	DC	Chicago
chlorobenzenes	Water	oz	1.43E-7	1.43E-7	1.43E-7	1.43E-7	1.43E-7
chromate	Water	oz	0.398	0.467	0.271	0.313	0.317
Cl-	Water	tn.sh	1.11	1.33	1.94	1.87	2.15
Co	Water	oz	0.73	0.734	0.734	0.74	0.753
COD	Water	lb	250	322	441	433	507
Cr	Water	oz	19.5	26.6	46.2	44.1	53.2
Cr (VI)	Water	oz	0.000873	0.000874	0.000874	0.000874	0.000875
crude oil	Water	oz	9.79	9.8	9.8	9.81	9.84
Cs	Water	oz	0.00383	0.00383	0.00383	0.00384	0.00384
Cu	Water	oz	1.91	1.91	1.91	1.93	1.97
CxHy	Water	oz	57.4	57.5	57.5	57.5	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	0.000869	0.00087
cyanide	Water	oz	0.202	0.214	0.243	0.242	0.261
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	3.6E-7	3.6E-7	3.6E-7
dibutyl p-phthalate	Water	oz	3.06E-6	3.06E-6	3.06E-6	3.06E-6	3.06E-6
dichloroethane	Water	oz	0.00463	0.00463	0.00463	0.00463	0.00463
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-5	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	9.59	13.9	25.7	24.4	29.9
dissolved substances	Water	oz	157	158	158	159	161
DOC	Water	oz	0.808	0.808	0.808	0.808	0.808
ethyl benzene	Water	oz	0.092	0.092	0.092	0.092	0.0921
F2	Water	oz	0.238	0.301	0.301	0.301	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				
			Miami	Phoenix	Seattle	DC	Chicago
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	9.01
Fe	Water	lb	158	181	93.3	111	107
fluoride ions	Water	oz	302	311	275	282	281
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	9.25	9.26	9.29
H2S	Water	oz	0.0249	0.0261	0.0261	0.0285	0.0332
H2SO4	Water	oz	393	456	220	267	258
herbicides	Water	oz	5.21E-8	5.21E-8	5.21E-8	5.21E-8	5.21E-8
hexachloroethane	Water	oz	7.93E-8	7.93E-8	7.93E-8	7.93E-8	7.93E-8
Hg	Water	oz	0.00329	0.00386	0.0054	0.00526	0.00603
HOCL	Water	oz	2.46	2.46	2.46	2.46	2.46
I	Water	oz	0.382	0.382	0.382	0.382	0.382
inorganic general	Water	lb	588	588	588	588	588
K	Water	oz	133	134	134	135	137
Kjeldahl-N	Water	oz	3.83	4.46	4.46	5.74	8.3
metallic ions	Water	oz	36.1	38.9	32.8	34.3	35.1
Mg	Water	oz	314	316	316	318	323
Mn	Water	lb	84.7	98	47.3	57.5	55.3
Mo	Water	oz	1.21	1.21	1.21	1.22	1.24
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	9.4
N organically bound	Water	oz	0.383	0.383	0.383	0.383	0.384
Na	Water	lb	298	298	298	298	298
NH3	Water	oz	30.1	34.4	19.2	22.3	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				
			Miami	Phoenix	Seattle	DC	Chicago
NH3 (as N)	Water	oz	14.4	14.4	14.4	14.4	14.5
NH4+	Water	oz	0.109	0.109	0.109	0.109	0.109
Ni	Water	oz	1.91	1.91	1.91	1.93	1.96
nitrate	Water	oz	16.3	17.2	13.8	14.5	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	0.105	0.316	0.738
OCI-	Water	oz	0.561	0.561	0.561	0.561	0.562
oil	Water	lb	386	555	1.03E3	977	1.19E3
other organics	Water	lb	80.5	111	177	171	205
P-compounds	Water	oz	0.00164	0.00166	0.00166	0.00168	0.00174
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	0.0915	0.0916	0.0916
Pb	Water	oz	2.25	2.26	2.26	2.28	2.32
pesticides	Water	oz	2.65E-8	2.65E-8	2.65E-8	2.65E-8	2.65E-8
phenol	Water	oz	0.52	0.529	0.509	0.514	0.517
phenols	Water	oz	0.247	0.247	0.247	0.247	0.247
phosphate	Water	oz	411	442	325	348	344
Ru	Water	oz	0.0175	0.0176	0.0176	0.0176	0.0176
S	Water	oz	0.0643	0.0643	0.0643	0.0644	0.0644
salt	Water	oz	13.7	13.7	13.7	13.7	13.8
salts	Water	oz	176	176	176	177	179
Sb	Water	oz	0.00557	0.00557	0.00557	0.00558	0.00558
Se	Water	oz	1.86	1.87	1.87	1.89	1.92
Si	Water	oz	0.0532	0.0532	0.0532	0.0533	0.0533

*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				
			Miami	Phoenix	Seattle	DC	Chicago
Sn	Water	oz	0.0044	0.00441	0.00441	0.00441	0.00441
SO3	Water	oz	0.398	0.398	0.398	0.398	0.398
Sr	Water	oz	27.5	27.5	27.5	27.6	27.7
sulphate	Water	lb	1.3E3	1.72E3	2.4E3	2.35E3	2.78E3
sulphates	Water	lb	142	143	143	143	143
sulphide	Water	oz	0.0575	0.0785	0.0785	0.121	0.205
suspended solids	Water	lb	1.89E3	2.18E3	1.14E3	1.35E3	1.32E3
suspended substances	Water	oz	163	164	164	164	164
tetrachloroethene	Water	oz	9.4E-6	9.4E-6	9.4E-6	9.41E-6	9.41E-6
tetrachloromethane	Water	oz	1.44E-5	1.44E-5	1.44E-5	1.44E-5	1.44E-5
Ti	Water	oz	21.9	22	22	22.2	22.6
TOC	Water	oz	90.2	90.3	90.3	90.4	90.5
toluene	Water	oz	0.446	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	0.000775	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	0.808
undissolved substances	Water	lb	129	129	129	129	129
V	Water	oz	1.97	1.98	1.98	1.99	2.02
vinyl chloride	Water	oz	2.67E-6	2.67E-6	2.67E-6	2.67E-6	2.67E-6
VOC as C	Water	oz	0.61	0.61	0.61	0.61	0.61
W	Water	oz	0.007	0.00701	0.00701	0.00701	0.00702
xylene	Water	oz	0.37	0.37	0.37	0.37	0.37
Zn	Water	oz	9.36	11.8	18.5	17.8	21
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				
			Miami	Phoenix	Seattle	DC	Chicago
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	4.94	6.36	9.19
final waste (inert)	Solid	tn.lg	1.92	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	551	556	566
plastic production waste	Solid	oz	12	12	12	12	12
produc. waste (not inert)	Solid	lb	266	266	266	266	267
slag	Solid	oz	335	335	335	335	336
slags/ash	Solid	oz	66	66	66	66	66
solid waste	Solid	tn.lg	238	280	173	196	201
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	3.07	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	9.45
Ca (ind.)	Soil	oz	12.3	12.3	12.3	12.3	12.3
Cd (ind.)	Soil	oz	5.06E-5	5.07E-5	5.07E-5	5.09E-5	5.13E-5
Co (ind.)	Soil	oz	4.74E-5	4.74E-5	4.74E-5	4.74E-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				
			Miami	Phoenix	Seattle	DC	Chicago
Fe (ind.)	Soil	oz	6.16	6.16	6.16	6.16	6.17
Hg (ind.)	Soil	oz	7.69E-6	7.75E-6	7.75E-6	7.88E-6	8.15E-6
Mn (ind.)	Soil	oz	0.123	0.123	0.123	0.123	0.123
N	Soil	oz	0.00305	0.00311	0.00311	0.00325	0.00353
Ni (ind.)	Soil	oz	0.000355	0.000355	0.000355	0.000355	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	5.87
P-tot	Soil	oz	0.163	0.163	0.163	0.164	0.165
Pb (ind.)	Soil	oz	0.00108	0.00108	0.00108	0.00108	0.00108
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	0.0398
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	0.032	0.0321
Am241 to air	Non mat.	Bq	0.765	0.765	0.765	0.766	0.766
Am241 to water	Non mat.	Bq	101	101	101	101	101
Ar41 to air	Non mat.	Bq	8.62E4	8.62E4	8.62E4	8.62E4	8.63E4
Ba140 to air	Non mat.	Bq	0.181	0.181	0.181	0.181	0.182
Ba140 to water	Non mat.	Bq	0.932	0.932	0.932	0.933	0.933
beta radiation (unspecified) to air	Non mat.	Bq	0.00841	0.00841	0.00841	0.00842	0.00842
C14 to air	Non mat.	Bq	6.26E4	6.26E4	6.26E4	6.26E4	6.27E4
C14 to water	Non mat.	Bq	5.08E3	5.08E3	5.08E3	5.09E3	5.09E3
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	0.00372	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	8.14	8.14	8.15

*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				
			Miami	Phoenix	Seattle	DC	Chicago
Ce144 to water	Non mat.	Bq	2.3E3	2.3E3	2.3E3	2.31E3	2.31E3
Cm (alpha) to air	Non mat.	Bq	1.21	1.21	1.21	1.21	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-6	3.89E-6	3.9E-6
Cm244 to air	Non mat.	Bq	3.53E-5	3.53E-5	3.53E-5	3.54E-5	3.54E-5
Co57 to air	Non mat.	Bq	6.78E-5	6.78E-5	6.78E-5	6.79E-5	6.79E-5
Co57 to water	Non mat.	Bq	0.96	0.96	0.96	0.96	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	586
Co60 to air	Non mat.	Bq	1.71	1.71	1.71	1.71	1.71
Co60 to water	Non mat.	Bq	2.25E4	2.25E4	2.25E4	2.26E4	2.26E4
Conv. to continuous urban land	Non mat.	sq.yd	2.05	2.07	2.07	2.09	2.14
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	29.1
Cs134 to water	Non mat.	Bq	5.14E3	5.14E3	5.14E3	5.15E3	5.15E3
Cs136 to water	Non mat.	Bq	0.00502	0.00502	0.00502	0.00502	0.00502
Cs137 to air	Non mat.	Bq	56	56.1	56.1	56.1	56.1
Cs137 to water	Non mat.	Bq	4.75E4	4.75E4	4.75E4	4.75E4	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	0.0165
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	6.2E5	6.21E5	6.21E5
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	60.7	61.8	63.9

*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				
			Miami	Phoenix	Seattle	DC	Chicago
heat losses to soil	Non mat.	kWh	25.5	25.5	25.5	25.5	25.6
heat losses to water	Non mat.	MWh	-3.41	-3.4	-3.4	-3.4	-3.4
I129 to air	Non mat.	Bq	218	218	218	219	219
I129 to water	Non mat.	Bq	1.45E4	1.45E4	1.45E4	1.45E4	1.46E4
I131 to air	Non mat.	Bq	31.3	31.3	31.3	31.3	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	4.28
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	143
K40 to water	Non mat.	Bq	387	387	387	387	388
Kr85 to air	Non mat.	Bq	3.76E9	3.76E9	3.76E9	3.76E9	3.77E9
Kr85m to air	Non mat.	Bq	6.79E3	6.79E3	6.79E3	6.79E3	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	1.72E5	1.73E5
Kr89 to air	Non mat.	Bq	2.14E3	2.14E3	2.14E3	2.14E3	2.14E3
La140 to air	Non mat.	Bq	0.102	0.102	0.102	0.102	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	390	391	391
land use II-IV	Non mat.	m2a	215	215	215	215	215
land use III-IV	Non mat.	m2a	24.6	24.6	24.6	24.7	24.7
land use IV-IV	Non mat.	m2a	0.243	0.243	0.243	0.243	0.243
Mn54 to air	Non mat.	Bq	0.0406	0.0406	0.0406	0.0406	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				
			Miami	Phoenix	Seattle	DC	Chicago
Mo99 to water	Non mat.	Bq	0.0654	0.0654	0.0654	0.0654	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	0.00723	0.00724
Nb95 to water	Non mat.	Bq	0.531	0.531	0.531	0.531	0.531
Np237 to air	Non mat.	Bq	4E-5	4E-5	4E-5	4.01E-5	4.01E-5
Np237 to water	Non mat.	Bq	6.44	6.44	6.44	6.44	6.45
Occup. as contin. urban land	Non mat.	m2a	13.9	14.8	14.8	16.4	19.6
Occup. as convent. arable land	Non mat.	m2a	1.26E3	1.26E3	1.26E3	1.27E3	1.27E3
Occup. as forest land	Non mat.	m2a	0.0476	0.0476	0.0476	0.0476	0.0477
Occup. as industrial area	Non mat.	m2a	924	930	930	938	955
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	24.2	24.3	24.3
Pa234m to water	Non mat.	Bq	449	449	449	449	450
Pb210 to air	Non mat.	Bq	775	775	775	775	776
Pb210 to water	Non mat.	Bq	308	308	308	308	308
Pm147 to air	Non mat.	Bq	20.6	20.6	20.6	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	308
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	400	401	401
Pu238 to air	Non mat.	Bq	8.77E-5	8.77E-5	8.77E-5	8.77E-5	8.78E-5
Pu241 beta	Non mat.	Bq	9.95E3	9.95E3	9.95E3	9.95E3	9.96E3
Pu241 Beta to air	Non mat.	Bq	66.8	66.8	66.8	66.8	66.9
Ra224 to water	Non mat.	Bq	2.47E3	2.47E3	2.47E3	2.47E3	2.48E3
Ra226 to air	Non mat.	Bq	890	891	891	891	892
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				
			Miami	Phoenix	Seattle	DC	Chicago
Ra228 to air	Non mat.	Bq	70.4	70.4	70.4	70.4	70.5
Ra228 to water	Non mat.	Bq	4.94E3	4.94E3	4.94E3	4.94E3	4.94E3
radio active noble gases to air	Non mat.	Bq	9.87E3	9.88E3	9.88E3	9.88E3	9.88E3
radioactive substance to air	Non mat.	Bq	5.81E10	6.17E10	4.77E10	5.06E10	5E10
radioactive substance to water	Non mat.	Bq	3.2E8	3.2E8	3.2E8	3.2E8	3.2E8
radionuclides (mixed) to water	Non mat.	Bq	0.227	0.227	0.227	0.227	0.227
Rn220 to air	Non mat.	Bq	5.82E3	5.82E3	5.82E3	5.82E3	5.83E3
Rn222 (long term) to air	Non mat.	Bq	5.4E9	5.4E9	5.4E9	5.4E9	5.41E9
Rn222 to air	Non mat.	Bq	5.86E7	5.86E7	5.86E7	5.86E7	5.86E7
Ru103 to air	Non mat.	Bq	0.000441	0.000441	0.000441	0.000441	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	0.932	0.933	0.933
Sb124 to air	Non mat.	Bq	0.011	0.011	0.011	0.0111	0.0111
Sb124 to water	Non mat.	Bq	76.1	76.2	76.2	76.2	76.2
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	7.62	7.63	7.63
Sr89 to air	Non mat.	Bq	0.0711	0.0711	0.0711	0.0711	0.0712
Sr89 to water	Non mat.	Bq	2.11	2.11	2.11	2.11	2.11
Sr90 to air	Non mat.	Bq	40	40	40	40.1	40.1
Sr90 to water	Non mat.	Bq	4.85E3	4.85E3	4.85E3	4.86E3	4.86E3
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				
			Miami	Phoenix	Seattle	DC	Chicago
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	59.6	59.6	59.7
Th228 to water	Non mat.	Bq	9.9E3	9.9E3	9.9E3	9.9E3	9.9E3
Th230 to air	Non mat.	Bq	270	270	270	270	271
Th230 to water	Non mat.	Bq	7.02E4	7.02E4	7.02E4	7.02E4	7.03E4
Th232 to air	Non mat.	Bq	37.8	37.8	37.8	37.9	37.9
Th232 to water	Non mat.	Bq	72.1	72.1	72.1	72.1	72.2
Th234 to air	Non mat.	Bq	24.2	24.2	24.2	24.3	24.3
Th234 to water	Non mat.	Bq	453	453	453	453	454
U alpha to air	Non mat.	Bq	868	868	868	869	870
U alpha to water	Non mat.	Bq	2.93E4	2.93E4	2.93E4	2.94E4	2.94E4
U234 to air	Non mat.	Bq	291	291	291	291	291
U234 to water	Non mat.	Bq	600	600	600	600	601
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	896	897
U238 to air	Non mat.	Bq	395	395	395	395	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	-1.15E4	-1.14E4
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	2.68E6	2.68E6	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	4.96E5	4.97E5	4.97E5
Xe135m to air	Non mat.	Bq	6.73E4	6.73E4	6.73E4	6.73E4	6.73E4

