Test

Design Option Comparison

4/13/2017

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Report Summary

Created with Tally
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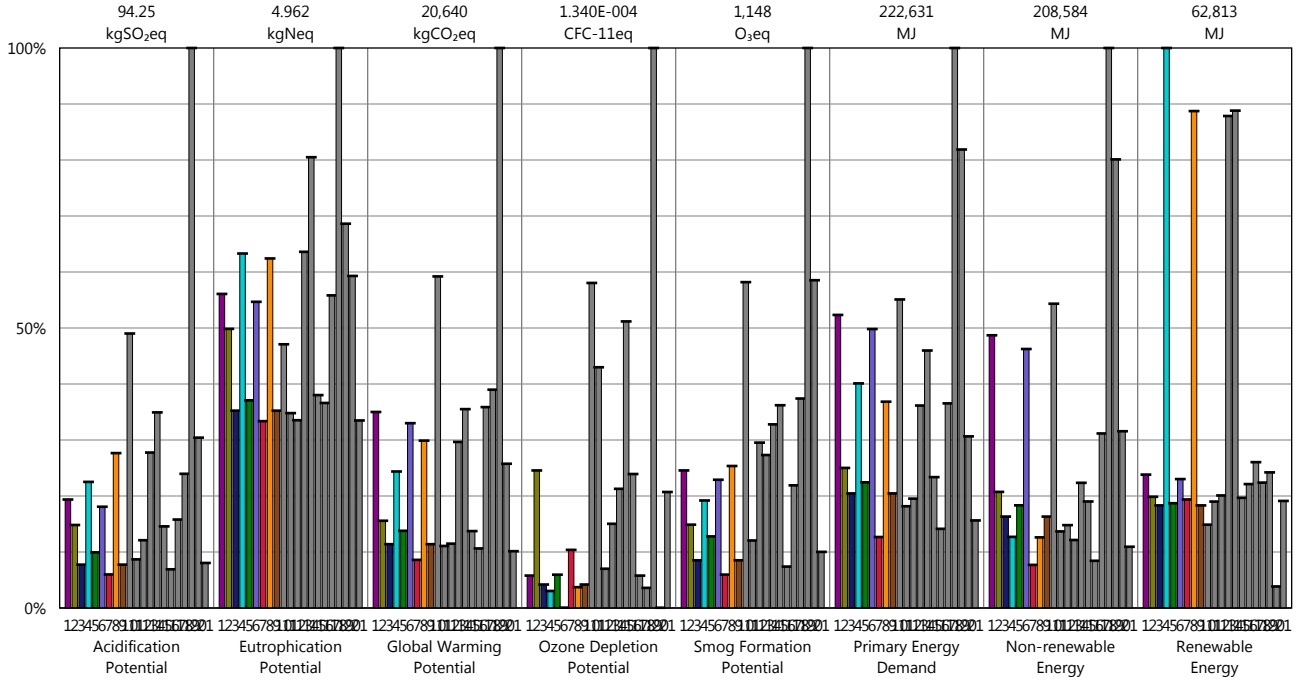
Goal and Scope of Assessment
Whole-Building Design Option Comparision

Author	Josh
Company	Penn
Date	4/13/2017
Project	Test
Location	Philadelphia
Gross Area	100 ft^2
Building Life	60
Boundaries	Cradle-to-Grave; see appendix for a full list of materials and processes
Construction	Not included
Operations	Not included



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Design Options

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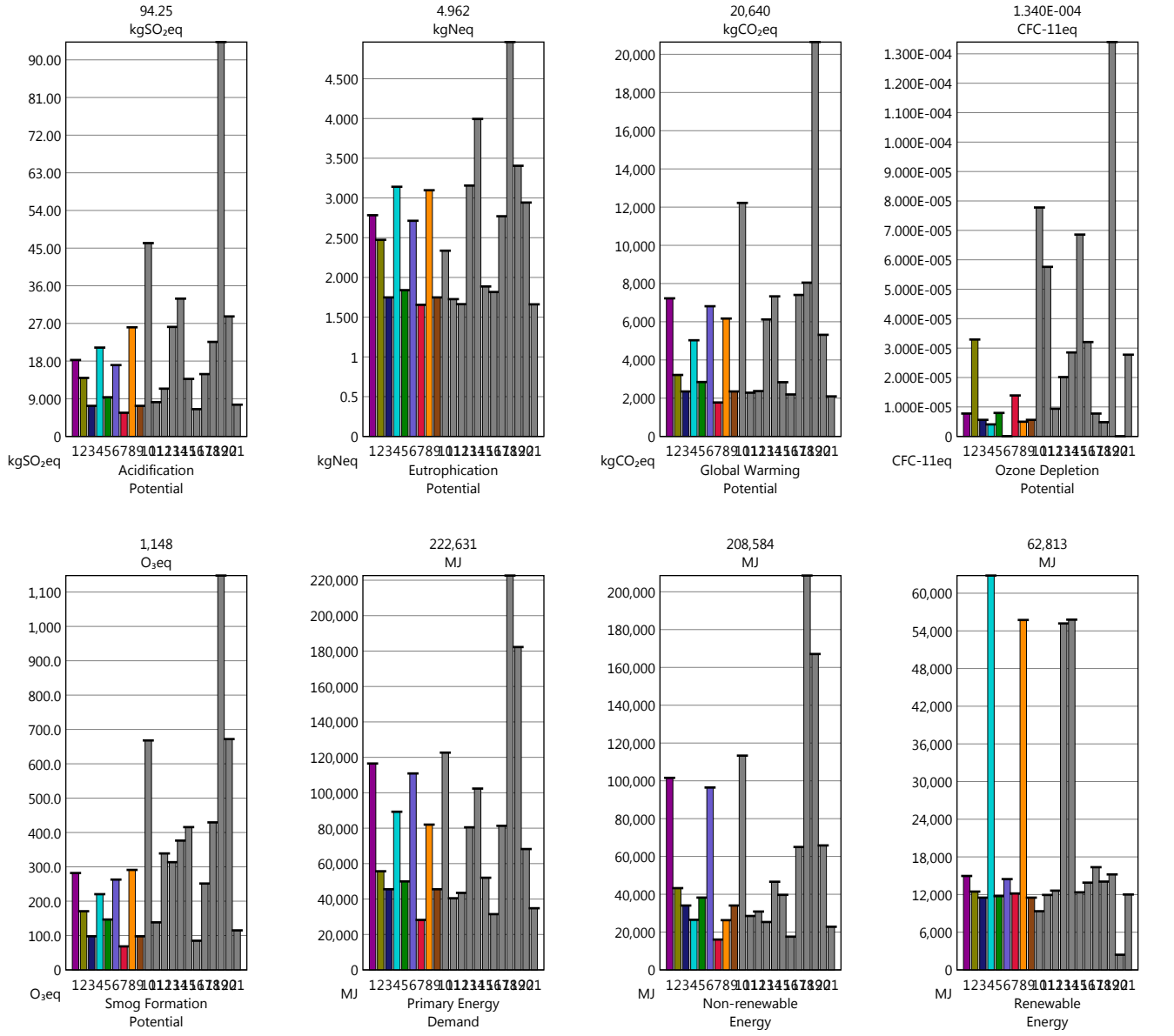
Report Summary (continued)



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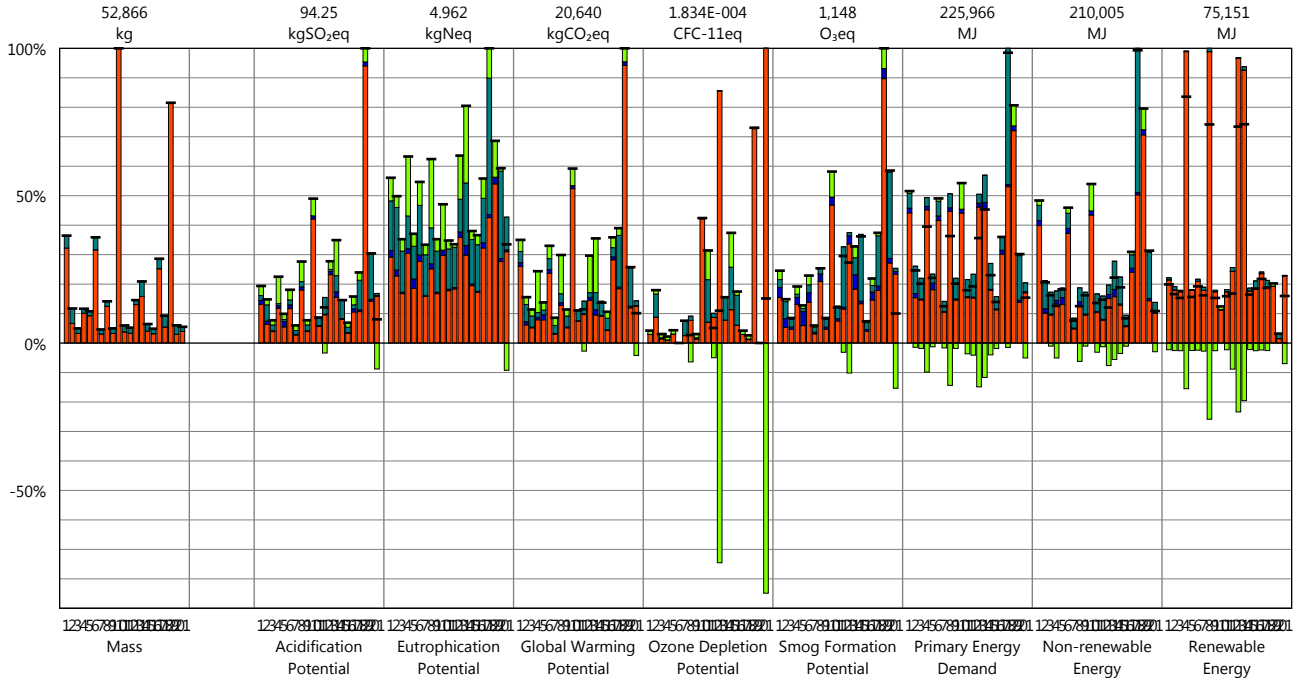
Results per Life Cycle Stage



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Net value (impacts + credits)

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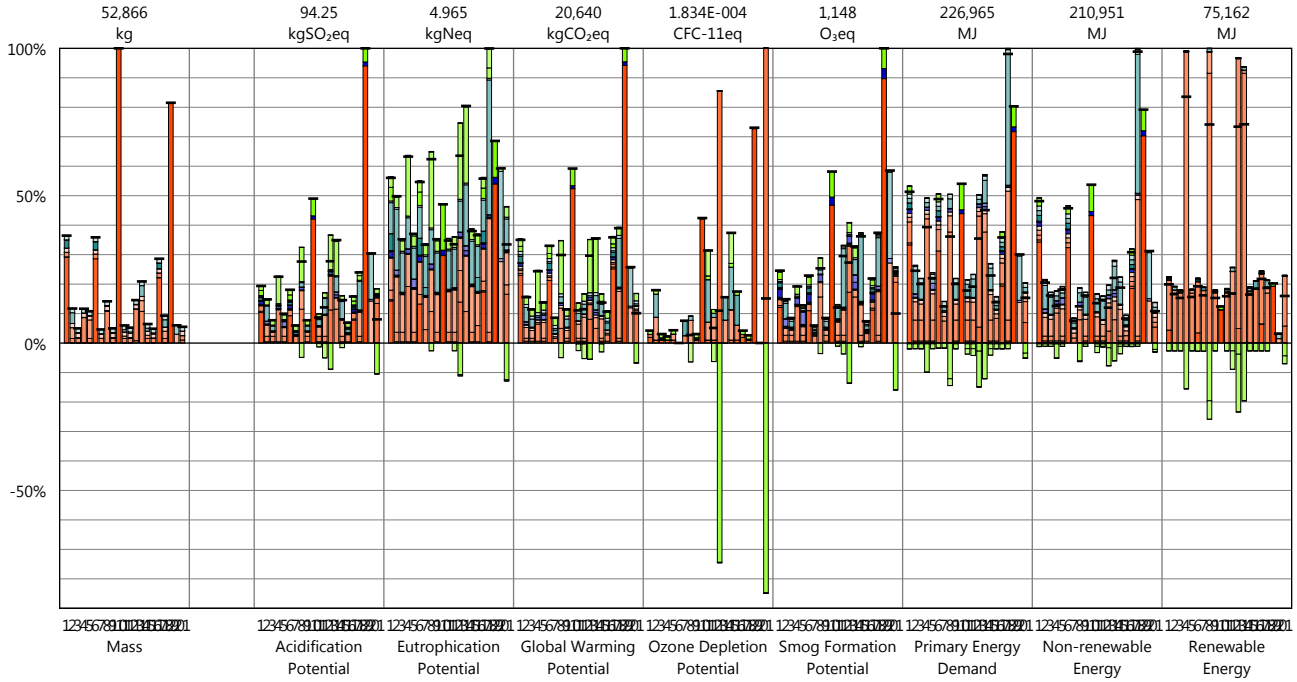
Life Cycle Stages

Manufacturing
Transportation
Maintenance and Replacement
End of Life

Results per Life Cycle Stage, itemized by Division



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Manufacturing

03 - Concrete
04 - Masonry
05 - Metals
06 - Wood/Plastics/Composites
07 - Thermal and Moisture Protection
08 - Openings and Glazing
09 - Finishes

Transportation

03 - Concrete
04 - Masonry
05 - Metals
06 - Wood/Plastics/Composites
07 - Thermal and Moisture Protection
08 - Openings and Glazing
09 - Finishes

Maintenance and Replacement

03 - Concrete
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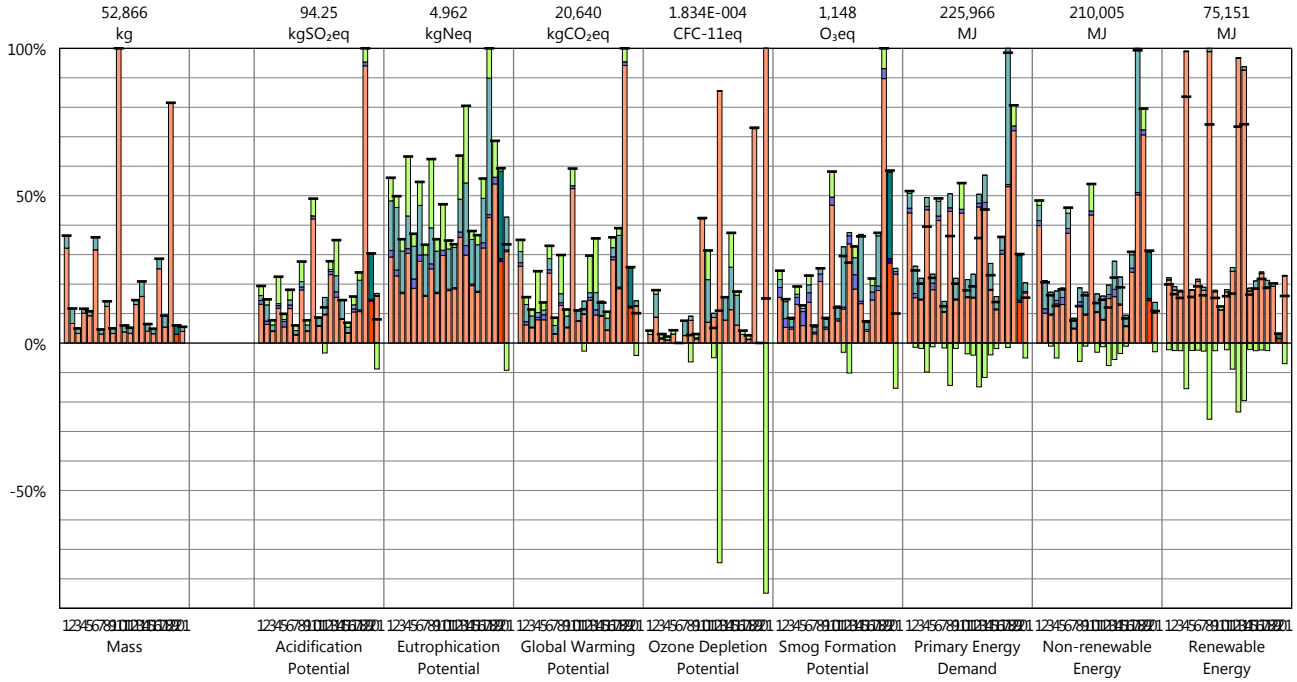
07 - Thermal and Moisture Protection
08 - Openings and Glazing
09 - Finishes

End of Life

03 - Concrete
04 - Masonry
05 - Metals
06 - Wood/Plastics/Composites
07 - Thermal and Moisture Protection
08 - Openings and Glazing
09 - Finishes

Results per Life Cycle Stage, itemized by Revit Category



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Net value (impacts + credits)