*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				
			Miami	Phoenix	Seattle	DC	Chicago
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	60.9
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 ICF Houses – U.S. Customary Units*

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
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	415	415	415	415	415
bauxite	Raw	lb	489	489	489	489	490
bentonite	Raw	oz	321	321	321	322	322
chromium (in ore)	Raw	lb	161	161	161	161	161
clay	Raw	lb	5.44E3	5.6E3	5.6E3	5.9E3	6.52E3
clay minerals	Raw	oz	0.246	0.246	0.246	0.246	0.246
coal	Raw	lb	2.65E3	2.73E3	2.73E3	2.89E3	3.22E3
coal ETH	Raw	tn.lg	6.88	6.91	6.91	6.96	7.08
coal FAL	Raw	tn.lg	453	519	263	313	303
cobalt (in ore)	Raw	oz	1.71E-5	1.71E-5	1.71E-5	1.71E-5	1.71E-5
copper (in ore)	Raw	lb	216	216	216	216	216
crude oil	Raw	oz	572	593	593	634	716
crude oil (feedstock) FAL	Raw	lb	4.14E3	4.21E3	4.21E3	4.34E3	4.6E3
crude oil ETH	Raw	tn.lg	2.05	2.05	2.05	2.05	2.05
crude oil FAL	Raw	tn.lg	21.7	25	17.7	19.5	20.4
crude oil IDEMAT	Raw	tn.lg	9.15	9.16	9.16	9.17	9.2
dolomite	Raw	oz	298	460	460	460	577
energy (undef.)	Raw	MWh	8.75	8.75	8.75	8.76	8.78
energy from hydro power	Raw	MWh	201	228	123	144	139
energy from uranium	Raw	kWh	11.3	11.7	11.7	12.5	14.1
feldspar	Raw	oz	298	460	460	460	577
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	93	95.6	95.6	101	111

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
gypsum	Raw	lb	4.1E3	4.22E3	4.22E3	4.45E3	4.92E3
iron (in ore)	Raw	lb	4.04E3	4.18E3	4.18E3	4.45E3	5E3
iron (ore)	Raw	tn.lg	2.8	2.81	2.81	2.82	2.85
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	1.31	1.31	1.31	1.31	1.32
limestone	Raw	tn.lg	69.6	74.6	59.9	65.2	69.5
manganese (in ore)	Raw	oz	422	437	437	467	527
manganese (ore)	Raw	oz	x	x	x	x	x
marl	Raw	tn.lg	12.6	12.8	12.8	13.2	14.2
methane (kg)	Raw	lb	68.7	68.8	68.8	68.8	68.9
methane (kg) ETH	Raw	oz	678	686	686	703	738
molybdene (in ore)	Raw	oz	3.68E-5	3.68E-5	3.68E-5	3.68E-5	3.68E-5
NaCl	Raw	lb	1.33E3	1.33E3	1.33E3	1.33E3	1.33E3
NaOH	Raw	lb	55.9	86.2	86.2	86.2	108
natural gas	Raw	tn.lg	3.61	3.62	3.62	3.62	3.64
natural gas (feedstock) FAL	Raw	lb	1.08E3	1.09E3	1.09E3	1.13E3	1.19E3
natural gas ETH	Raw	cu.yd	2.11E3	2.11E3	2.11E3	2.12E3	2.12E3
natural gas FAL	Raw	tn.lg	175	244	445	430	524
nickel (in ore)	Raw	oz	10.8	10.8	10.8	10.8	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	81.1	81.1	81.1	81.2	81.2
phosphate (ore)	Raw	oz	x	x	x	x	x

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
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	2.27	2.27	2.27	2.27	2.27
reservoir content ETH	Raw	m3y	175	175	175	175	175
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	6.08E-5	6.08E-5
rock salt	Raw	lb	1.45E3	1.45E3	1.45E3	1.45E3	1.45E3
sand	Raw	tn.lg	71.4	73.4	73.4	77.3	85.2
scrap, external	Raw	lb	1.88E3	1.88E3	1.88E3	1.88E3	1.88E3
shale	Raw	lb	4.36E3	4.48E3	4.48E3	4.73E3	5.22E3
silicon (in SiO2)	Raw	oz	207	215	215	229	259
silver	Raw	oz	0.122	0.123	0.123	0.123	0.123
silver (in ore)	Raw	oz	0.1	0.1	0.1	0.1	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	5.52E4	5.52E4	5.52E4	5.52E4	5.53E4
uranium (in ore)	Raw	oz	14.1	14.1	14.1	14.1	14.1
uranium (in ore) ETH	Raw	oz	3.18	3.18	3.18	3.18	3.19
uranium (ore)	Raw	oz	248	248	248	248	248
uranium FAL	Raw	oz	63.5	72.9	36.7	43.7	42.2
water	Raw	tn.lg	978	979	979	982	987
wood	Raw	tn.lg	20	20	20	20	20
wood (dry matter) ETH	Raw	tn.lg	9.21	9.21	9.21	9.21	9.21
wood/wood wastes FAL	Raw	lb	741	888	732	783	851
zeolite	Raw	oz	2.85	2.85	2.85	2.85	2.85
zinc (in ore)	Raw	oz	0.235	0.235	0.235	0.235	0.236
1,2-dichloroethane	Air	oz	0.0021	0.0021	0.0021	0.00211	0.00211

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
acetaldehyde	Air	oz	0.498	0.498	0.498	0.498	0.498
acetic acid	Air	oz	1.76	1.76	1.76	1.76	1.76
acetone	Air	oz	0.42	0.42	0.42	0.42	0.42
acrolein	Air	oz	0.55	0.631	0.318	0.379	0.366
Al	Air	oz	12.7	12.7	12.7	12.7	12.8
aldehydes	Air	oz	170	198	191	199	220
alkanes	Air	oz	5.05	5.06	5.06	5.06	5.06
alkenes	Air	oz	4.6	4.6	4.6	4.6	4.61
ammonia	Air	oz	169	190	109	125	122
As	Air	oz	3.49	3.78	2.7	2.92	2.88
B	Air	oz	2.64	2.64	2.64	2.65	2.65
Ba	Air	oz	0.164	0.164	0.164	0.164	0.165
Be	Air	oz	0.228	0.261	0.134	0.159	0.154
benzaldehyde	Air	oz	2.07E-5	2.07E-5	2.07E-5	2.07E-5	2.08E-5
benzene	Air	oz	5.7	5.82	5.39	5.48	5.49
benzo(a)pyrene	Air	oz	0.0137	0.0142	0.0142	0.0151	0.0169
Br	Air	oz	0.562	0.562	0.562	0.563	0.563
butane	Air	oz	6.61	6.61	6.61	6.61	6.62
butene	Air	oz	0.193	0.193	0.193	0.193	0.193
Ca	Air	oz	4.4	4.4	4.4	4.41	4.41
Cd	Air	oz	0.508	0.578	0.387	0.429	0.438
CFC-11	Air	oz	0.001	0.001	0.001	0.001	0.001
CFC-114	Air	oz	0.0265	0.0265	0.0265	0.0265	0.0266
CFC-116	Air	oz	0.0861	0.0861	0.0861	0.0861	0.0861
CFC-12	Air	oz	0.000216	0.000216	0.000216	0.000216	0.000216
CFC-13	Air	oz	0.000135	0.000135	0.000135	0.000135	0.000135

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
CFC-14	Air	oz	0.772	0.772	0.772	0.772	0.772
Cl2	Air	oz	48.2	50.2	50.1	53.5	60.6
CO	Air	tn.lg	1.37	1.73	2.53	2.49	2.94
CO2	Air	tn.lg	259	379	887	839	1.04E3
CO2 (fossil)	Air	tn.lg	1.23E3	1.42E3	804	930	925
CO2 (non-fossil)	Air	lb	1.02E3	1.21E3	956	1.03E3	1.11E3
coal dust	Air	oz	0.00913	0.00913	0.00913	0.00913	0.00913
cobalt	Air	oz	0.816	0.925	0.569	0.642	0.639
Cr	Air	oz	3.41	3.88	2.12	2.47	2.4
Cu	Air	oz	0.426	0.43	0.43	0.437	0.452
CxHy	Air	lb	125	126	126	126	127
CxHy aromatic	Air	oz	0.0591	0.0591	0.0591	0.0592	0.0592
CxHy chloro	Air	oz	0.0821	0.126	0.126	0.126	0.159
cyanides	Air	oz	0.00244	0.00249	0.00249	0.00257	0.00274
dichloroethane	Air	oz	0.00576	0.00576	0.00576	0.00576	0.00576
dichloromethane	Air	oz	2.33	2.68	1.35	1.61	1.55
dioxin (TEQ)	Air	oz	9.72E-6	1.04E-5	8.69E-6	9.49E-6	1.04E-5
dust	Air	lb	44.4	61.3	133	126	154
dust (coarse)	Air	oz	756	757	757	757	758
dust (coarse) process	Air	oz	150	151	151	152	155
dust (PM10)	Air	lb	201	206	206	218	240
dust (PM10) mobile	Air	oz	5.31	5.31	5.31	5.31	5.31
dust (PM10) stationary	Air	oz	251	251	251	251	251
dust (SPM)	Air	oz	209	213	213	217	227
ethane	Air	oz	12.4	12.4	12.4	12.5	12.5
ethanol	Air	oz	0.842	0.842	0.842	0.842	0.842

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
ethene	Air	oz	3.78	3.81	3.81	3.85	3.95
ethylbenzene	Air	oz	2.09	2.09	2.09	2.09	2.09
ethyne	Air	oz	0.0706	0.0714	0.0714	0.0729	0.076
F2	Air	oz	0.641	0.705	0.705	0.745	0.858
Fe	Air	oz	6.35	6.36	6.36	6.37	6.39
fluoranthene	Air	oz	0.0355	0.0368	0.0368	0.0393	0.0444
fluoride	Air	oz	0.0857	0.0857	0.0857	0.0857	0.0857
formaldehyde	Air	oz	6.57	6.85	5.81	6.02	5.99
H2	Air	oz	7.91	7.91	7.91	7.91	7.91
H2S	Air	oz	8.22	8.47	8.47	8.96	9.95
HALON-1301	Air	oz	0.0223	0.0223	0.0223	0.0224	0.0224
HCFC-21	Air	oz	0.0196	0.0197	0.0197	0.0197	0.0197
HCFC-22	Air	oz	0.000239	0.000239	0.000239	0.000239	0.000239
HCl	Air	lb	181	207	108	127	123
He	Air	oz	2.2	2.2	2.2	2.2	2.2
heptane	Air	oz	1.28	1.28	1.28	1.28	1.28
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	492	549	331	373	364
HFC-134a	Air	oz	-1.06E-15	-1.06E-15	-1.06E-15	-1.06E-15	-1.06E-15
Hg	Air	oz	1.09	1.25	0.659	0.775	0.753
I	Air	oz	0.206	0.206	0.206	0.206	0.207
K	Air	oz	1.9	1.91	1.91	1.91	1.92
kerosene	Air	oz	14	16.1	8.09	9.65	9.31
La	Air	oz	0.0048	0.00481	0.00481	0.00482	0.00485
metals	Air	oz	9.38	10.6	8.93	9.43	9.93

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
methane	Air	tn.lg	3.34	4.1	4.23	4.36	4.93
methanol	Air	oz	0.864	0.864	0.864	0.865	0.865
Mg	Air	oz	4.14	4.15	4.15	4.15	4.17
Mn	Air	oz	6.56	7.48	3.99	4.67	4.53
Mo	Air	oz	0.034	0.034	0.034	0.034	0.034
MTBE	Air	oz	0.00222	0.00222	0.00222	0.00222	0.00222
n-nitrodimethylamine	Air	oz	0.116	0.133	0.0672	0.0801	0.0773
N2	Air	oz	13.6	13.6	13.6	13.6	13.6
N2O	Air	lb	52.9	61	69.6	69.9	77.6
Na	Air	oz	2.31	2.31	2.31	2.32	2.32
naphthalene	Air	oz	0.23	0.235	0.223	0.226	0.227
Ni	Air	oz	8.38	9.53	6.15	6.86	6.91
NO2	Air	oz	97.6	101	101	106	118
non methane VOC	Air	tn.lg	1.86	2.51	4.27	4.15	5.01
NOx	Air	tn.lg	4.97	5.82	4.25	4.65	4.9
NOx (as NO2)	Air	oz	840	840	840	841	843
organic substances	Air	lb	50.9	55.1	57.5	59.3	65.3
P	Air	oz	0.104	0.104	0.104	0.104	0.104
P-tot	Air	oz	0.0475	0.0476	0.0476	0.0477	0.048
PAH's	Air	oz	0.119	0.119	0.119	0.119	0.119
particulates (PM10)	Air	lb	528	603	307	365	352
particulates (unspecified)	Air	lb	2.68E3	3.06E3	1.63E3	1.91E3	1.86E3
Pb	Air	oz	18.9	19.2	18.3	18.5	18.6
pentachlorobenzene	Air	oz	9.52E-7	9.52E-7	9.52E-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	12	12	12	12.1

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
phenol	Air	oz	1.56	1.83	1.09	1.24	1.27
phosphate	Air	oz	0.0416	0.0416	0.0416	0.0416	0.0416
propane	Air	oz	8.69	8.7	8.7	8.71	8.74
propene	Air	oz	0.502	0.504	0.504	0.507	0.513
propionic acid	Air	oz	0.0107	0.0107	0.0107	0.0108	0.0109
Pt	Air	oz	2.05E-5	2.05E-5	2.05E-5	2.05E-5	2.05E-5
Sb	Air	oz	0.254	0.293	0.167	0.193	0.192
Sc	Air	oz	0.00194	0.00194	0.00194	0.00195	0.00196
Se	Air	oz	3.99	4.56	2.36	2.79	2.7
silicates	Air	oz	24.1	24.1	24.1	24.1	24.2
Sn	Air	oz	0.00406	0.00407	0.00407	0.00407	0.00408
SO2	Air	lb	894	899	905	911	928
soot	Air	oz	64.5	64.7	64.7	65	65.5
SOx	Air	tn.lg	12.7	16	19	19.2	22.2
SOx (as SO2)	Air	lb	92	92.1	92.1	92.1	92.2
Sr	Air	oz	0.195	0.195	0.195	0.195	0.196
tetrachloroethene	Air	oz	0.524	0.602	0.304	0.362	0.349
tetrachloromethane	Air	oz	0.86	0.988	0.515	0.608	0.593
Th	Air	oz	0.00907	0.00908	0.00908	0.00909	0.00911
Ti	Air	oz	0.578	0.579	0.579	0.58	0.581
Tl	Air	oz	0.000746	0.000747	0.000747	0.000748	0.000751
toluene	Air	oz	6.93	6.93	6.93	6.94	6.95
trichloroethene	Air	oz	0.52	0.596	0.301	0.358	0.346
trichloromethane	Air	oz	0.000152	0.000152	0.000152	0.000152	0.000152
U	Air	oz	0.00466	0.00466	0.00466	0.00467	0.00468
V	Air	oz	4.36	4.36	4.36	4.36	4.36