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Manufacturing

Curtain Panels
Walls

Transportation

Curtain Panels
Walls

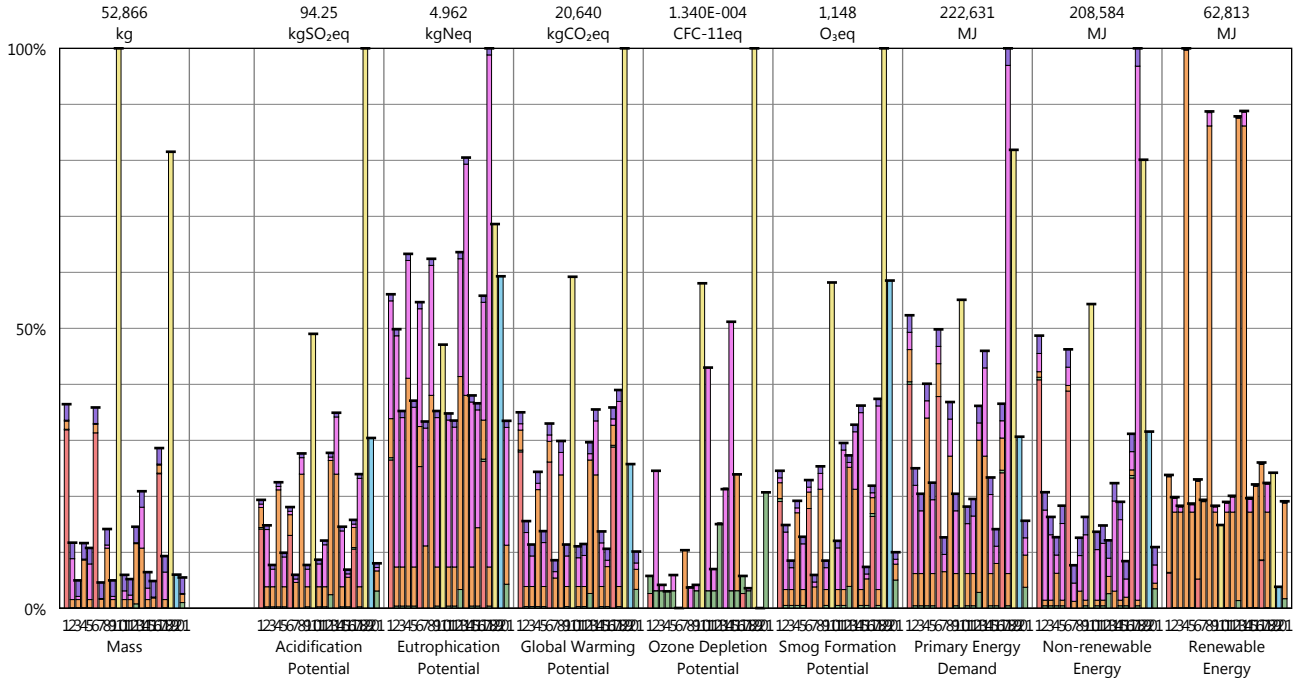
Maintenance and Replacement

Curtain Panels
Walls

End of Life

Curtain Panels
Walls

Results per Division



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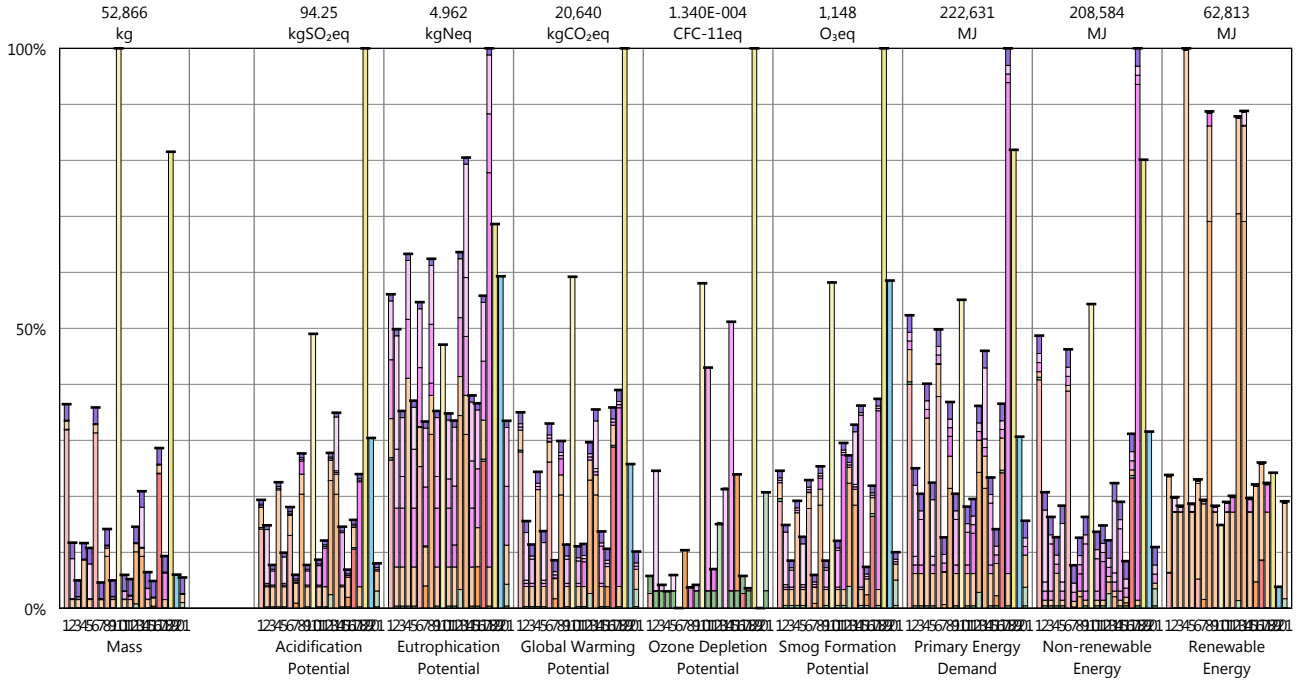
Divisions

- 03 - Concrete
- 04 - Masonry
- 05 - Metals
- 06 - Wood/Plastics/Composites
- 07 - Thermal and Moisture Protection
- 08 - Openings and Glazing
- 09 - Finishes

Results per Division, itemized by Tally Entry



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03 - Concrete

Cast-in-place concrete, lightweight aggregate structural concrete, expanded s...
Cast-in-place concrete, reinforced structural concrete, 3000 psi (20 Mpa)

04 - Masonry

Autoclaved aerated concrete block (AAC)
Brick, generic, grouted

05 - Metals

Steel, C-stud metal framing
Titanium zinc sheet

06 - Wood/Plastics/Composites

Decorative high pressure laminate (HPL), sheet
Domestic softwood
Plywood, exterior grade
Wood framing

07 - Thermal and Moisture Protection

Aluminum siding
Exterior insulation and finish system (EIFS)
Flashspun HDPE vapor retarder
Metal wall panel, formed
Plastic siding, vinyl
Polyethelene sheet vapor barrier (HDPE)
Porcelain tile
Terracotta tile

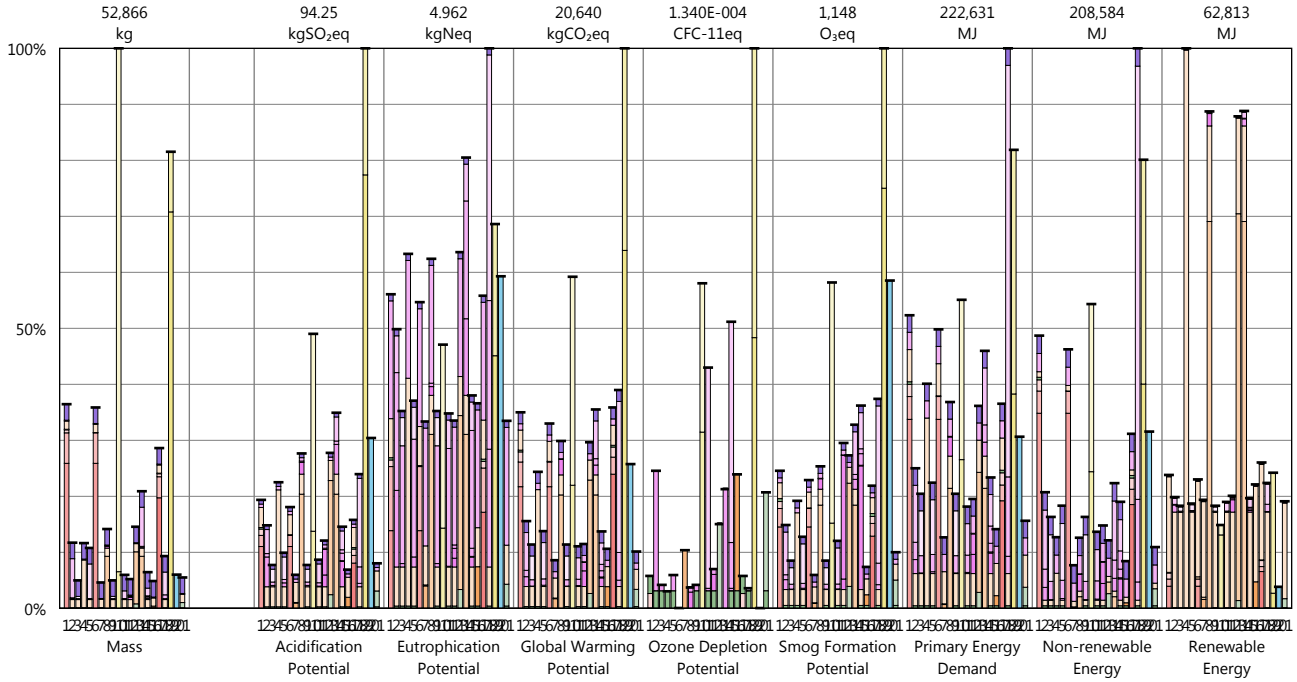
08 - Openings and Glazing

Glazing, double pane IGU

09 - Finishes

Wall board, gypsum

Results per Division, itemized by Material



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03 - Concrete

- Lightweight aggregate structural concrete, expanded shale mix
- Steel, reinforcing rod
- Structural concrete, 3000 psi, 50% fly ash