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
vinyl chloride	Air	oz	0.00214	0.00214	0.00214	0.00214	0.00214
VOC	Air	lb	26.4	38.9	91	86.2	107
water	Air	tn.lg	17.7	17.7	17.7	17.7	17.7
xylene	Air	oz	4.68	4.69	4.69	4.69	4.69
Zn	Air	oz	7.4	7.44	7.44	7.46	7.52
Zr	Air	oz	0.000988	0.00101	0.00101	0.00106	0.00115
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	2.76	2.81	2.81	2.9	3.08
Ag	Water	oz	0.00241	0.00242	0.00242	0.00242	0.00242
Al	Water	oz	400	402	402	405	412
alkanes	Water	oz	0.488	0.488	0.488	0.488	0.488
alkenes	Water	oz	0.0446	0.0446	0.0446	0.0446	0.0446
AOX	Water	oz	0.0133	0.0133	0.0133	0.0134	0.0134
As	Water	oz	0.809	0.813	0.813	0.819	0.832
B	Water	lb	92.7	106	54.1	64.3	62.2
Ba	Water	oz	40.8	40.9	40.9	41.2	41.7
baryte	Water	oz	84	84.1	84.1	84.1	84.2
Be	Water	oz	0.000301	0.000301	0.000301	0.000301	0.000301
benzene	Water	oz	0.493	0.493	0.493	0.493	0.494
BOD	Water	lb	26.1	33.6	53.8	52.4	62.3
calcium compounds	Water	oz	295	295	295	295	296
calcium ions	Water	lb	523	523	523	523	523
Cd	Water	oz	15.2	21.2	38.6	37.3	45.4
chlorinated solvents (unspec.)	Water	oz	0.00024	0.000241	0.000241	0.000242	0.000243

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
chlorobenzenes	Water	oz	1.08E-7	1.08E-7	1.08E-7	1.08E-7	1.08E-7
chromate	Water	oz	0.379	0.439	0.266	0.303	0.307
Cl-	Water	tn.sh	1.09	1.28	1.82	1.78	2.03
Co	Water	oz	0.787	0.791	0.791	0.797	0.81
COD	Water	lb	247	308	414	411	478
Cr	Water	oz	19.3	25.3	42.7	41.4	49.6
Cr (VI)	Water	oz	0.000863	0.000863	0.000863	0.000864	0.000865
crude oil	Water	oz	9.76	9.77	9.77	9.79	9.81
Cs	Water	oz	0.00369	0.00369	0.00369	0.00369	0.00369
Cu	Water	oz	2.05	2.06	2.06	2.08	2.12
CxHy	Water	oz	57	57.1	57.1	57.1	57.1
CxHy aromatic	Water	oz	2.29	2.29	2.29	2.29	2.3
CxHy chloro	Water	oz	0.000868	0.000869	0.000869	0.000869	0.00087
cyanide	Water	oz	0.227	0.237	0.263	0.263	0.28
detergent/oil	Water	oz	1.35	1.35	1.35	1.35	1.35
di(2-ethylhexyl)phthalate	Water	oz	2.99E-7	2.99E-7	2.99E-7	2.99E-7	2.99E-7
dibutyl p-phthalate	Water	oz	2.81E-6	2.81E-6	2.81E-6	2.81E-6	2.81E-6
dichloroethane	Water	oz	0.00402	0.00402	0.00402	0.00402	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	1.77E-5	1.77E-5
dissolved organics	Water	oz	43.8	43.8	43.8	43.8	43.8
dissolved solids	Water	tn.lg	9.29	12.9	23.4	22.6	27.6
dissolved substances	Water	oz	168	169	169	170	173
DOC	Water	oz	0.77	0.77	0.77	0.77	0.77
ethyl benzene	Water	oz	0.0885	0.0885	0.0885	0.0886	0.0886
F2	Water	oz	0.117	0.18	0.18	0.18	0.227

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
fats/oils	Water	oz	34.4	34.4	34.4	34.4	34.4
fatty acids as C	Water	oz	8.28	8.28	8.28	8.28	8.29
Fe	Water	lb	150	170	92.5	108	105
fluoride ions	Water	oz	298	306	274	281	279
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	9.12	9.12	9.12	9.14	9.16
H2S	Water	oz	0.0508	0.052	0.052	0.0544	0.0591
H2SO4	Water	oz	370	425	216	257	249
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	0.00354	0.00403	0.0054	0.00532	0.00602
HOCL	Water	oz	2.41	2.41	2.41	2.41	2.41
I	Water	oz	0.368	0.368	0.368	0.368	0.368
inorganic general	Water	lb	588	588	588	588	588
K	Water	oz	141	142	142	143	145
Kjeldahl-N	Water	oz	17.8	18.4	18.4	19.7	22.3
metallic ions	Water	oz	37.2	39.7	34.3	35.7	36.4
Mg	Water	oz	337	338	338	341	346
Mn	Water	lb	80	91.7	46.8	55.5	53.7
Mo	Water	oz	1.27	1.28	1.28	1.28	1.3
MTBE	Water	oz	0.000257	0.000257	0.000257	0.000257	0.000257
N-tot	Water	oz	9.13	9.13	9.13	9.13	9.13
N organically bound	Water	oz	0.346	0.346	0.346	0.346	0.347
Na	Water	lb	296	297	296	296	297
NH3	Water	oz	28.8	32.6	19.1	21.8	21.5

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
NH3 (as N)	Water	oz	14.1	14.1	14.1	14.1	14.1
NH4+	Water	oz	0.109	0.109	0.109	0.109	0.109
Ni	Water	oz	2.05	2.06	2.06	2.07	2.11
nitrate	Water	oz	15.8	16.6	13.6	14.1	14
nitrite	Water	oz	0.126	0.126	0.126	0.127	0.127
nitrogen	Water	oz	0.266	0.266	0.266	0.266	0.266
non methane VOC	Water	oz	6.78	6.89	6.89	7.1	7.52
OCI-	Water	oz	0.514	0.514	0.514	0.514	0.515
oil	Water	lb	374	518	937	905	1.1E3
other organics	Water	lb	77.3	103	162	158	190
P-compounds	Water	oz	0.00186	0.00188	0.00188	0.00191	0.00196
P-tot	Water	oz	0.000465	0.000465	0.000465	0.000465	0.000465
P2O5	Water	oz	0.464	0.464	0.464	0.464	0.464
PAH's	Water	oz	0.0898	0.0898	0.0898	0.0898	0.0899
Pb	Water	oz	2.4	2.41	2.41	2.42	2.46
pesticides	Water	oz	x	x	x	x	x
phenol	Water	oz	0.513	0.521	0.503	0.508	0.51
phenols	Water	oz	0.227	0.227	0.227	0.227	0.228
phosphate	Water	oz	401	429	325	345	341
Ru	Water	oz	0.0161	0.0161	0.0161	0.0161	0.0161
S	Water	oz	0.0643	0.0644	0.0644	0.0644	0.0644
salt	Water	oz	13.7	13.7	13.7	13.8	13.8
salts	Water	oz	168	169	169	169	171
Sb	Water	oz	0.00548	0.00549	0.00549	0.00549	0.0055
Se	Water	oz	2.01	2.01	2.01	2.03	2.06
Si	Water	oz	0.0499	0.0499	0.0499	0.0499	0.05

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
Sn	Water	oz	0.00435	0.00435	0.00435	0.00435	0.00436
SO3	Water	oz	0.337	0.337	0.337	0.337	0.337
Sr	Water	oz	27	27	27	27.1	27.1
sulphate	Water	lb	1.25E3	1.61E3	2.21E3	2.2E3	2.59E3
sulphates	Water	lb	142	142	142	143	143
sulphide	Water	oz	1.41	1.43	1.43	1.47	1.56
suspended solids	Water	lb	1.79E3	2.05E3	1.12E3	1.31E3	1.28E3
suspended substances	Water	oz	164	164	164	164	164
tetrachloroethene	Water	oz	7.81E-6	7.81E-6	7.81E-6	7.81E-6	7.81E-6
tetrachloromethane	Water	oz	1.19E-5	1.19E-5	1.19E-5	1.19E-5	1.19E-5
Ti	Water	oz	23.6	23.7	23.7	23.9	24.3
TOC	Water	oz	84.7	84.8	84.8	84.8	85
toluene	Water	oz	0.43	0.43	0.43	0.43	0.43
tributyltin	Water	oz	0.0138	0.0138	0.0138	0.0138	0.0138
trichloroethene	Water	oz	0.000674	0.000674	0.000674	0.000674	0.000675
trichloromethane	Water	oz	0.00183	0.00183	0.00183	0.00183	0.00183
triethylene glycol	Water	oz	0.77	0.77	0.77	0.77	0.77
undissolved substances	Water	lb	129	129	129	129	129
V	Water	oz	2.11	2.12	2.12	2.13	2.16
vinyl chloride	Water	oz	2.22E-6	2.22E-6	2.22E-6	2.22E-6	2.22E-6
VOC as C	Water	oz	0.56	0.56	0.56	0.56	0.561
W	Water	oz	0.00676	0.00676	0.00676	0.00677	0.00678
xylene	Water	oz	0.356	0.356	0.356	0.356	0.356
Zn	Water	oz	9.53	11.6	17.6	17.1	20
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 ICF Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
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	19.7	20.4	20.4	21.8	24.7
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	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	283	283	283	283	283
mineral waste	Solid	lb	123	123	123	123	123
oil	Solid	oz	542	545	545	550	560
plastic production waste	Solid	oz	12	12	12	12	12
produc. waste (not inert)	Solid	lb	266	266	266	267	267
slag	Solid	oz	332	332	332	332	332
slags/ash	Solid	oz	58.5	58.5	58.5	58.5	58.5
solid waste	Solid	tn.lg	226	262	167	188	192
unspecified	Solid	oz	0.246	0.246	0.246	0.246	0.246
wood (sawdust)	Solid	tn.lg	1.33	1.33	1.33	1.33	1.33
Al (ind.)	Soil	oz	2.86	2.86	2.86	2.86	2.86
As (ind.)	Soil	oz	0.00114	0.00115	0.00115	0.00115	0.00115
C (ind.)	Soil	oz	8.79	8.79	8.79	8.79	8.8
Ca (ind.)	Soil	oz	11.4	11.5	11.5	11.5	11.5
Cd (ind.)	Soil	oz	4.87E-5	4.88E-5	4.88E-5	4.9E-5	4.94E-5
Co (ind.)	Soil	oz	4.36E-5	4.36E-5	4.36E-5	4.36E-5	4.36E-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 ICF Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
Fe (ind.)	Soil	oz	5.74	5.74	5.74	5.74	5.74
Hg (ind.)	Soil	oz	8.59E-6	8.65E-6	8.65E-6	8.78E-6	9.04E-6
Mn (ind.)	Soil	oz	0.114	0.115	0.115	0.115	0.115
N	Soil	oz	0.00441	0.00448	0.00448	0.00462	0.00489
Ni (ind.)	Soil	oz	0.000326	0.000326	0.000326	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	0.16	0.16	0.16	0.161	0.163
Pb (ind.)	Soil	oz	0.000997	0.000997	0.000997	0.000998	0.000999
S (ind.)	Soil	oz	1.72	1.72	1.72	1.72	1.72
Zn (ind.)	Soil	oz	0.0451	0.0451	0.0451	0.0451	0.0451
Ag110m to air	Non mat.	Bq	0.0363	0.0363	0.0363	0.0363	0.0364
Ag110m to water	Non mat.	Bq	248	248	248	248	249
alpha radiation (unspecified) to water	Non mat.	Bq	0.0293	0.0293	0.0293	0.0293	0.0293
Am241 to air	Non mat.	Bq	0.695	0.695	0.695	0.695	0.696
Am241 to water	Non mat.	Bq	91.3	91.3	91.3	91.3	91.4
Ar41 to air	Non mat.	Bq	7.88E4	7.88E4	7.88E4	7.88E4	7.89E4
Ba140 to air	Non mat.	Bq	0.161	0.161	0.161	0.161	0.161
Ba140 to water	Non mat.	Bq	0.771	0.771	0.771	0.772	0.772
beta radiation (unspecified) to air	Non mat.	Bq	0.00707	0.00707	0.00707	0.00707	0.00708
C14 to air	Non mat.	Bq	5.66E4	5.66E4	5.66E4	5.66E4	5.67E4
C14 to water	Non mat.	Bq	4.61E3	4.61E3	4.61E3	4.62E3	4.62E3
Cd109 to water	Non mat.	Bq	0.00447	0.00447	0.00447	0.00447	0.00448
Ce141 to air	Non mat.	Bq	0.00339	0.00339	0.00339	0.0034	0.0034
Ce141 to water	Non mat.	Bq	0.115	0.115	0.115	0.115	0.116
Ce144 to air	Non mat.	Bq	7.39	7.39	7.39	7.39	7.4

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
Ce144 to water	Non mat.	Bq	2.09E3	2.09E3	2.09E3	2.09E3	2.1E3
Cm (alpha) to air	Non mat.	Bq	1.1	1.1	1.1	1.1	1.1
Cm (alpha) to water	Non mat.	Bq	121	121	121	121	121
Cm242 to air	Non mat.	Bq	3.56E-6	3.56E-6	3.56E-6	3.56E-6	3.56E-6
Cm244 to air	Non mat.	Bq	3.23E-5	3.23E-5	3.23E-5	3.23E-5	3.23E-5
Co57 to air	Non mat.	Bq	6.2E-5	6.2E-5	6.2E-5	6.2E-5	6.21E-5
Co57 to water	Non mat.	Bq	0.794	0.794	0.794	0.794	0.795
Co58 to air	Non mat.	Bq	1.03	1.03	1.03	1.03	1.03
Co58 to water	Non mat.	Bq	506	506	506	506	506
Co60 to air	Non mat.	Bq	1.56	1.56	1.56	1.56	1.56
Co60 to water	Non mat.	Bq	2.04E4	2.04E4	2.04E4	2.04E4	2.05E4
Conv. to continuous urban land	Non mat.	sq.yd	2.33	2.34	2.34	2.37	2.42
Conv. to industrial area	Non mat.	sq.yd	1.42	1.42	1.42	1.42	1.42
Cr51 to air	Non mat.	Bq	0.13	0.13	0.13	0.13	0.13
Cr51 to water	Non mat.	Bq	17	17	17	17.1	17.1
Cs134 to air	Non mat.	Bq	26.3	26.3	26.3	26.4	26.4
Cs134 to water	Non mat.	Bq	4.67E3	4.67E3	4.67E3	4.67E3	4.68E3
Cs136 to water	Non mat.	Bq	0.00415	0.00415	0.00415	0.00415	0.00416
Cs137 to air	Non mat.	Bq	50.9	50.9	50.9	50.9	51
Cs137 to water	Non mat.	Bq	4.31E4	4.31E4	4.31E4	4.31E4	4.32E4
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	266	266
H3 to air	Non mat.	Bq	5.65E5	5.66E5	5.66E5	5.66E5	5.67E5
H3 to water	Non mat.	Bq	1.37E8	1.37E8	1.37E8	1.37E8	1.37E8
heat losses to air	Non mat.	MWh	71.9	72.4	72.4	73.5	75.6

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
heat losses to soil	Non mat.	kWh	25.5	25.6	25.6	25.6	25.6
heat losses to water	Non mat.	MWh	-3.4	-3.4	-3.4	-3.4	-3.4
I129 to air	Non mat.	Bq	198	198	198	198	199
I129 to water	Non mat.	Bq	1.32E4	1.32E4	1.32E4	1.32E4	1.32E4
I131 to air	Non mat.	Bq	27.2	27.2	27.2	27.2	27.2
I131 to water	Non mat.	Bq	9.9	9.9	9.9	9.91	9.92
I133 to air	Non mat.	Bq	12.1	12.1	12.1	12.1	12.1
I133 to water	Non mat.	Bq	3.54	3.54	3.54	3.54	3.54
I135 to air	Non mat.	Bq	18	18	18	18	18
K40 to air	Non mat.	Bq	134	134	134	134	134
K40 to water	Non mat.	Bq	357	357	357	357	357
Kr85 to air	Non mat.	Bq	3.42E9	3.42E9	3.42E9	3.42E9	3.42E9
Kr85m to air	Non mat.	Bq	5.75E3	5.75E3	5.75E3	5.76E3	5.76E3
Kr87 to air	Non mat.	Bq	2.3E3	2.3E3	2.3E3	2.3E3	2.3E3
Kr88 to air	Non mat.	Bq	1.57E5	1.57E5	1.57E5	1.57E5	1.58E5
Kr89 to air	Non mat.	Bq	1.81E3	1.81E3	1.81E3	1.81E3	1.82E3
La140 to air	Non mat.	Bq	0.0928	0.0928	0.0928	0.0929	0.093
La140 to water	Non mat.	Bq	0.16	0.16	0.16	0.16	0.16
land use (sea floor) II-III	Non mat.	m2a	100	100	100	100	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	358	358	358	358	359
land use II-IV	Non mat.	m2a	162	162	162	162	162
land use III-IV	Non mat.	m2a	22.2	22.2	22.2	22.2	22.3
land use IV-IV	Non mat.	m2a	0.239	0.239	0.239	0.239	0.239
Mn54 to air	Non mat.	Bq	0.0371	0.0371	0.0371	0.0371	0.0371
Mn54 to water	Non mat.	Bq	3.11E3	3.11E3	3.11E3	3.11E3	3.11E3

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
Mo99 to water	Non mat.	Bq	0.0541	0.0541	0.0541	0.0542	0.0542
Na24 to water	Non mat.	Bq	23.8	23.8	23.8	23.8	23.8
Nb95 to air	Non mat.	Bq	0.00658	0.00659	0.00659	0.00659	0.0066
Nb95 to water	Non mat.	Bq	0.439	0.439	0.439	0.439	0.44
Np237 to air	Non mat.	Bq	3.63E-5	3.63E-5	3.63E-5	3.64E-5	3.64E-5
Np237 to water	Non mat.	Bq	5.84	5.84	5.84	5.85	5.85
Occup. as contin. urban land	Non mat.	m2a	31.5	32.3	32.3	33.9	37.2
Occup. as convent. arable land	Non mat.	m2a	1.26E3	1.27E3	1.27E3	1.27E3	1.27E3
Occup. as forest land	Non mat.	m2a	0.0476	0.0476	0.0476	0.0476	0.0477
Occup. as industrial area	Non mat.	m2a	920	925	925	934	951
Occup. as rail/road area	Non mat.	m2a	6.66E4	6.66E4	6.66E4	6.66E4	6.66E4
Pa234m to air	Non mat.	Bq	22	22	22	22	22.1
Pa234m to water	Non mat.	Bq	408	408	408	408	409
Pb210 to air	Non mat.	Bq	718	718	718	719	720
Pb210 to water	Non mat.	Bq	284	284	284	284	284
Pm147 to air	Non mat.	Bq	18.7	18.7	18.7	18.7	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	284	284	284
Pu alpha to air	Non mat.	Bq	2.2	2.2	2.2	2.2	2.21
Pu alpha to water	Non mat.	Bq	363	363	363	364	364
Pu238 to air	Non mat.	Bq	8.01E-5	8.01E-5	8.01E-5	8.02E-5	8.03E-5
Pu241 beta	Non mat.	Bq	9.03E3	9.03E3	9.03E3	9.04E3	9.05E3
Pu241 Beta to air	Non mat.	Bq	60.6	60.6	60.6	60.7	60.7
Ra224 to water	Non mat.	Bq	2.27E3	2.27E3	2.27E3	2.27E3	2.27E3
Ra226 to air	Non mat.	Bq	812	812	812	813	814
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 ICF Houses – U.S. Customary Units (Continued)*

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
Ra228 to air	Non mat.	Bq	65.9	66	66	66	66.1
Ra228 to water	Non mat.	Bq	4.54E3	4.54E3	4.54E3	4.54E3	4.54E3
radio active noble gases to air	Non mat.	Bq	8.17E3	8.17E3	8.17E3	8.17E3	8.18E3
radioactive substance to air	Non mat.	Bq	5.67E10	5.99E10	4.75E10	4.99E10	4.94E10
radioactive substance to water	Non mat.	Bq	3.2E8	3.2E8	3.2E8	3.2E8	3.2E8
radionuclides (mixed) to water	Non mat.	Bq	0.204	0.204	0.204	0.205	0.205
Rn220 to air	Non mat.	Bq	5.39E3	5.39E3	5.39E3	5.39E3	5.4E3
Rn222 (long term) to air	Non mat.	Bq	4.91E9	4.91E9	4.91E9	4.91E9	4.91E9
Rn222 to air	Non mat.	Bq	5.32E7	5.32E7	5.32E7	5.32E7	5.33E7
Ru103 to air	Non mat.	Bq	0.000396	0.000396	0.000396	0.000396	0.000397
Ru103 to water	Non mat.	Bq	0.259	0.259	0.259	0.26	0.26
Ru106 to air	Non mat.	Bq	220	220	220	220	221
Ru106 to water	Non mat.	Bq	2.2E4	2.2E4	2.2E4	2.2E4	2.21E4
Sb122 to water	Non mat.	Bq	0.771	0.771	0.771	0.772	0.772
Sb124 to air	Non mat.	Bq	0.0101	0.0101	0.0101	0.0101	0.0101
Sb124 to water	Non mat.	Bq	68.4	68.4	68.4	68.5	68.5
Sb125 to air	Non mat.	Bq	0.00171	0.00171	0.00171	0.00171	0.00172
Sb125 to water	Non mat.	Bq	6.31	6.31	6.31	6.31	6.31
Sr89 to air	Non mat.	Bq	0.0648	0.0648	0.0648	0.0649	0.0649
Sr89 to water	Non mat.	Bq	1.75	1.75	1.75	1.75	1.75
Sr90 to air	Non mat.	Bq	36.3	36.3	36.3	36.4	36.4
Sr90 to water	Non mat.	Bq	4.4E3	4.41E3	4.41E3	4.41E3	4.41E3
Tc99 to air	Non mat.	Bq	0.00154	0.00154	0.00154	0.00154	0.00154
Tc99 to water	Non mat.	Bq	2.31E3	2.31E3	2.31E3	2.31E3	2.32E3
Tc99m to water	Non mat.	Bq	0.365	0.365	0.365	0.365	0.366
Te123m to air	Non mat.	Bq	0.162	0.162	0.162	0.162	0.162

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
Te123m to water	Non mat.	Bq	0.0326	0.0326	0.0326	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	55.8	55.9	55.9	55.9	56
Th228 to water	Non mat.	Bq	9.09E3	9.09E3	9.09E3	9.09E3	9.1E3
Th230 to air	Non mat.	Bq	245	245	245	245	246
Th230 to water	Non mat.	Bq	6.37E4	6.37E4	6.37E4	6.38E4	6.38E4
Th232 to air	Non mat.	Bq	35.4	35.5	35.5	35.5	35.5
Th232 to water	Non mat.	Bq	66.4	66.4	66.4	66.5	66.5
Th234 to air	Non mat.	Bq	22	22	22	22	22.1
Th234 to water	Non mat.	Bq	411	411	411	412	412
U alpha to air	Non mat.	Bq	788	788	788	789	790
U alpha to water	Non mat.	Bq	2.66E4	2.67E4	2.67E4	2.67E4	2.67E4
U234 to air	Non mat.	Bq	264	264	264	264	264
U234 to water	Non mat.	Bq	545	545	545	545	546
U235 to air	Non mat.	Bq	12.8	12.8	12.8	12.8	12.8
U235 to water	Non mat.	Bq	813	813	813	814	815
U238 to air	Non mat.	Bq	362	362	362	362	363
U238 to water	Non mat.	Bq	1.39E3	1.39E3	1.39E3	1.39E3	1.39E3
waste heat to air	Non mat.	kWh	-19.5	1.18	1.18	42.5	125
waste heat to soil	Non mat.	kWh	91.1	91.1	91.1	91.1	91.1
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	2.44E6	2.44E6	2.44E6	2.44E6
Xe133m to air	Non mat.	Bq	1.2E3	1.2E3	1.2E3	1.2E3	1.2E3
Xe135 to air	Non mat.	Bq	4.44E5	4.44E5	4.44E5	4.45E5	4.45E5
Xe135m to air	Non mat.	Bq	5.73E4	5.73E4	5.73E4	5.73E4	5.73E4

*An x means there are no data.

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

Substance	Compartment	Unit	ICF				
			Miami	Phoenix	Seattle	DC	Chicago
Xe137 to air	Non mat.	Bq	1.34E3	1.34E3	1.34E3	1.34E3	1.34E3
Xe138 to air	Non mat.	Bq	1.56E4	1.56E4	1.56E4	1.56E4	1.57E4
Y90 to water	Non mat.	Bq	0.0895	0.0896	0.0896	0.0896	0.0896
Zn65 to air	Non mat.	Bq	0.167	0.167	0.167	0.168	0.168
Zn65 to water	Non mat.	Bq	50.4	50.4	50.4	50.4	50.4
Zr95 to air	Non mat.	Bq	0.00235	0.00235	0.00235	0.00236	0.00236
Zr95 to water	Non mat.	Bq	187	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.

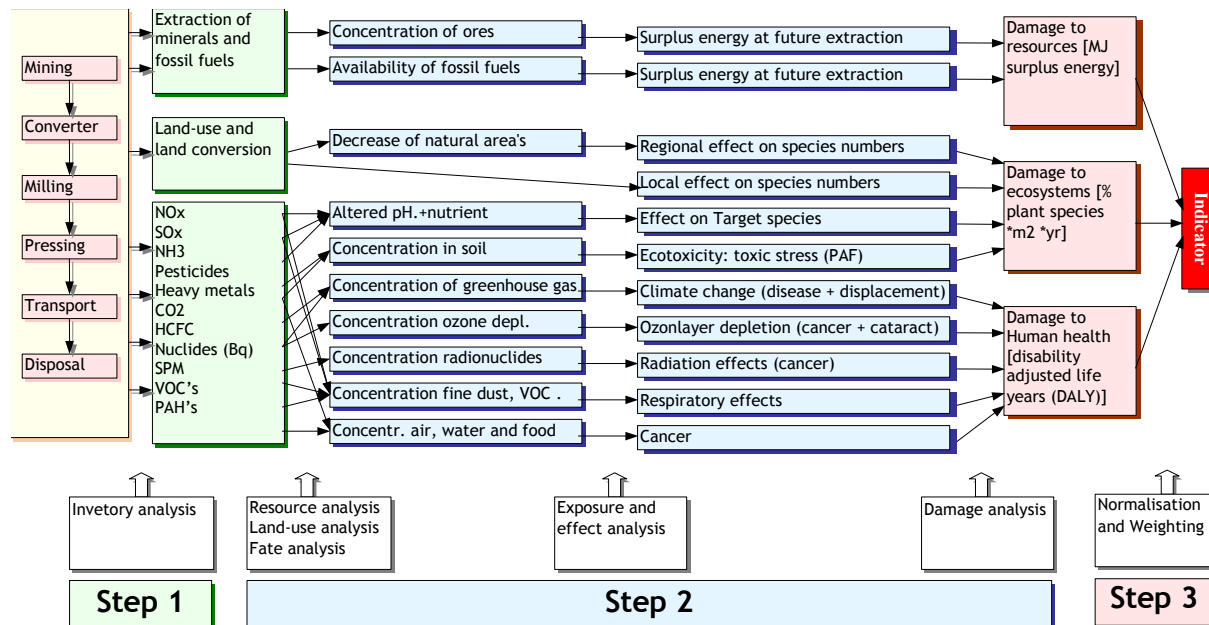


Figure 1: Detailed representation of the damage model

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 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 effects 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 extract 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

Hierchist 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 hierchist version of Eco-indicator 99 with average weighting is chosen default. In general value choices made in the hierachist 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. In 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 NO_x, 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 indicators:

- 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 ICF 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					ICF houses				
	Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Carcinogens	883	1,190	1,870	1,810	2,160	860	1,120	1,730	1,690	2,010
Respiratory organics	49	69	119	114	139	50	66	111	108	130
Respiratory inorganics	26,100	32,300	31,800	32,900	37,000	25,400	30,800	30,400	31,500	35,300
Climate change	6,760	8,330	7,830	8,150	9,110	6,500	7,860	7,410	7,750	8,610
Radiation	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4
Ozone layer	0.8	0.9	0.5	0.6	0.6	0.8	0.9	0.5	0.6	0.6
Ecotoxicity	465	515	430	451	467	452	495	419	439	453
Acidification/eutrophication	4,370	5,320	4,660	4,910	5,420	4,190	5,010	4,430	4,680	5,130
Land use	6,350	6,360	6,360	6,360	6,360	5,720	5,720	5,720	5,720	5,720
Minerals	166	166	166	167	167	169	169	169	169	169
Fossil fuels	60,600	77,400	90,600	91,000	105,000	58,400	72,800	84,600	85,700	98,600
Total (rounded)	106,000	132,000	144,000	146,000	166,000	102,000	124,000	135,000	138,000	156,000

*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					ICF houses				
	Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Carcinogens	1,180	1,590	2,510	2,430	2,900	1,150	1,500	2,320	2,270	2,700
Respiratory organics	66	93	160	153	186	66	89	149	145	174
Respiratory inorganics	34,900	43,200	42,600	44,000	49,600	34,000	41,200	40,600	42,200	47,200
Climate change	9,070	11,200	10,500	10,900	12,200	8,720	10,500	9,950	10,400	11,600
Radiation	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6
Ozone layer	1.1	1.2	0.7	0.8	0.8	1.0	1.2	0.7	0.8	0.8
Ecotoxicity	372	412	344	361	374	361	396	335	351	363
Acidification/eutrophication	3,490	4,260	3,730	3,930	4,330	3,350	4,010	3,540	3,740	4,100
Land use	5,080	5,080	5,080	5,080	5,090	4,580	4,580	4,580	4,580	4,580
Minerals	118	118	118	118	118	119	119	119	120	120
Fossil fuels	38,900	53,700	89,400	85,900	104,000	38,000	50,600	82,300	80,300	96,300
Total (rounded)	93,200	120,000	154,000	153,000	178,000	90,400	113,000	144,000	144,000	167,000

*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					ICF houses				
	Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Carcinogens	1,350	1,860	3,190	3,050	3,690	1,310	1,750	2,930	2,850	3,420
Respiratory organics	157	220	380	364	442	158	211	354	344	414
Respiratory inorganics	41,800	52,900	58,900	59,700	68,600	41,100	50,600	56,000	57,200	65,300
Climate change	22,100	27,300	25,600	26,700	29,800	21,300	25,700	24,300	25,400	28,200
Radiation	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Ozone layer	2.3	2.5	1.5	1.7	1.7	2.1	2.4	1.5	1.6	1.6
Ecotoxicity	38	45	52	52	59	37	43	49	49	55
Acidification/eutrophication	2,490	3,030	2,650	2,800	3,080	2,380	2,850	2,520	2,660	2,920
Land use	3,620	3,620	3,620	3,620	3,620	3,260	3,260	3,260	3,260	3,260
Minerals	6,610	6,610	6,610	6,620	6,640	6,700	6,710	6,710	6,720	6,740
Total (rounded)	78,200	95,500	101,000	103,000	116,000	76,300	91,200	96,100	98,400	110,000