04 - Masonry

- Autoclaved aerated concrete block (AAC), 10x8x24
- Brick, generic
- Lime mortar (Mortar type K)
- Steel, reinforcing rod

05 - Metals

- Cold formed structural steel
- Titanium zinc sheet, prePATINA blue-grey/graphite-grey, EPD - Rheinzink

06 - Wood/Plastics/Composites

- Decorative high pressure laminate (HPL), Flex 0.50 mm, EPD - Egger
- Decorative high pressure laminate (HPL), Micro 0.15-0.20 mm, EPD - Egger
- Domestic softwood, US
- Exterior grade plywood, US

07 - Thermal and Moisture Protection

- Aluminum siding
- Enamel paint, solvent based, metal stock
- Fasteners, galvanized steel
- Fasteners, stainless steel
- Galvanized steel support
- Polyethelene sheet vapor barrier (HDPE)
- Polystyrene board (XPS), Pentane foaming agent
- Porcelain ceramic tile, glazed
- Steel, sheet
- Stucco, latex
- Terracotta
- Vinyl siding

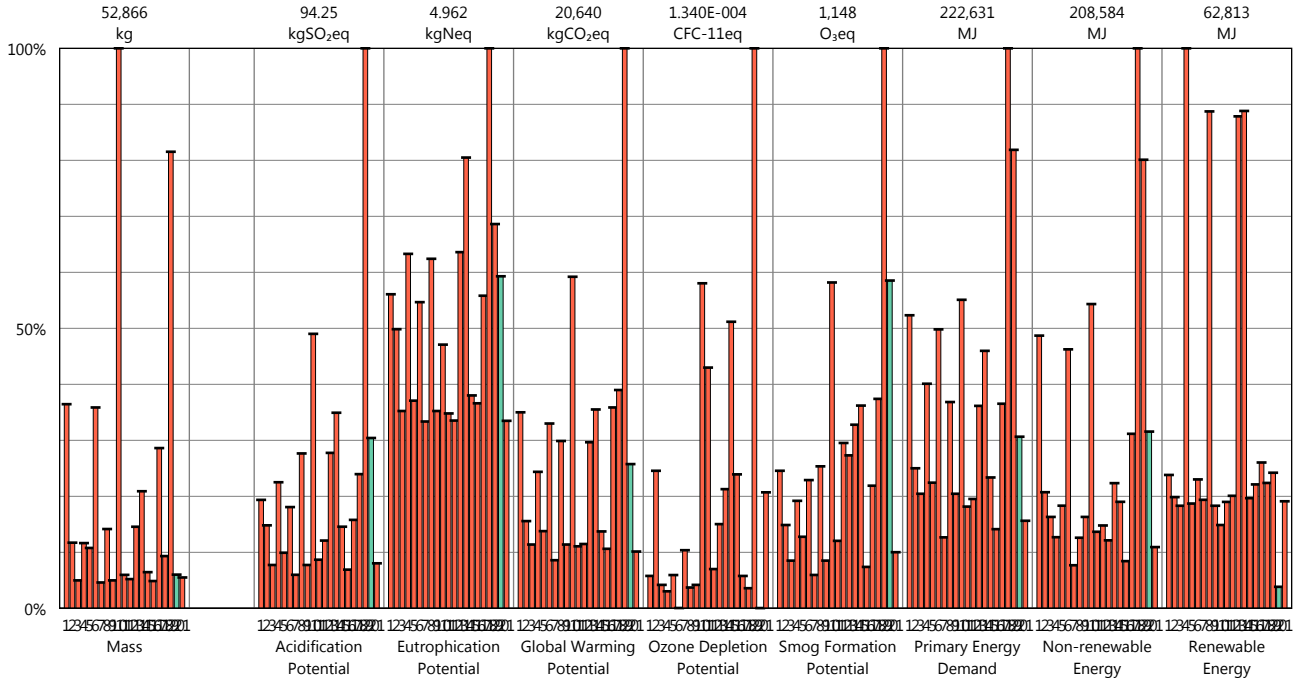
08 - Openings and Glazing

- Glazing, double, insulated (air), low-E

09 - Finishes

- Wall board, gypsum, natural

Results per Revit Category



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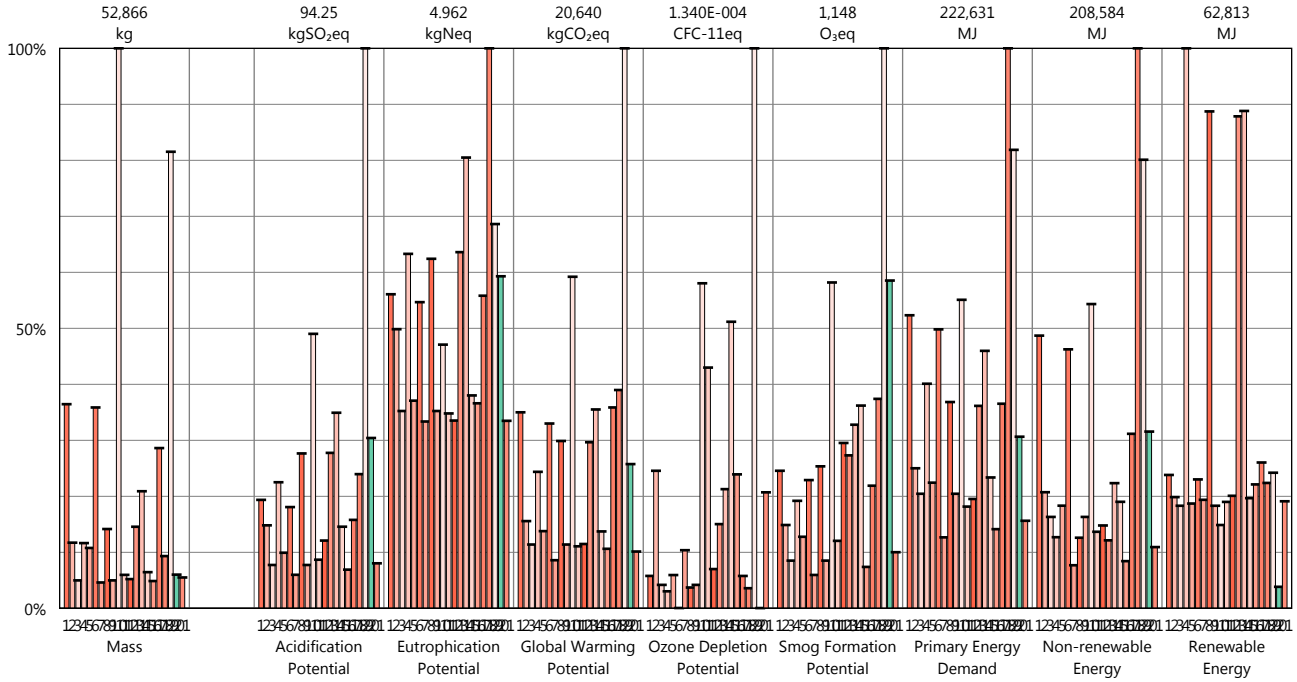
Revit Categories

Curtain Panels
Walls

Results per Revit Category, itemized by Family



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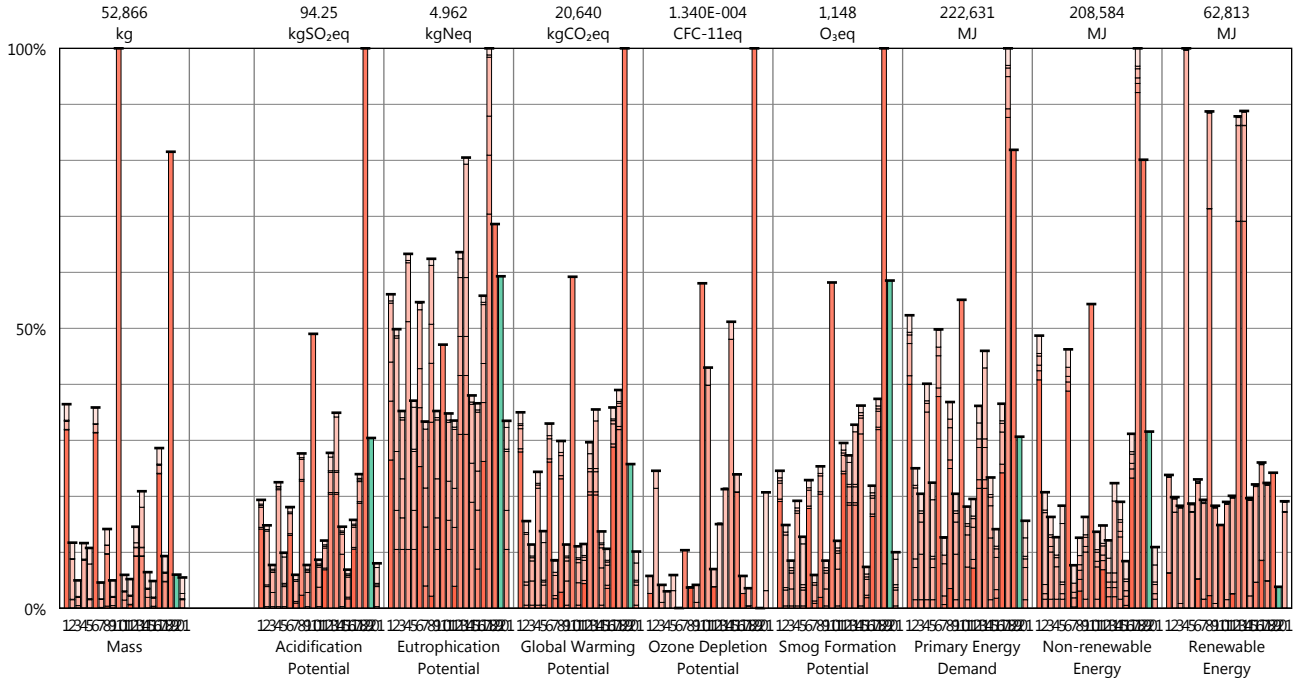
Curtain Panels