*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					ICF houses				
	Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Global warming (GWP 100)	251,000	310,000	293,000	304,000	340,000	242,000	292,000	277,000	289,000	322,000
Ozone depletion	4,530	5,100	3,030	3,450	3,380	4,270	4,770	2,940	3,300	3,240
Acidification	185,000	234,000	256,000	260,000	298,000	178,000	220,000	239,000	245,000	279,000
Eutrophication	29,200	34,600	24,900	27,300	28,800	28,000	32,700	24,000	26,200	27,700
Photochemical smog	4,130	5,310	7,000	6,910	8,100	4,130	5,140	6,630	6,630	7,700
Ecotoxicity water, chronic	6,920	8,500	10,600	10,500	12,100	6,820	8,180	10,100	10,100	11,500
Ecotoxicity water, acute	612	759	988	974	1,120	605	731	934	930	1,070
Ecotoxicity soil, chronic	27	28	27	27	27	27	27	26	27	27
Human toxicity, air	91	101	87	91	95	88	98	85	88	92
Human toxicity, water	2,320	2,670	2,240	2,360	2,500	2,240	2,550	2,160	2,280	2,410
Human toxicity, soil	1,320	1,500	1,230	1,300	1,370	1,270	1,430	1,180	1,250	1,310
Bulk waste	209	244	155	175	178	199	229	151	168	171
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	0.03	0.03	0.03	0.03	0.03
Resources (all)	0	0	0	0	0	0	0	0	0	0
Total (rounded)	486,000	603,000	599,000	618,000	696,000	467,000	568,000	565,000	585,000	656,000

*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					ICF houses				
	Miami	Phoenix	Seattle	DC	Chicago	Miami	Phoenix	Seattle	DC	Chicago
Life expectancy	91,000	119,000	160,000	158,000	186,000	90,600	114,000	151,000	151,000	177,000
Severe morbidity	2,200	5,350	24,300	21,700	28,100	2,790	5,430	22,200	20,400	26,100
Morbidity	3,940	5,490	9,630	9,200	11,200	3,910	5,220	8,900	8,630	10,400
Severe nuisance	1,540	1,570	1,480	1,500	1,510	1,560	1,590	1,510	1,530	1,540
Nuisance	10,400	13,100	14,900	15,000	17,300	9,930	12,300	13,900	14,100	16,200
Crop growth capacity	580	698	568	607	658	558	660	545	582	629
Wood growth capacity	-1,010	-1,360	-2,110	-2,040	-2,440	-1,000	-1,300	-1,960	-1,930	-2,290
Fish and meat production	-165	-194	-129	-144	-150	-158	-183	-126	-139	-144
Soil acidification	276	349	382	388	444	265	327	357	365	416
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	307,000	404,000	637,000	614,000	731,000	301,000	383,000	590,000	577,000	682,000
Species extinction	3,510	3,620	4,320	4,220	4,460	3,180	3,280	3,890	3,820	4,030
Total (rounded)	419,000	551,000	851,000	823,000	978,000	412,000	525,000	791,000	775,000	915,000

*No units: data have been normalized and weighted.

**An x means there are no data.

**APPENDIX I – GRAPHICAL PRESENTATION OF LCA
SINGLE-SCORE SUMMARY**

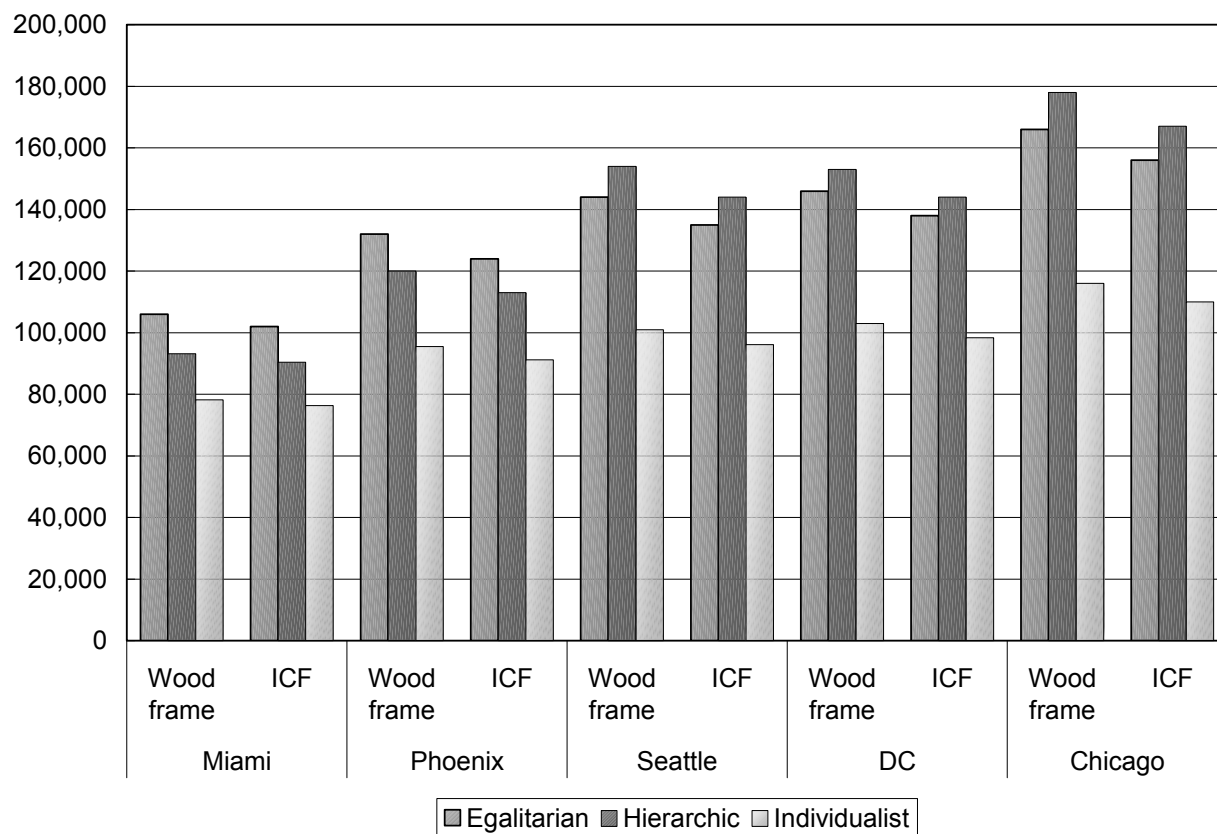


Figure I-1. LCA single score summary using the Eco-Indicator 99 method of impact assessment (there are no units because the data have been weighted and normalized).

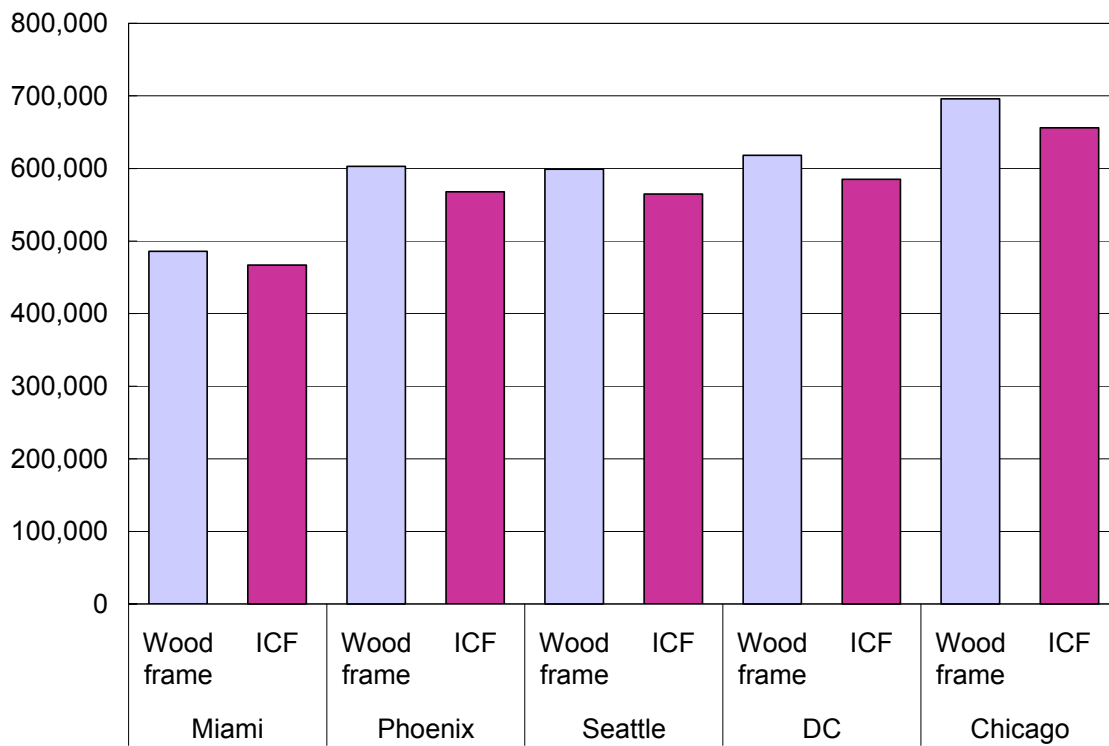


Figure I-2. LCA single score summary using the EDIP/UMIP 96 method of impact assessment (there are no units because the data have been weighted and normalized).

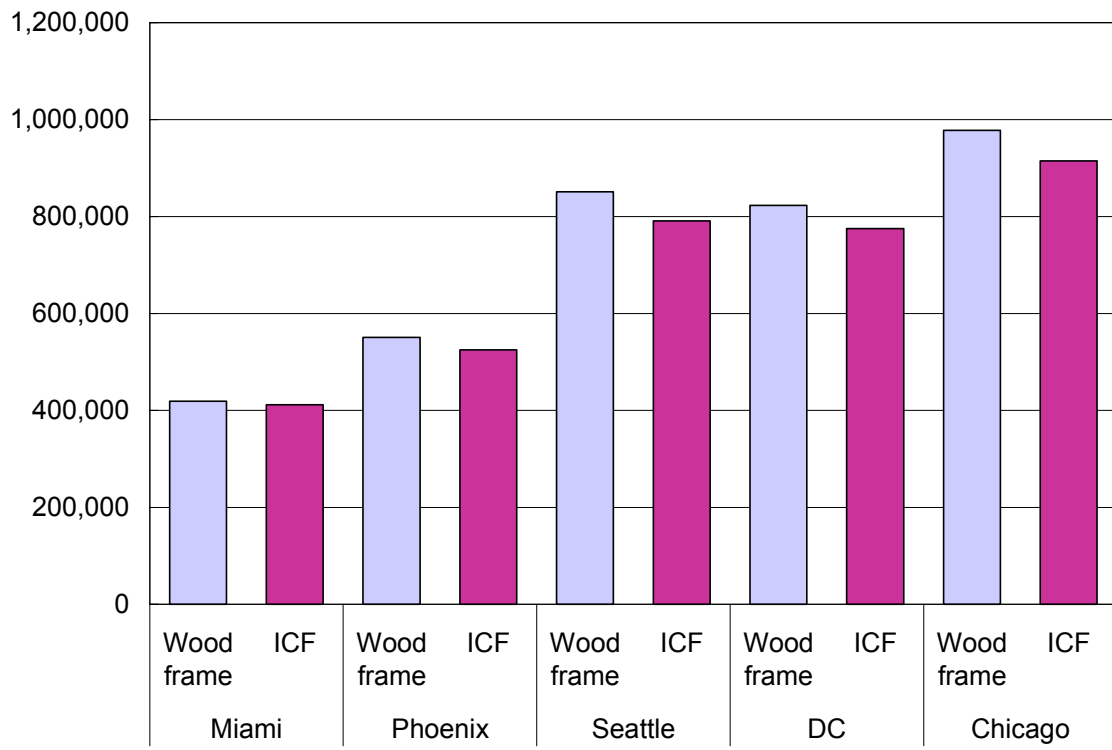


Figure I-3. LCA single score summary using the EPS 2000 method of impact assessment (there are no units because the data have been weighted and normalized).

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

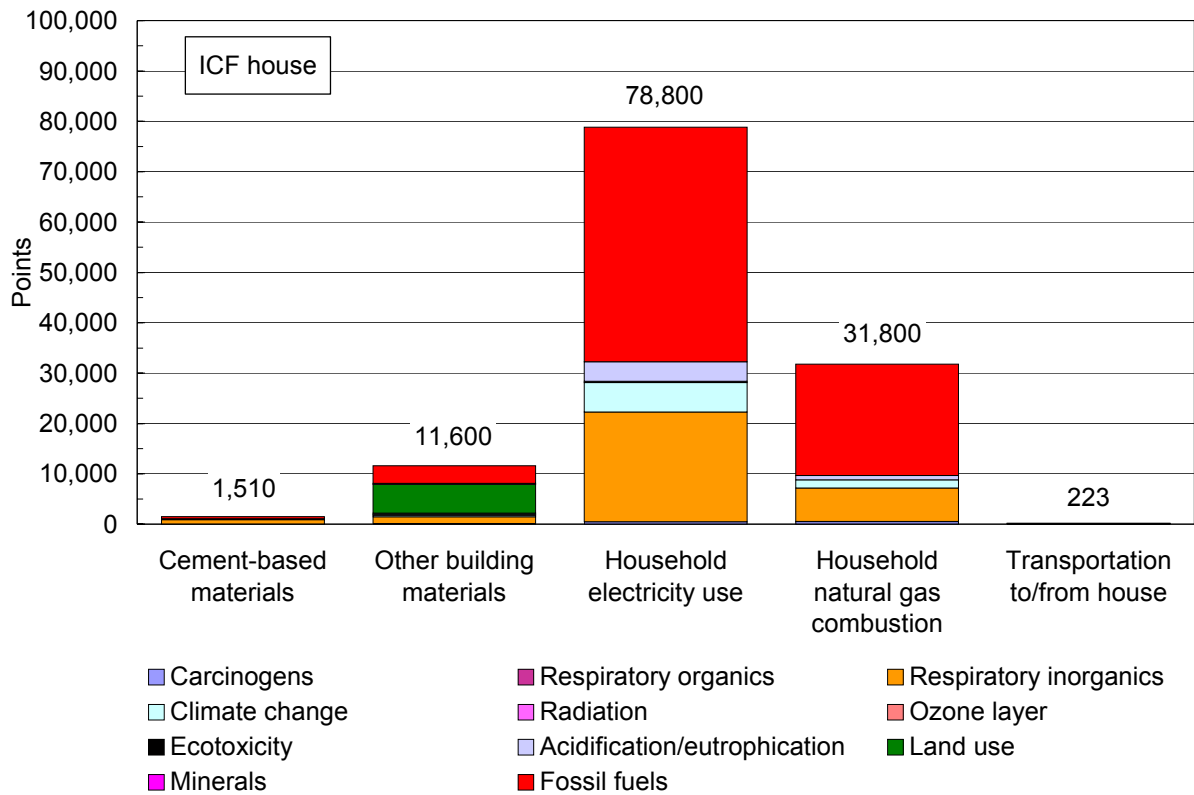


Figure J-1. Single-score life cycle inventory assessment of ICF house in Phoenix showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

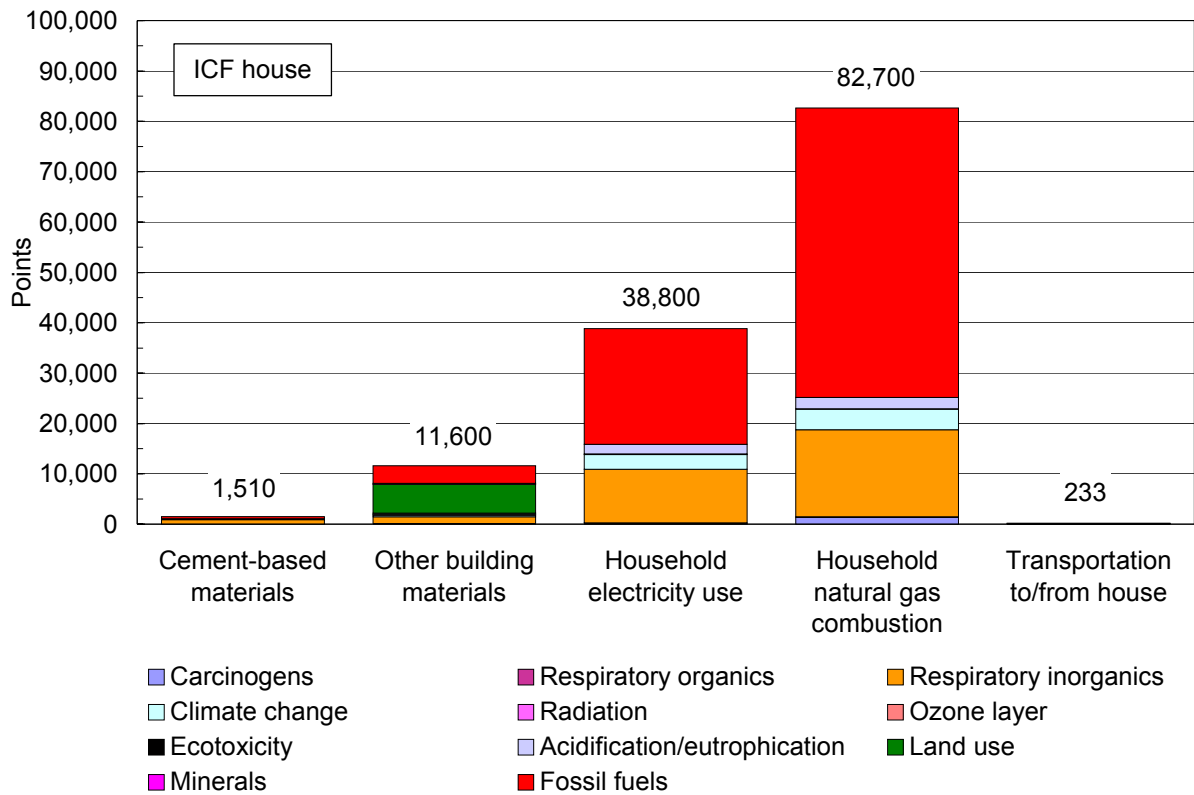


Figure J-2. Single-score life cycle inventory assessment of ICF house in Seattle showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

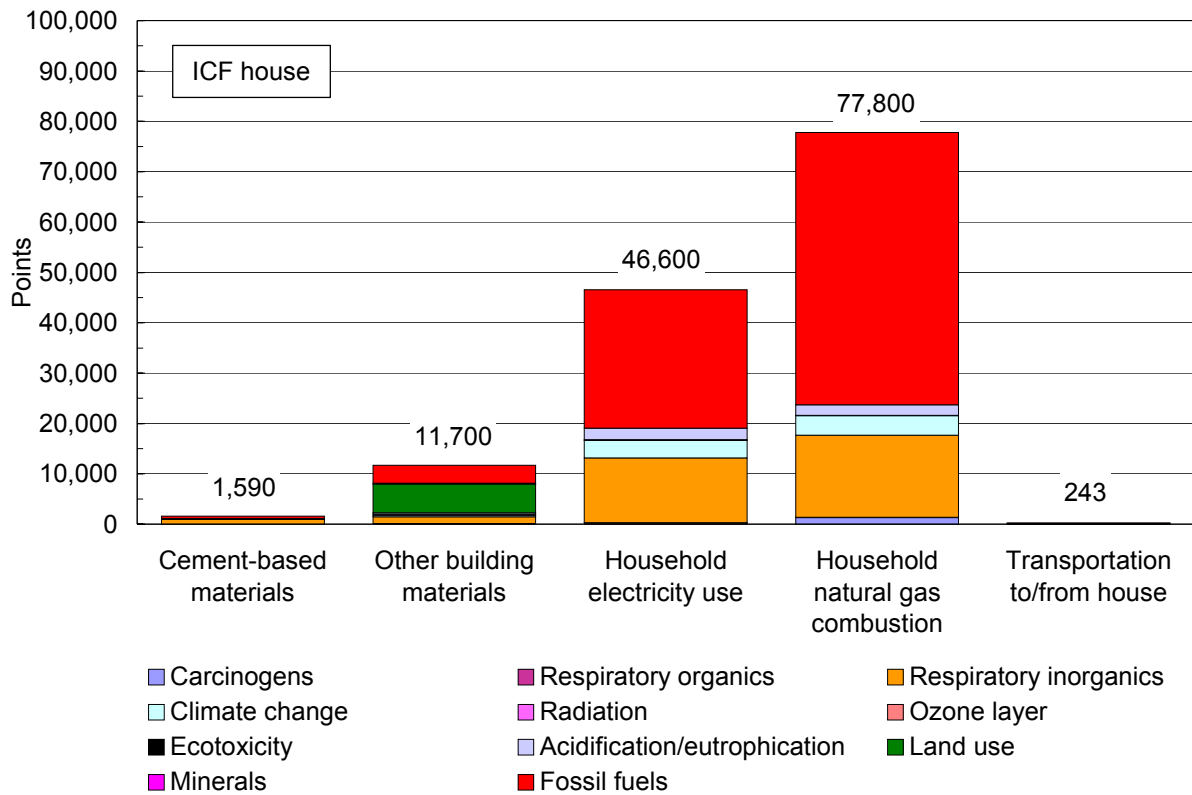


Figure J-3. Single-score life cycle inventory assessment of ICF house in Washington, DC, showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

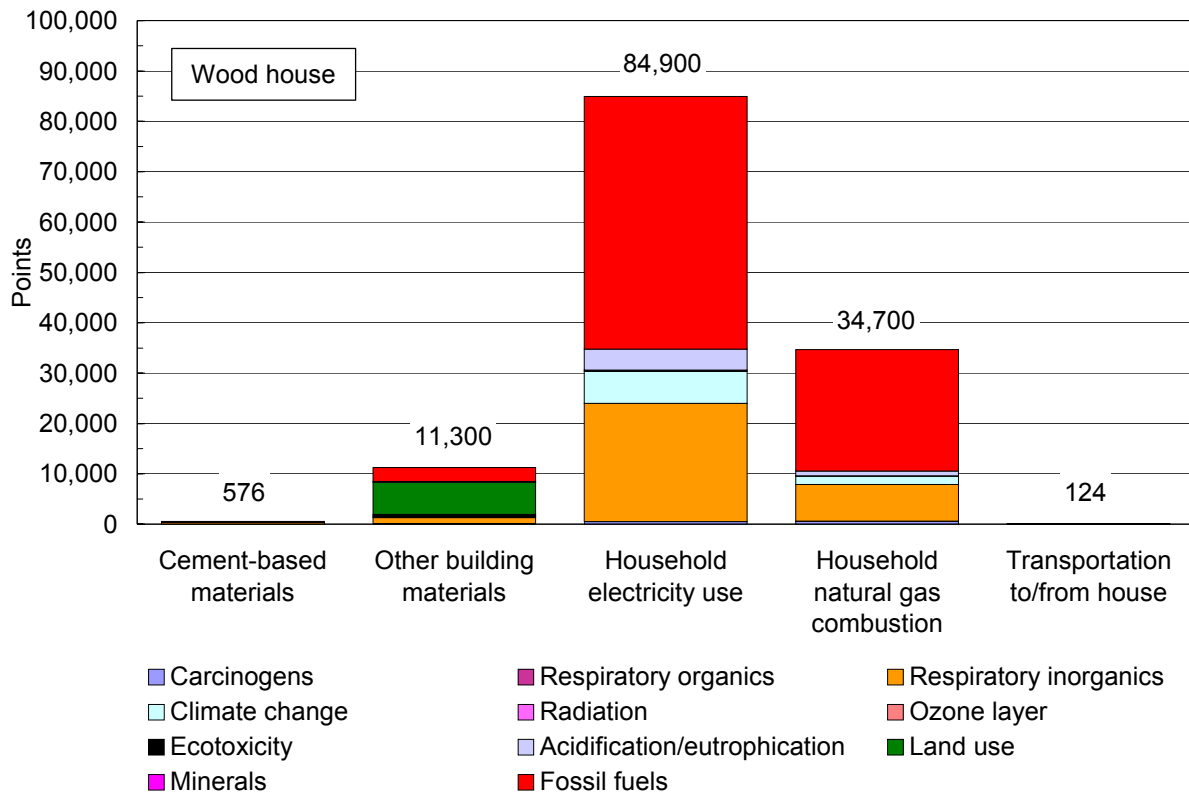


Figure J-4. Single-score life cycle inventory assessment of wood house in Phoenix showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

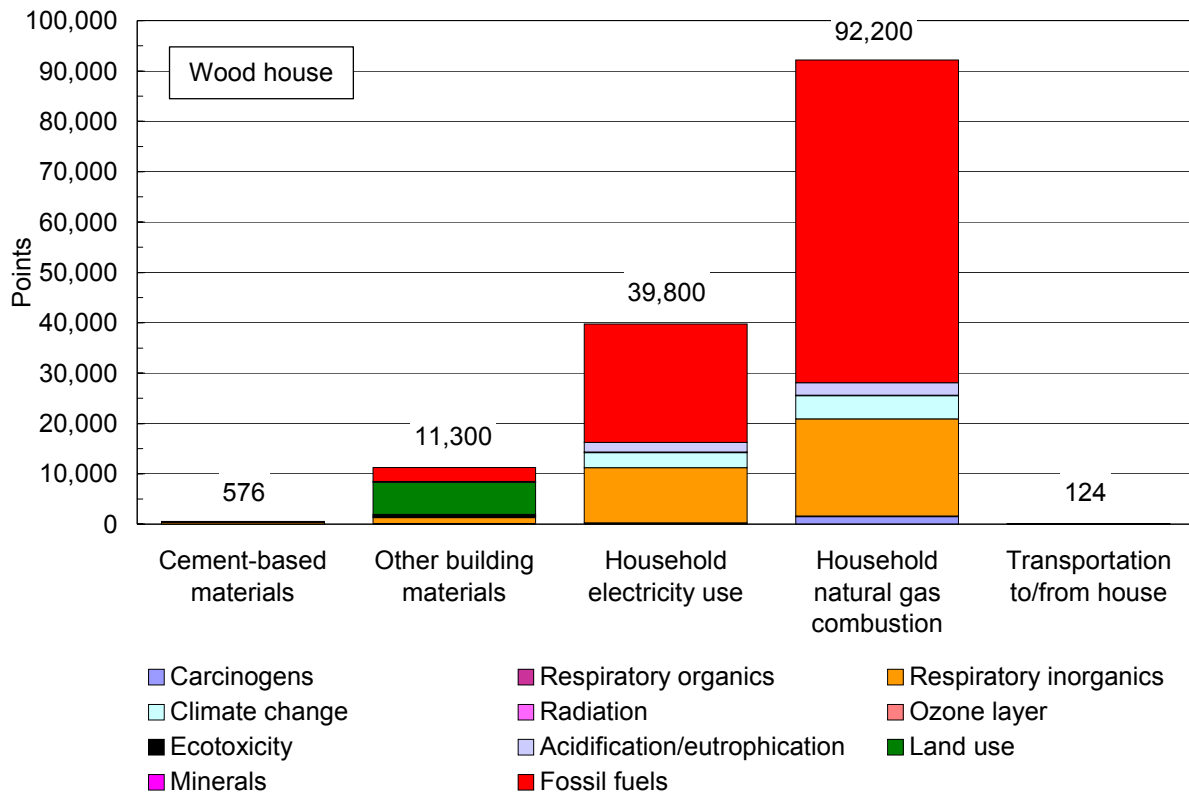


Figure J-5. Single-score life cycle inventory assessment of wood house in Seattle showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

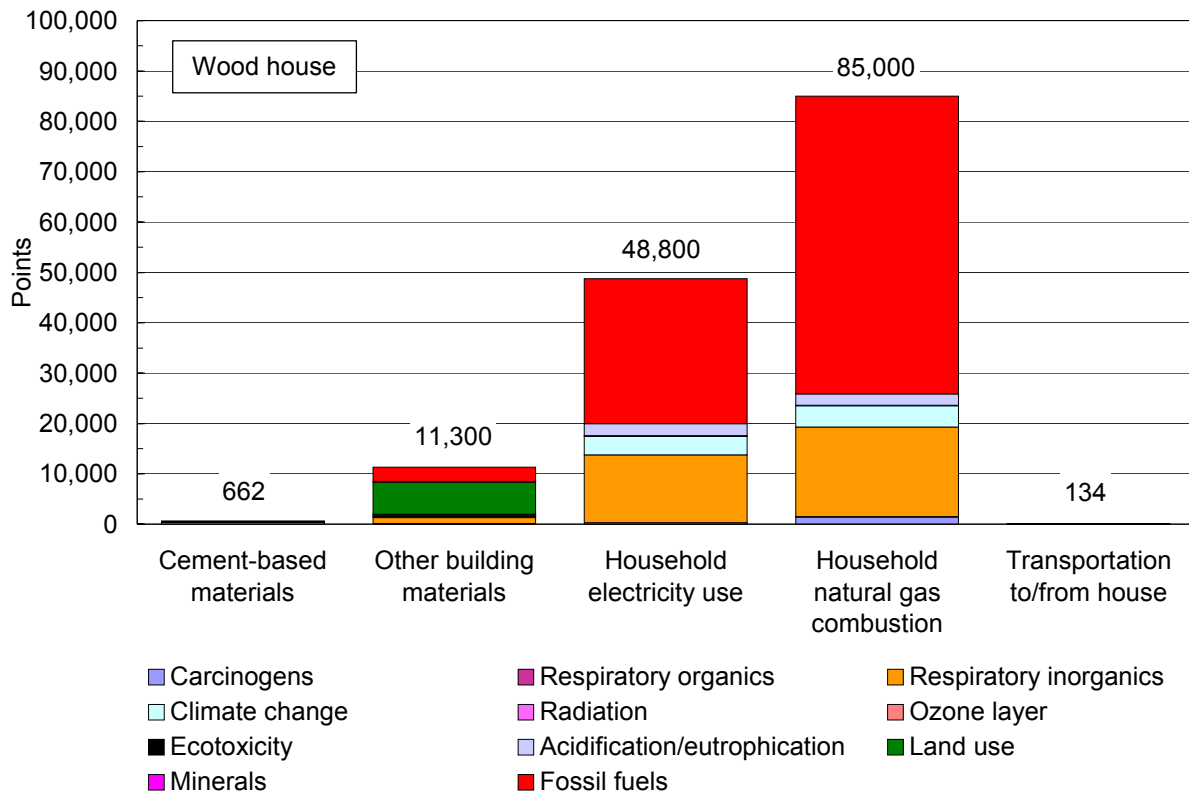


Figure J-6. Single-score life cycle inventory assessment of wood house in Washington, DC, showing contribution of each major process/product stage (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