System Panel: Glazed

Walls

Exterior - Aluminum on Mtl. Stud
Exterior - Aluminum on Wood Stud
Exterior - Brick on Mtl. Stud
Exterior - Brick on Wood Stud
Exterior - CMU on Mtl. Stud
Exterior - EIFS on Mtl. Stud
Exterior - Iron on Mtl. Stud
Exterior - Iron on Wood Stud
Exterior - Laminate on Mtl. Stud
Exterior - Laminate on Wood Stud
Exterior - Mosaic on Mtl. Stud
Exterior - Polyvinyl on Mtl. Stud
Exterior - Porcelain on Mtl. Stud
Exterior - Porcelain on Wood Stud
Exterior - Steel Carbon on Mtl. Stud
Exterior - Steel Chrome on Mtl. Stud
Exterior - Steel on Mtl. Stud
Exterior - Vinyl on Mtl. Stud
Foundation - 12" Concrete
Generic - 12"

Results per Revit Category, itemized by Tally Entry



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Curtain Panels

Glazing, double pane IGU

Walls

Aluminum siding
Autoclaved aerated concrete block (AAC)
Brick, generic, grouted
Cast-in-place concrete, lightweight aggregate structural concrete, expanded s...
Cast-in-place concrete, reinforced structural concrete, 3000 psi (20 Mpa)
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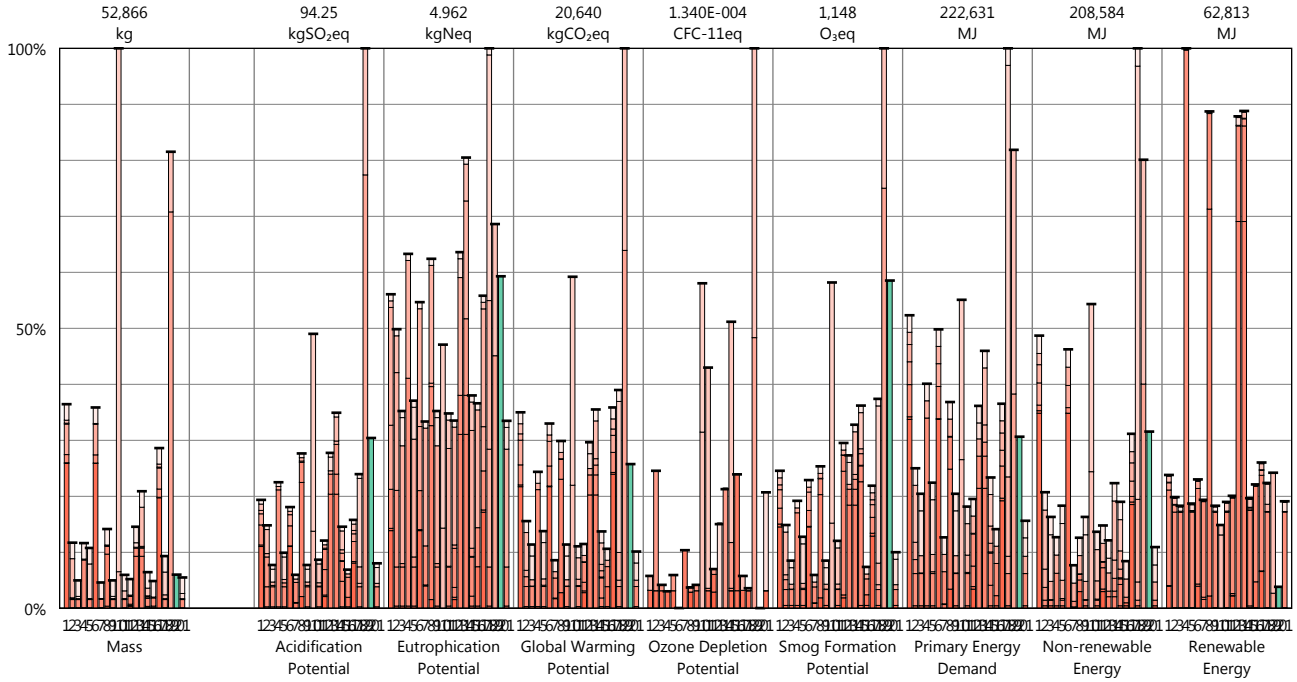
Domestic softwood
Exterior insulation and finish system (EIFS)
Flashspun HDPE vapor retarder
Metal wall panel, formed
Plastic siding, vinyl
Plywood, exterior grade
Polyethelene sheet vapor barrier (HDPE)
Porcelain tile
Steel, C-stud metal framing
Terracotta tile
Titanium zinc sheet
Wall board, gypsum
Wood framing

Results per Revit Category, itemized by Material



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Curtain Panels

Glazing, double, insulated (air), low-E

Walls

Aluminum siding
Autoclaved aerated concrete block (AAC), 10x8x24
Brick, generic
Cold formed structural steel
Decorative high pressure laminate (HPL), Flex 0.50 mm, EPD - Egger
Decorative high pressure laminate (HPL), Micro 0.15-0.20 mm, EPD - Egger
Domestic softwood, US
Enamel paint, solvent based, metal stock
Exterior grade plywood, US
Fasteners, galvanized steel
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Galvanized steel support
Lightweight aggregate structural concrete, expanded shale mix
Lime mortar (Mortar type K)
Polyethelene sheet vapor barrier (HDPE)
Polystyrene board (XPS), Pentane foaming agent
Porcelain ceramic tile, glazed
Steel, reinforcing rod
Steel, sheet
Structural concrete, 3000 psi, 50% fly ash
Stucco, latex
Terracotta
Titanium zinc sheet, prePATINA blue-grey/graphite-grey, EPD - Rheinzink
Vinyl siding
Wall board, gypsum, natural

Calculation Methodology

Studied objects
The life cycle analysis (LCA) results reported represent either an analysis of a single building or a comparative analysis of two or more building design options. The single building may represent the complete architectural, structural, and finish systems of a building or a subset of those systems, and it may be used to compare the relative environmental impacts associated with building components or for comparative study with one or more reference buildings. Design options may represent a full building across various stages of the design process, or they may represent multiple schemes of a full or partial building that are being compared to one another across a range of evaluation criteria.

Functional unit and reference flow
The functional unit of a single building is the usable floor space of the building under study. For a design option comparison of a partial building, the functional unit is the complete set of building systems that performs a given function. The reference flow is the amount of material required to produce a building or portion thereof, and is designed according to the given goal and scope of the assessment over the full life of the building. If construction impacts are included in the assessment, the reference flow also includes the energy, water, and fuel consumed on the building site during construction. If operational energy is included in the assessment, the reference flow includes the electrical and thermal energy consumed on site over the life of the building. It is the responsibility of the modeler to assure that reference buildings or design options are functionally equivalent in terms of scope, size, and relevant performance. The expected life of the building has a default value of 60 years and can be modified by the practitioner.

System boundaries and delimitations
The analysis accounts for the full cradle-to-grave life cycle of the design options studied, including material manufacturing, maintenance and replacement, eventual end-of-life, and the materials and energy used across all life cycle stages. Optionally, the construction impacts and operational energy of the building can be included within the scope.

Architectural materials and assemblies include all materials required for the product's manufacturing and use including hardware, sealants, adhesives, coatings, and finishing. The materials are included up to a 1% cut-off factor by mass with the exception of known materials that have high environmental impacts at low levels. In these cases, a 1% cut-off was implemented by impact.