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

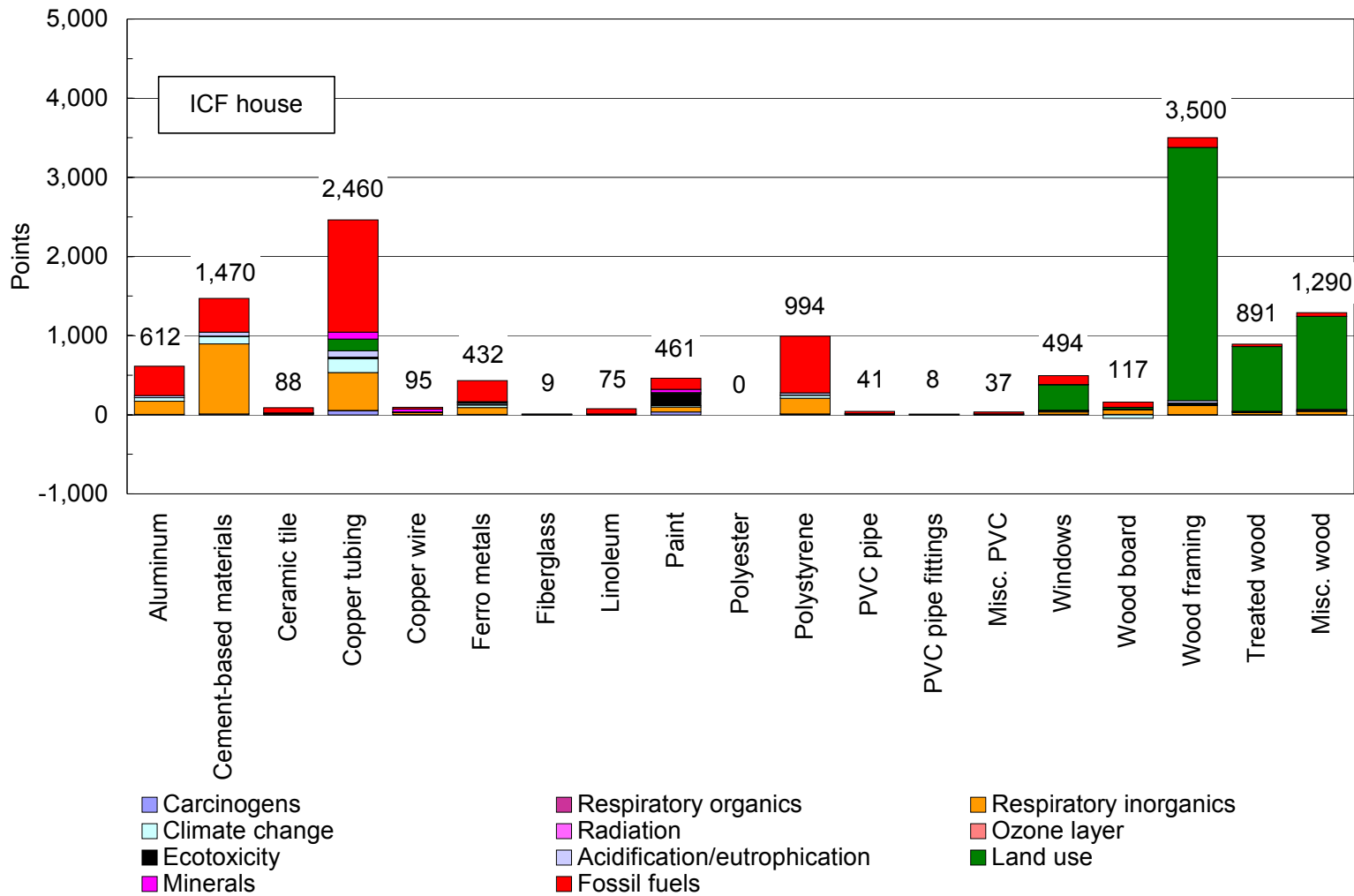


Figure K-1. Single-score life cycle inventory assessment for construction materials in the ICF house in Miami (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

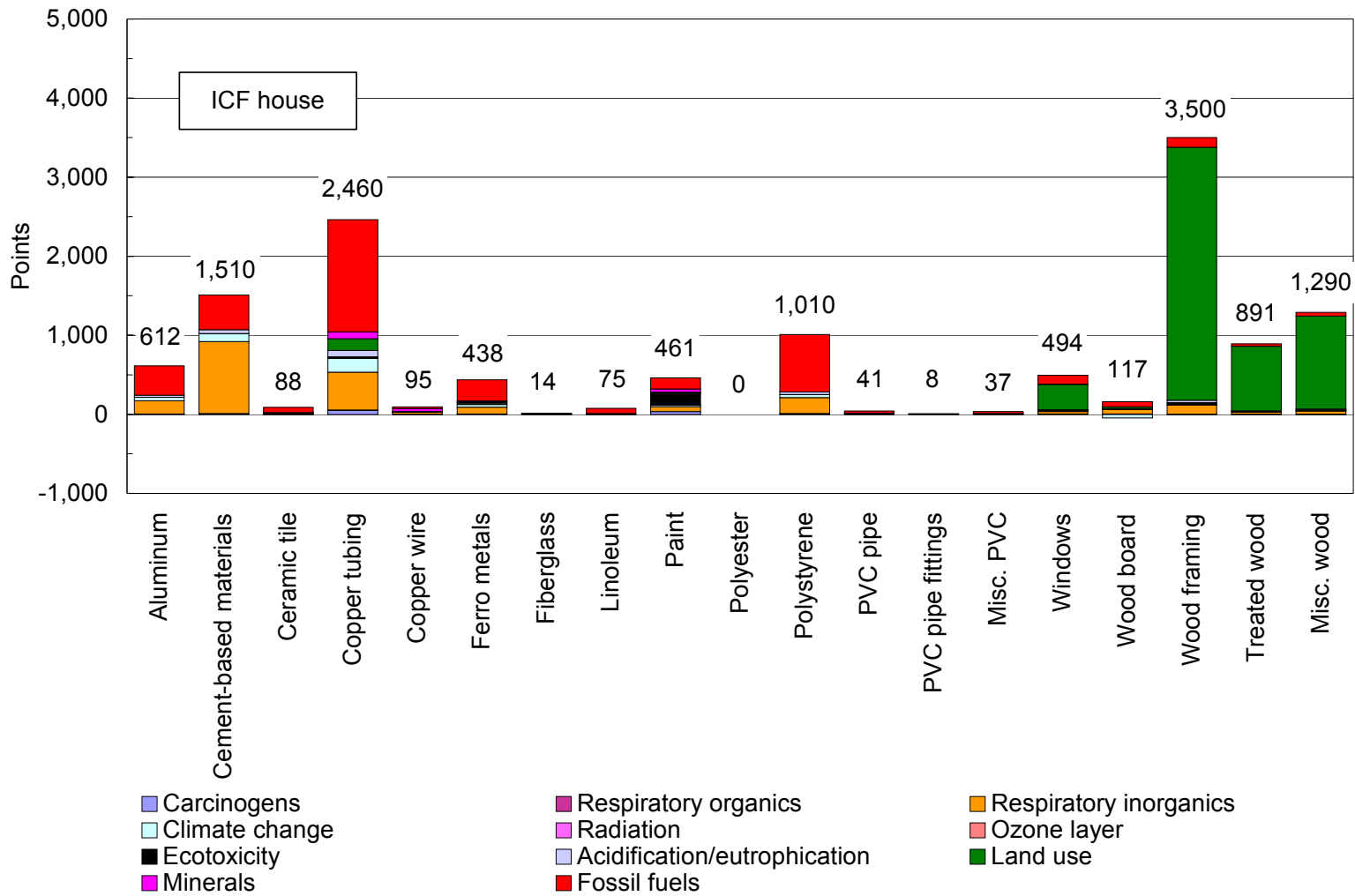


Figure K-2. Single-score life cycle inventory assessment for construction materials in the ICF house in Phoenix (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

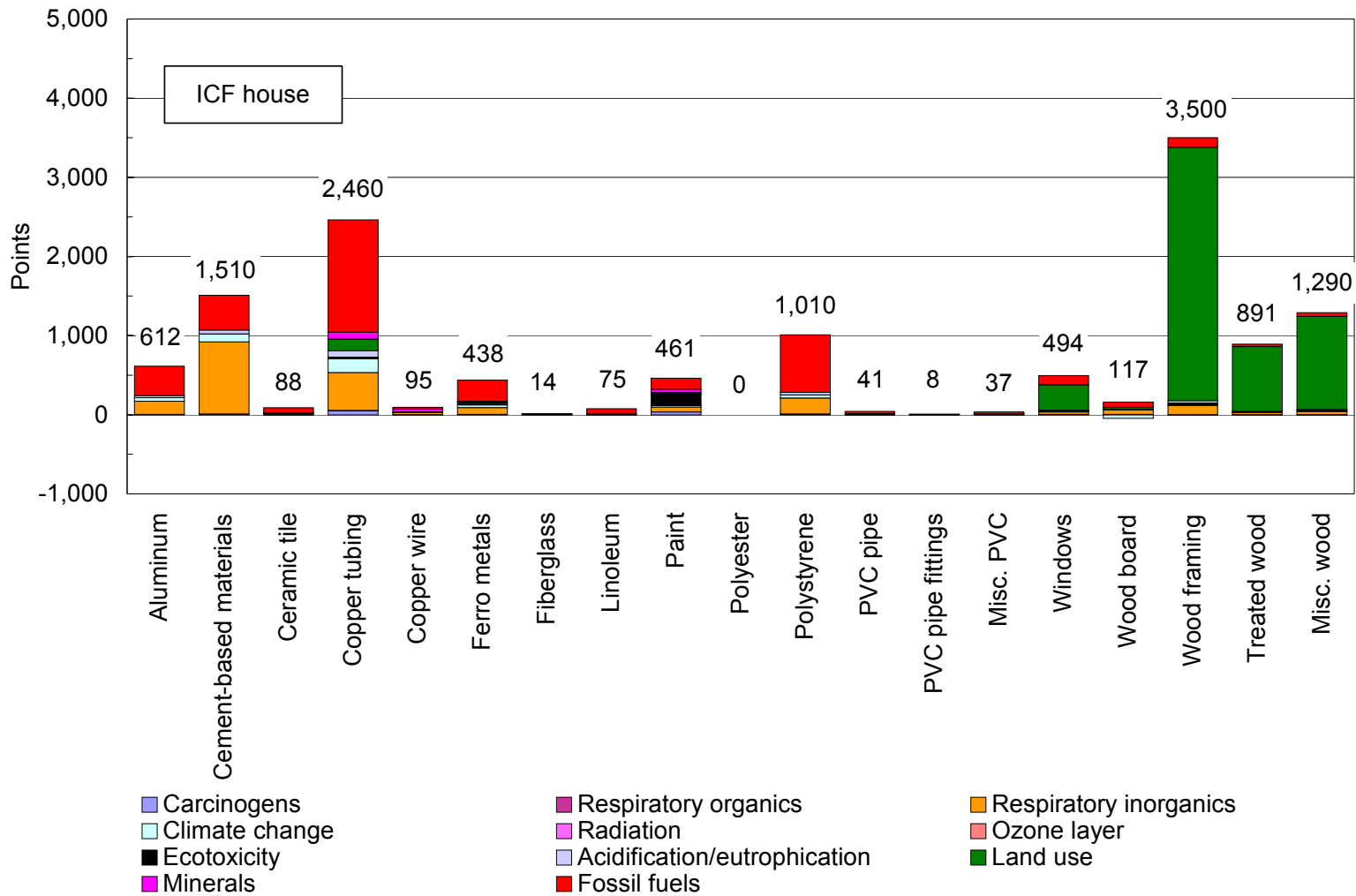


Figure K-3. Single-score life cycle inventory assessment for construction materials in the ICF house in Seattle (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

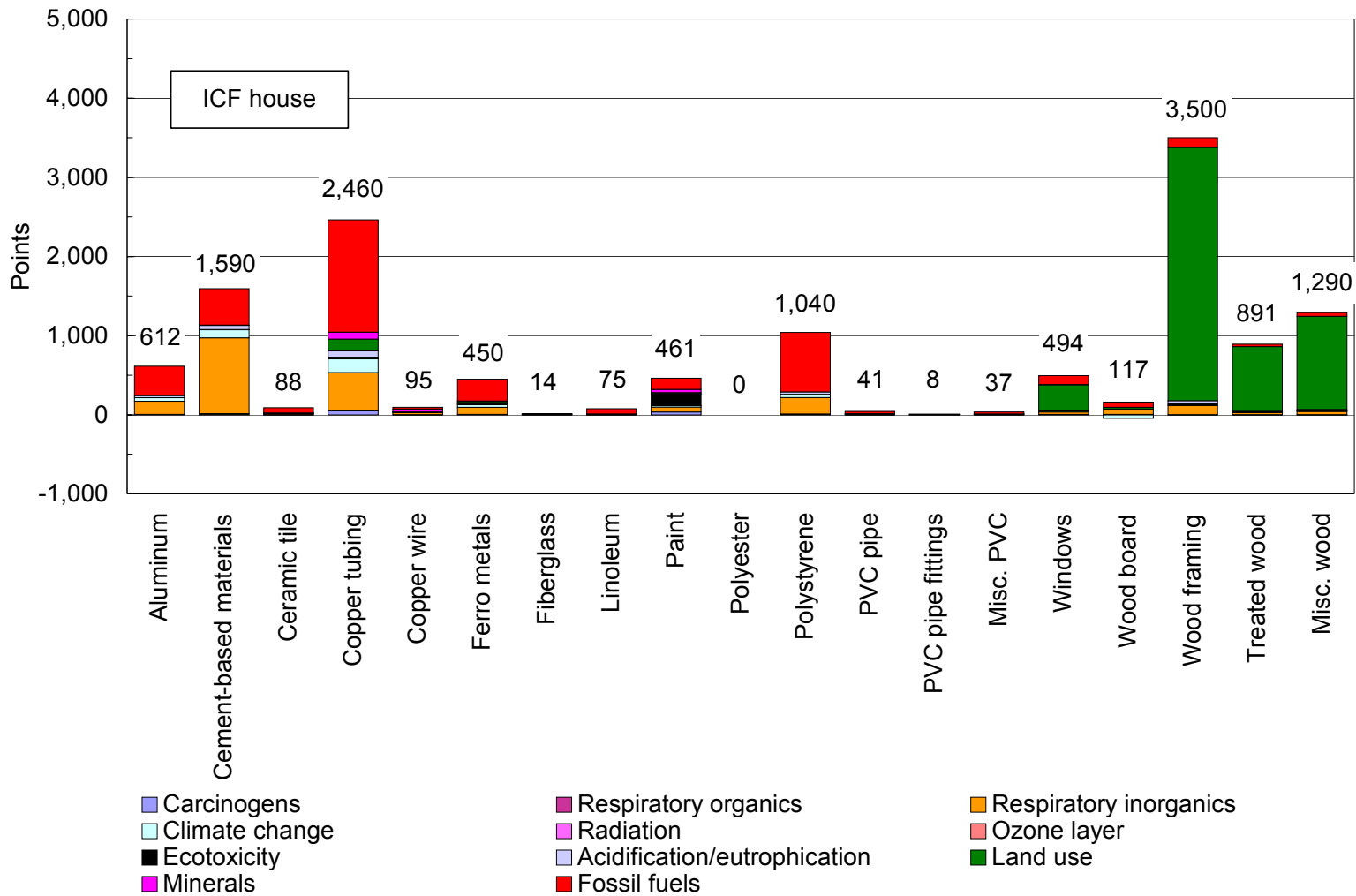


Figure K-4. Single-score life cycle inventory assessment for construction materials in the ICF house in Washington, DC (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