Manufacturing [EN 15804 A1-A3] include processes wherever possible. This includes raw material extraction and processing, intermediate transportation, and final manufacturing and assembly. The manufacturing scope is listed for each entry, detailing any specific inclusions or exclusions that fall outside of the cradle-to-gate scope. Infrastructure (buildings and machinery) required for the manufacturing and assembly of building materials are not included and are considered outside the scope of assessment.

Transportation [EN 15804 A4] between the manufacturer and building site is included separately and can be modified by the practitioner. Transportation at the product's end-of-life is excluded from this study.

Construction [EN 15804 A5] is based on the anticipated or measured energy and water consumed during the construction of the building.

Maintenance and replacement [EN 15804 B2-B5] encompasses the replacement of materials in accordance with the expected service life. This includes the end-of-life treatment of the existing products [EN 15804 C2-C4], transportation to site, and cradle-to-gate manufacturing of the replacement products. The service life is specified separately for each product.

Operational energy treatment [EN 15804 B6] is based on the anticipated energy consumed at the building site over the lifetime of the building. Each associated dataset includes relevant upstream impacts associated with extraction of energy resources (such as coal or crude oil), including refining, combustion, transmission, losses, and other associated factors. For further detail, see Energy Metadata in the appendix.

End-of-life treatment [EN 15804 C2-C4] is based on average US construction and demolition waste treatment methods and rates. This includes the relevant material collection rates for recycling, processing requirements for recycled materials, incineration rates, and landfilling rates. Along with processing requirements, the recycling of materials is modeled using an avoided burden approach, where the burden of primary material production is allocated to the subsequent life cycle based on the quantity of recovered secondary material. Incineration of materials includes credit for average US energy recovery rates. The impacts associated with landfilling are based on average material properties, such as plastic waste, biodegradable waste, or inert material. Specific end-of-life scenarios are detailed for each entry.

Data source and quality
Tally utilizes a custom designed LCA database that combines material attributes, assembly details, and architectural specifications with environmental impact data resulting from the collaboration between KieranTimberlake and thinkstep. LCA modeling was conducted in GaBi 6 using GaBi databases and in accordance with GaBi databases and modeling principles.

The data used are intended to represent the US and the year 2013. Where representative data were unavailable, proxy data were used. The datasets used, their geographic region, and year of reference are listed for each entry. An effort was made to choose proxy datasets that are technologically consistent with the relevant entry.

Uncertainty in results can stem from both the data used and its application. Data quality is judged by: its measured, calculated, or estimated precision; its completeness, such as unreported emissions; its consistency, or degree of uniformity of the methodology applied on a study serving as a data source; and geographical, temporal, and technological representativeness. The GaBi LCI databases have been used in LCA models worldwide in both industrial and scientific applications. These LCI databases have additionally been used both as internal and critically reviewed and published studies. Uncertainty introduced by the use of proxy data is reduced by using technologically, geographically, and/or temporally similar data. It is the responsibility of the modeler to appropriately apply the predefined material entries to the building under study.

Tally methodology is consistent with LCA standards ISO 14040-14044.

Glossary of LCA Terminology

Environmental Impact Categories

The following list provides a description of environmental impact categories reported according to the TRACI 2.1 characterization scheme. References: [Bare 2010, EPA 2012, Guinée 2001]

Acidification Potential (AP) kg SO_2 eq

A measure of emissions that cause acidifying effects to the environment. The acidification potential is a measure of a molecule's capacity to increase the hydrogen ion (H^+) concentration in the presence of water, thus decreasing the pH value. Potential effects include fish mortality, forest decline, and the deterioration of building materials.

Eutrophication Potential (EP) kg N eq

Eutrophication covers potential impacts of excessively high levels of macronutrients, the most important of which are nitrogen (N) and phosphorus (P). Nutrient enrichment may cause an undesirable shift in species composition and elevated biomass production in both aquatic and terrestrial ecosystems. In aquatic ecosystems increased biomass production may lead to depressed oxygen levels, because of the additional consumption of oxygen in biomass decomposition.

Global Warming Potential (GWP) kg CO_2 eq

A measure of greenhouse gas emissions, such as carbon dioxide and methane. These emissions are causing an increase in the absorption of radiation emitted by the earth, increasing the natural greenhouse effect. This may in turn have adverse impacts on ecosystem health, human health, and material welfare.

Ozone Depletion Potential (ODP) kg CFC-11 eq

A measure of air emissions that contribute to the depletion of the stratospheric ozone layer. Depletion of the ozone leads to higher levels of UVB ultraviolet rays reaching the earth's surface with detrimental effects on humans and plants.

Smog Formation Potential (SFP) kg O_3 eq

Ground level ozone is created by various chemical reactions, which occur between nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in sunlight. Human health effects can result in a variety of respiratory issues including increasing symptoms of bronchitis, asthma, and emphysema. Permanent lung damage may result from prolonged exposure to ozone. Ecological impacts include damage to various ecosystems and crop damage. The primary sources of ozone precursors are motor vehicles, electric power utilities, and industrial facilities.

Primary Energy Demand (PED) MJ (lower heating value)

A measure of the total amount of primary energy extracted from the earth. PED is expressed in energy demand from non-renewable resources (e.g. petroleum, natural gas, etc.) and energy demand from renewable resources (e.g. hydropower, wind energy, solar, etc.). Efficiencies in energy conversion (e.g. power, heat, steam, etc.) are taken into account.

LCA Metadata

NOTES

The following list provides a summary of all energy, construction, transportation, and materials inputs present in the selected study. Materials are listed in alphabetical order along with a list of all Revit families and Tally entries in which they occur and any notes and system boundaries accompanying their database entries. The mass given here refers to the full life-cycle mass of material, including manufacturing and replacement.

Transportation by Barge

Description:
Barge

Transportation Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by barge. The default transportation distances are based on the transportation distances by three-digit material commodity code in the 2012 Commodity Flow Survey published by the US Department of Transportation Bureau of Transportation Statistics and the US Department of Commerce where more specific industry-level transportation was not available.

Entry Source:
GLO: Barge PE (2012), US: Diesel mix at filling station PE (2011)

Transportation by Container Ship

Description:
Container Ship

Transportation Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by container ship. The default transportation distances are based on the transportation distances by three-digit material commodity code in the 2012 Commodity Flow Survey published by the US Department of Transportation Bureau of Transportation Statistics and the US Department of Commerce where more specific industry-level transportation was not available.

Entry Source:
GLO: Container ship PE (2013), US: Heavy fuel oil at refinery (0.3wt.% S) PE (2011)

Transportation by Rail

Description:
Rail

Transportation Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by cargo rail. The default transportation distances are based on the transportation distances by three-digit material commodity code in the 2012 Commodity Flow Survey published by the US Department of Transportation Bureau of Transportation Statistics and the US Department of Commerce where more specific industry-level transportation was not available.

Entry Source:
GLO: Rail transport cargo - Diesel PE (2013), US: Diesel mix at filling station PE (2011)

Transportation by Truck

Description:
Truck

Transportation Scope:
The data set represents the transportation of 1 kg of material from the manufacturer location to the building site by diesel truck. The default transportation distances are based on the transportation distances by three-digit material commodity code in the 2012 Commodity Flow Survey published by the US Department of Transportation Bureau of Transportation Statistics and the US Department of Commerce where more specific industry-level transportation was not available.

Entry Source:
US: Truck - Trailer, basic enclosed / 45,000 lb payload - 8b PE (2013), US: Diesel mix at filling station PE (2011)

Aluminum siding **409.6 kg**

Used in the following Revit families:
Exterior - Aluminum on Mtl. Stud 204.8 kg
Exterior - Aluminum on Wood Stud 204.8 kg

Used in the following Tally entries:
Aluminum siding

Description:
Aluminum sheet stock (0.02" thickness) factory formed and cut. Entry inclusive of siding material, exclusive of wood stud or other support material.

Life Cycle Inventory:
Aluminum

Manufacturing Scope:
Cradle to gate, excluding any coatings

Transportation Distance:
By truck: 663 km

End of Life Scope:
95% recovered (includes recycling, scrap preparation, and avoided burden credit)
5% landfilled (inert material)

Entry Source:
US: Electricity grid mix PE (2010)
US: Lubricants at refinery PE (2010)
EU-27: Aluminium sheet PE (2012)
NA: Primary Aluminium Ingot AA (2011)
EU-27: Aluminum clean scrap remelting & casting EAA (2005)
DE: Aluminium sheet deep drawing (adjustable) PE (2012)

Autoclaved aerated concrete block (AAC), 10x8x24 **10,434.5 kg**

Used in the following Revit families:
Exterior - CMU on Mtl. Stud 10,434.5 kg

Used in the following Tally entries:
Autoclaved aerated concrete block (AAC)

Description:
Autoclaved aerated concrete block (AAC), 10x8x24, excludes mortar

Life Cycle Inventory:
60-70% quartz sand
20-30% cement (type CEMI)
10-20% quick lime
2-5% gypsum

Manufacturing Scope:
Cradle to gate
excludes mortar
anchors, ties, and metal accessories outside of scope (<1% mass)

Transportation Distance:
By truck: 172 km

End of Life Scope:
50% recycled into coarse aggregate (includes grinding energy and avoided burden credit)
50% landfilled (inert material)

Entry Source:
EU-27: Aerated concrete block PE (2012)

Brick, generic **27,373.0 kg**

Used in the following Revit families:
Exterior - Brick on Mtl. Stud 13,686.5 kg
Exterior - Brick on Wood Stud 13,686.5 kg

Used in the following Tally entries:
Brick, generic, grouted

Description:
Generic brick, 3.675 x 2.25 x 8

LCA Metadata (continued)

Life Cycle Inventory:
2000 kg/m³ fired brick

Manufacturing Scope:
Cradle to gate
excludes mortar
anchors, ties, and metal accessories outside of scope (<1% mass)

Transportation Distance:
By truck: 172 km

End of Life Scope:
50% recycled into coarse aggregate (includes grinding energy and avoided burden credit)
50% landfilled (inert material)

Entry Source:
DE: Stoneware tiles, unglazed (EN15804 A1-A3) PE (2012)

Cold formed structural steel **717.0 kg**

Used in the following Revit families:

Exterior - Aluminum on Mtl. Stud	55.2 kg
Exterior - Brick on Mtl. Stud	55.2 kg
Exterior - CMU on Mtl. Stud	55.2 kg
Exterior - EIFS on Mtl. Stud	55.2 kg
Exterior - Iron on Mtl. Stud	55.2 kg
Exterior - Laminate on Mtl. Stud	55.2 kg
Exterior - Mosaic on Mtl. Stud	55.2 kg
Exterior - Polyvinyl on Mtl. Stud	55.2 kg
Exterior - Porcelain on Mtl. Stud	55.2 kg
Exterior - Steel Carbon on Mtl. Stud	55.2 kg
Exterior - Steel Chrome on Mtl. Stud	55.2 kg
Exterior - Steel on Mtl. Stud	55.2 kg
Exterior - Vinyl on Mtl. Stud	55.2 kg

Used in the following Tally entries:
Steel, C-stud metal framing

Description:
Cold-rolled steel

Life Cycle Inventory:
Cold rolled steel

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End of Life Scope:
98% recovered (product has 9.5% scrap input while remainder is processed and credited as avoided burden)
2% landfilled (inert material)

Entry Source:
NA: Steel finished cold rolled coil worldsteel (2007)
GLO: Steel sheet stamping and bending (5% loss) PE (2012)
US: Electricity grid mix PE (2010)
US: Lubricants at refinery PE (2010)
GLO: Compressed air 7 bar (medium power consumption) PE (2010)
GLO: Value of scrap worldsteel (2007)

Decorative high pressure laminate (HPL), Flex 0.50 mm, EPD - Egger **153.8 kg**

Used in the following Revit families:

Exterior - Laminate on Mtl. Stud	153.8 kg

Used in the following Tally entries:
Decorative high pressure laminate (HPL), sheet

Description:
Decorative, high-pressure laminate panels, 0.5 mm thick. EPD representative of German (DE) conditions.

Life Cycle Inventory:
Melamine resin
Decorative Paper
Phenolic Resin Impregnated Kraftpaper

Manufacturing Scope:
Cradle to gate, including packaging

Transportation Distance:
By truck: 641 km

End of Life Scope:
Includes disposal to landfill as inert waste

Entry Source:
DE: Laminate Flex - Egger PE-EPD (2008)

Decorative high pressure laminate (HPL), Micro 0.15-0.20 mm, EPD - ... **44.6 kg**

Used in the following Revit families:

Exterior - Laminate on Wood Stud	44.6 kg

Used in the following Tally entries:
Decorative high pressure laminate (HPL), sheet

Description:
Decorative, high-pressure laminate panels, 0.15-0.20 mm thick. EPD representative of German (DE) conditions.

Life Cycle Inventory:
Melamine resin
Decorative Paper
Phenolic Resin Impregnated Kraftpaper

Manufacturing Scope:
Cradle to gate, including packaging

Transportation Distance:
By truck: 641 km

End of Life Scope:
Includes disposal to landfill as inert waste

Entry Source:
DE: Laminate Micro - Egger PE-EPD (2008)

Domestic softwood, US **14,789.1 kg**

Used in the following Revit families:

Exterior - Aluminum on Wood Stud	4,910.9 kg
Exterior - Brick on Wood Stud	28.1 kg
Exterior - Iron on Wood Stud	4,910.9 kg
Exterior - Laminate on Wood Stud	28.1 kg
Exterior - Porcelain on Wood Stud	4,910.9 kg

Used in the following Tally entries:
Domestic softwood
Wood framing

Description:
Dimensional lumber, sawn, planed, dried and cut for standard framing or planking

Life Cycle Inventory:
17% US Pacific Northwest
30% US Southeast
11% US Inland Northwest
US Northeast/North Central 3%
39% CA
Softwood lumber

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 383 km

LCA Metadata (continued)

End of Life Scope:
14.5% recovered (credited as avoided burden)
22% incinerated with energy recovery
63.5% landfilled (untreated wood waste)

Entry Source:
RNA: Softwood lumber CORRIM (2011)

Enamel paint, solvent based, metal stock **258.6 kg**

Used in the following Revit families:

Exterior - Aluminum on Mtl. Stud	129.3 kg
Exterior - Steel on Mtl. Stud	129.3 kg

Used in the following Tally entries:
Aluminum siding
Metal wall panel, formed

Description:
Solvent paint

Life Cycle Inventory:
17% binding agent, 16% pigments and fillers, 67% solvent

Manufacturing Scope:
Cradle to gate, including emissions during application

Transportation Distance:
By truck: 642 km

End of Life Scope:
33% solids to landfill (plastic waste)

Entry Source:
DE: Solvent paint white (EN15804 A1-A3) PE (2012)

Exterior grade plywood, US **17,651.3 kg**

Used in the following Revit families:

Exterior - Aluminum on Mtl. Stud	773.0 kg
Exterior - Aluminum on Wood Stud	773.0 kg
Exterior - Brick on Mtl. Stud	773.0 kg
Exterior - Brick on Wood Stud	773.0 kg
Exterior - CMU on Mtl. Stud	773.0 kg
Exterior - EIFS on Mtl. Stud	773.0 kg
Exterior - Iron on Mtl. Stud	773.0 kg
Exterior - Iron on Wood Stud	773.0 kg
Exterior - Laminate on Mtl. Stud	773.0 kg
Exterior - Laminate on Wood Stud	773.0 kg
Exterior - Mosaic on Mtl. Stud	773.0 kg
Exterior - Polyvinyl on Mtl. Stud	773.0 kg
Exterior - Porcelain on Mtl. Stud	773.0 kg
Exterior - Porcelain on Wood Stud	773.0 kg
Exterior - Steel Carbon on Mtl. Stud	4,509.5 kg
Exterior - Steel Chrome on Mtl. Stud	773.0 kg
Exterior - Steel on Mtl. Stud	773.0 kg
Exterior - Vinyl on Mtl. Stud	773.0 kg

Used in the following Tally entries:
Plywood, exterior grade

Description:
Plywood, unfinished

Life Cycle Inventory:
33% PNW
67% SE
Plywood

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 468 km

End of Life Scope:
14.5% recovered (credited as avoided burden)
22% incinerated with energy recovery
63.5% landfilled (untreated wood waste)

Entry Source:
US: Plywood, at plywood plant, PNW USLCI/PE (2009)
US: Plywood, at plywood plant, SE USLCI/PE (2009)

Fasteners, galvanized steel **21.8 kg**

Used in the following Revit families:

Exterior - Steel Chrome on Mtl. Stud	10.9 kg
Exterior - Steel on Mtl. Stud	10.9 kg

Used in the following Tally entries:
Metal wall panel, formed

Description:
Galvanized steel part. Used for fasteners and some specialized hardware (bolts, rails, clips, etc.) that are linked to other entries by volume or weight of metal.

Life Cycle Inventory:
Galvanized steel

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End of Life Scope:
70% recovered (product has 27.6% scrap input while remainder is processed and credited as avoided burden)
30% landfilled (inert material)

Entry Source:
GLO: Steel wire rod worldsteel (2007)
GLO: Steel turning PE (2012)
GLO: Unit load galvanisation (1 m2 steel sheet part electrolytic) PE (2012)
GLO: Value of scrap worldsteel (2007)

Fasteners, stainless steel **192.2 kg**

Used in the following Revit families:

Exterior - Aluminum on Mtl. Stud	3.7 kg
Exterior - Aluminum on Wood Stud	3.7 kg
Exterior - Mosaic on Mtl. Stud	10.9 kg
Exterior - Polyvinyl on Mtl. Stud	3.7 kg
Exterior - Porcelain on Mtl. Stud	83.2 kg
Exterior - Porcelain on Wood Stud	83.2 kg
Exterior - Vinyl on Mtl. Stud	3.7 kg

Used in the following Tally entries:
Aluminum siding
Plastic siding, vinyl
Porcelain tile
Terracotta tile

Description:
Stainless steel part. Used for fasteners and some specialized hardware (bolts, rails, clips, etc.) that are linked to other entries by volume or weight of metal.