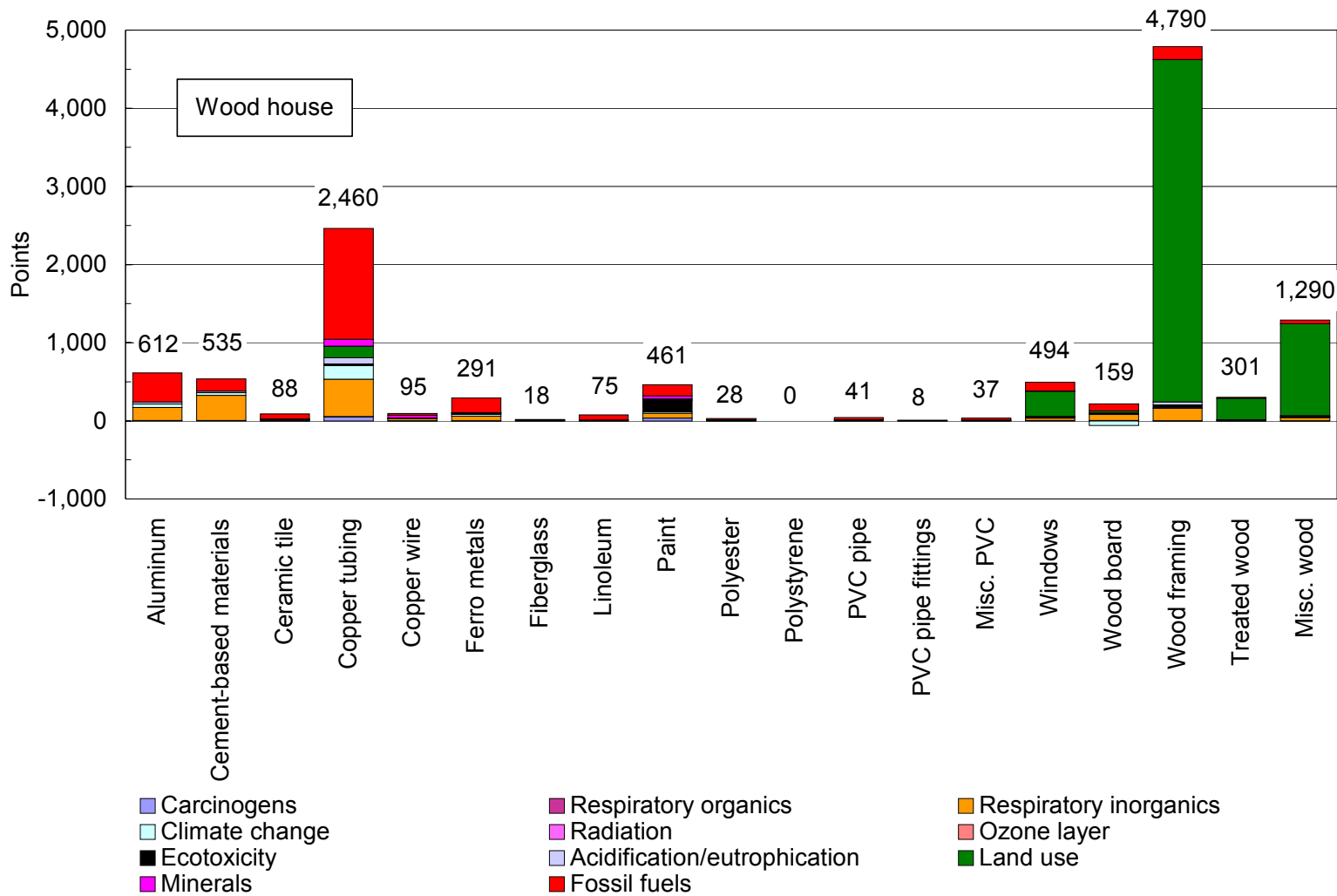


Figure K-5. Single-score life cycle inventory assessment for construction materials in the wood frame house in Miami (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

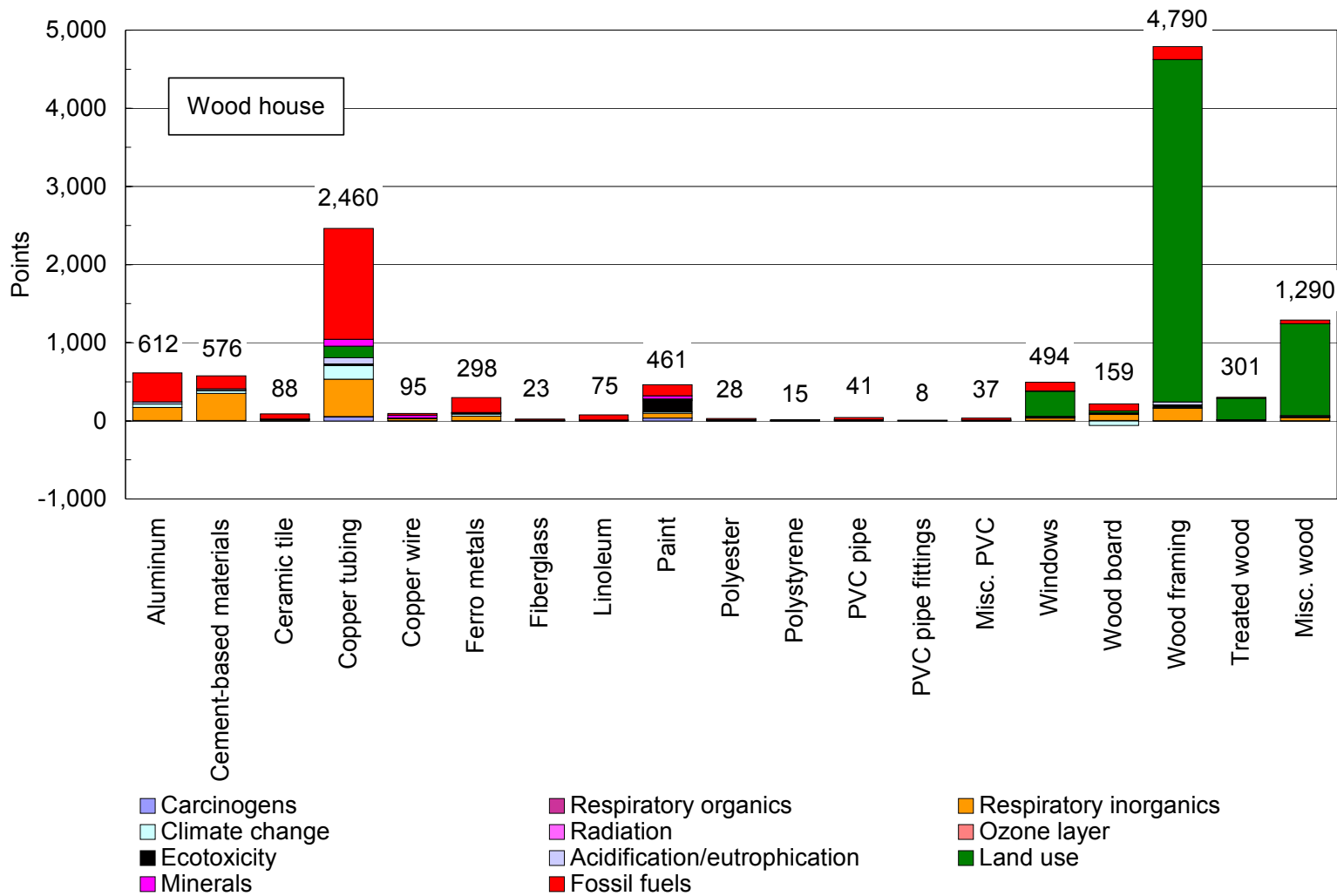


Figure K-6. Single-score life cycle inventory assessment for construction materials in the wood frame house in Phoenix (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

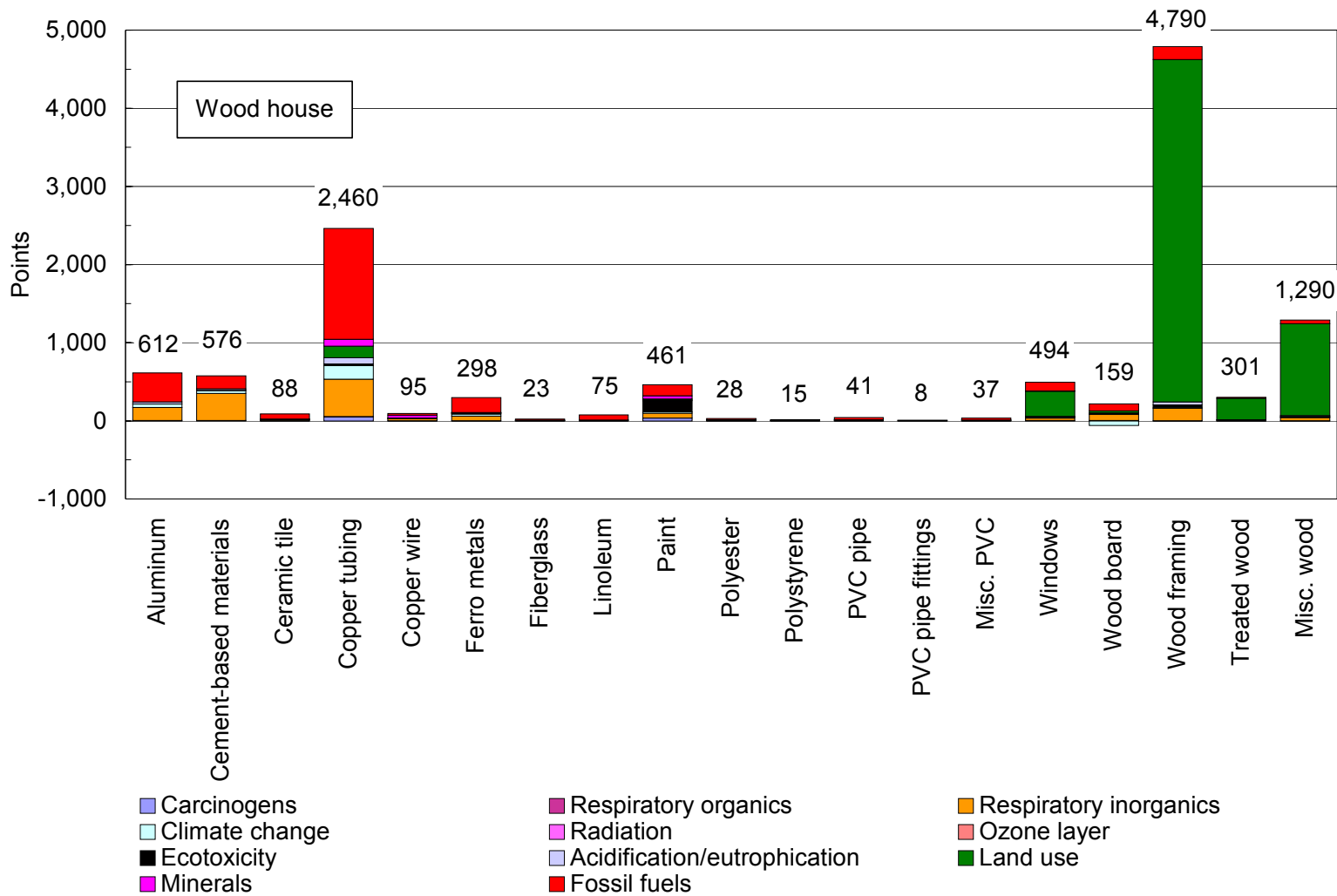


Figure K-7. Single-score life cycle inventory assessment for construction materials in the wood frame house in Seattle (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.

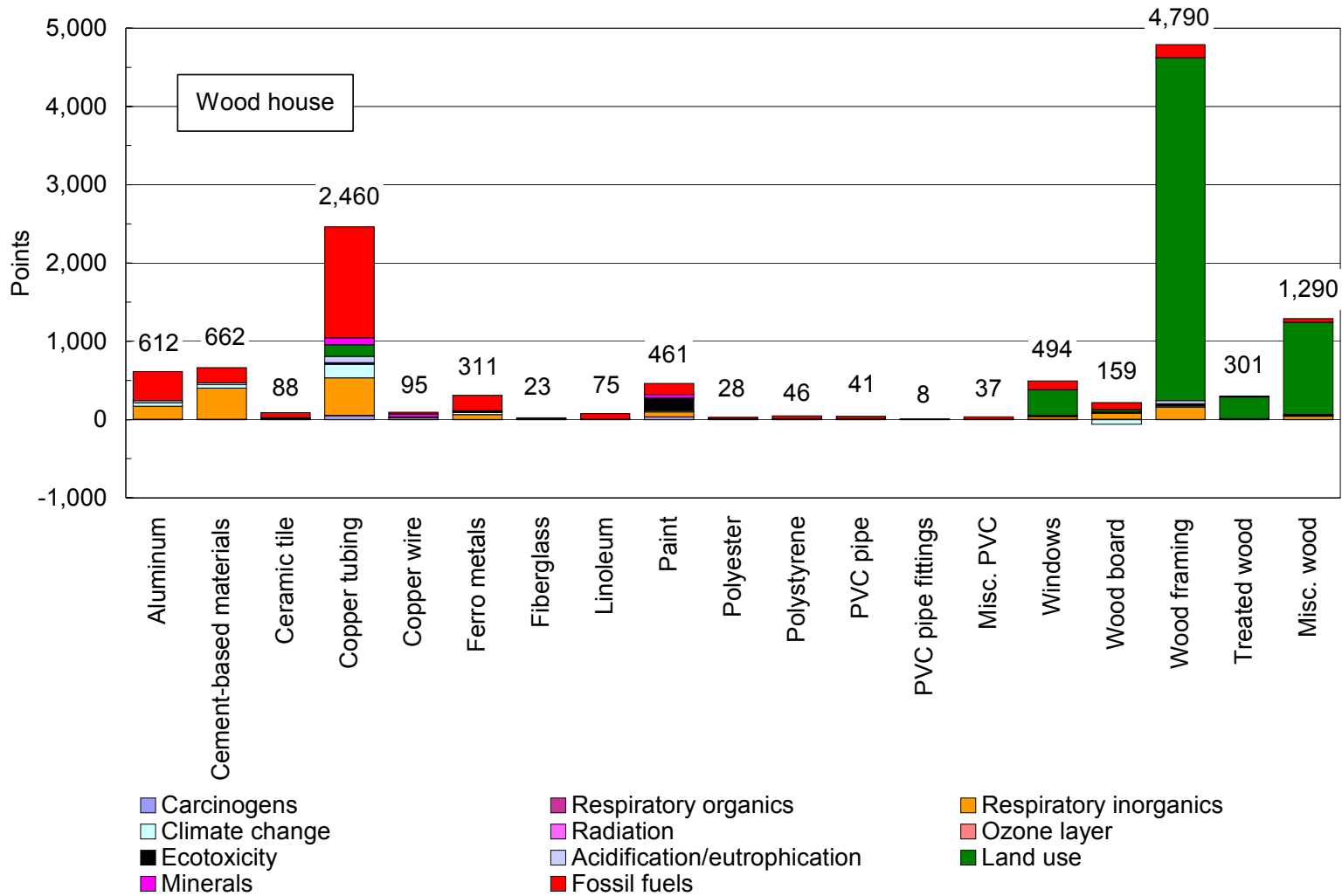


Figure K-8. Single-score life cycle inventory assessment for construction materials in the wood frame house in Washington, DC (output from SimaPro). The data have been normalized and weighted according to the Eco-Indicator 99 method using the Egalitarian perspective.