Life Cycle Inventory:
Stainless steel

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 1001 km

End of Life Scope:
98% recovered (product has 58.1% scrap input while remainder is processed and credited as avoided burden)
2% landfilled (inert material)

LCA Metadata (continued)

Entry Source:
RER: Stainless steel Quarto plate (304) Eurofer (2008)
GLO: Steel turning PE (2011)
US: Electricity grid mix PE (2010)
RER: Stainless steel flat product (304) - value of scrap Eurofer (2008)

Galvanized steel support **127.0 kg**

Used in the following Revit families:
Exterior - Steel on Mtl. Stud 127.0 kg

Used in the following Tally entries:
Metal wall panel, formed

Description:
Hot dipped galvanized steel profile, for use with cladding systems.

Life Cycle Inventory:
Steel, hot dip galvanization

Manufacturing Scope:
Cradle to gate. Entry inclusive of processes energy assocaited with rolling and forming member.

Transportation Distance:
By truck: 431 km

End of Life Scope:
98% recovered (product has 10.3% scrap input while remainder is processed and credited as avoided burden)
2% landfilled (inert material)

Entry Source:
NA: Steel hot dip galvanized worldsteel (2007)
GLO: Steel sheet stamping and bending (5% loss) PE (2011)
US: Electricity grid mix PE (2009)
US: Lubricants at refinery PE (2009)
GLO: Compressed air 7 bar (medium power consumption) PE (2009)
US: Metal roll forming M CA (2010)
GLO: Value of scrap worldsteel (2007)

Glazing, double, insulated (air), low-E **3,181.0 kg**

Used in the following Revit families:
System Panel: Glazed 3,181.0 kg

Used in the following Tally entries:
Glazing, double pane IGU

Description:
Glazing, double, insulated (air filled), 1/4" float glass, low-E, inclusive of sealant, and spacers

Life Cycle Inventory:
21.4 kg/m² glass. 0.40 kg/m² PVB film (30% adipic acid
70% PVB)
15.4 kg/m² glass
0.15 kg/m² low-e coating

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 940 km

End of Life Scope:
100% to landfill (inert waste)

Entry Source:
DE: Double glazing unit PE (2012), modified to exclude argon

Lightweight aggregate structural concrete, expanded shale mix **37,423.5 kg**

Used in the following Revit families:
Generic - 12" 37,423.5 kg

Used in the following Tally entries:
Cast-in-place concrete, lightweight aggregate structural concrete, expanded shale mix

Description:
Lightweight structural concrete with expanded shale aggregate mix

Life Cycle Inventory:
15% cement
53% sand
22% shale
10% water

Manufacturing Scope:
Cradle to gate
excludes mixing and pouring impacts

Transportation Distance:
By truck: 24 km

End of Life Scope:
50% recycled into coarse aggregate (includes grinding energy and avoided burden credit)
50% landfilled (inert material)

Entry Source:
US: Portland cement, at plant USLCI/PE (2009)
US: Tap water from groundwater PE (2012)
DE: Expanded shale (EN15804 A1-A3) PE (2012)
US: Silica sand (Excavation and processing) PE (2012)

Lime mortar (Mortar type K) **7,747.5 kg**

Used in the following Revit families:
Exterior - Brick on Mtl. Stud 2,879.9 kg
Exterior - Brick on Wood Stud 2,879.9 kg
Exterior - CMU on Mtl. Stud 1,987.8 kg

Used in the following Tally entries:
Autoclaved aerated concrete block (AAC)
Brick, generic, grouted

Description:
Lime mortar (traditionally used for historic masonry)

Life Cycle Inventory:
20-65% sand
40-70% limestone
5-15% hydrated lime
7-15% cement

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End of Life Scope:
50% recycled into coarse aggregate (includes grinding energy and avoided burden credit)
50% landfilled (inert material)

Entry Source:
DE: Light plaster (lime-cement) PE (2012)

LCA Metadata (continued)

Polyethelene sheet vapor barrier (HDPE) **1,510.6 kg**

Used in the following Revit families:

Exterior - Aluminum on Mtl. Stud	83.9 kg
Exterior - Aluminum on Wood Stud	83.9 kg
Exterior - Brick on Mtl. Stud	83.9 kg
Exterior - Brick on Wood Stud	83.9 kg
Exterior - CMU on Mtl. Stud	83.9 kg
Exterior - EIFS on Mtl. Stud	83.9 kg
Exterior - Iron on Mtl. Stud	83.9 kg
Exterior - Iron on Wood Stud	83.9 kg
Exterior - Laminate on Mtl. Stud	83.9 kg
Exterior - Laminate on Wood Stud	83.9 kg
Exterior - Mosaic on Mtl. Stud	83.9 kg
Exterior - Polyvinyl on Mtl. Stud	83.9 kg
Exterior - Porcelain on Mtl. Stud	83.9 kg
Exterior - Porcelain on Wood Stud	83.9 kg
Exterior - Steel Carbon on Mtl. Stud	83.9 kg
Exterior - Steel Chrome on Mtl. Stud	83.9 kg
Exterior - Steel on Mtl. Stud	83.9 kg
Exterior - Vinyl on Mtl. Stud	83.9 kg

Used in the following Tally entries:
Flashspun HDPE vapor retarder
Polyethelene sheet vapor barrier (HDPE)

Description:
Polyethelene sheet vapor barrier (HDPE) membrane (entry exclusive of adhesive or other co-products)

Life Cycle Inventory:
Polyethylene film

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 1299 km

End of Life Scope:
10.5% recycled into HDPE (includes processing and avoided burden credit)
89.5% landifilled (plastic waste)

Entry Source:
US: Polyethylene High Density Granulate (PE-HD) PE (2012)
GLO: Plastic Film (PE, PP, PVC) PE (2012)
US: Electricity grid mix PE (2010)
US: Thermal energy from natural gas PE (2010)
US: Lubricants at refinery PE (2010)

Polystyrene board (XPS), Pentane foaming agent **362.5 kg**

Used in the following Revit families:

Exterior - EIFS on Mtl. Stud	362.5 kg

Used in the following Tally entries:
Exterior insulation and finish system (EIFS)

Description:
XPS board, inclusive of pentane foaming agent

Life Cycle Inventory:
Extruded polystyrol rigid foam (XPS)

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 1299 km

End of Life Scope:
100% landfilled (plastic waste)

Entry Source:
DE: Extruded polystyrene (XPS) (EN15804 A1-A3) PE (2012)

Porcelain ceramic tile, glazed **7,384.7 kg**

Used in the following Revit families:

Exterior - Porcelain on Mtl. Stud	3,692.3 kg
Exterior - Porcelain on Wood Stud	3,692.3 kg

Used in the following Tally entries:
Porcelain tile

Description:
Porcelain ceramic tile, glazed, for use as cladding material.

Life Cycle Inventory:
Ceramic tile, glazed

Manufacturing Scope:
Cradle to gate, excludes any additional materials required for installation

Transportation Distance:
By truck: 1250 km

End of Life Scope:
50% recycled into coarse aggregate (includes grinding energy and avoided burden credit)
50% landfilled (inert material)

Entry Source:
DE: Stoneware tiles, glazed PE (2011)

Steel, reinforcing rod **9,704.1 kg**

Used in the following Revit families:

Exterior - Brick on Mtl. Stud	283.8 kg
Exterior - CMU on Mtl. Stud	283.8 kg
Foundation - 12" Concrete	3,458.5 kg
Generic - 12"	5,678.1 kg

Used in the following Tally entries:
Autoclaved aerated concrete block (AAC)
Brick, generic, grouted
Cast-in-place concrete, lightweight aggregate structural concrete, expanded shale mix
Cast-in-place concrete, reinforced structural concrete, 3000 psi (20 Mpa)

Description:
Steel rod suitable for structural reinforcement (rebar), common unfinished tempered steel

Life Cycle Inventory:
Steel rebar

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 431 km

End of Life Scope:
70% recovered (product has 69.8% scrap input while remainder is processed and credited as avoided burden)
30% landfilled (inert material)

Entry Source:
GLO: Steel rebar worldsteel (2007)

Steel, sheet **1,451.5 kg**

Used in the following Revit families:

Exterior - Steel Chrome on Mtl. Stud	725.7 kg
Exterior - Steel on Mtl. Stud	725.7 kg

Used in the following Tally entries:
Metal wall panel, formed

Description:
Steel sheet

Life Cycle Inventory:
Steel sheet

LCA Metadata (continued)

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 418 km

End of Life Scope:
98% recovered (product has 9.5% scrap input while remainder is processed and credited as avoided burden)
2% landfilled (inert material)

Entry Source:
NA: Steel finished cold rolled coil worldsteel (2007)

Structural concrete, 3000 psi, 50% fly ash **49,407.2 kg**

Used in the following Revit families:
Foundation - 12" Concrete 49,407.2 kg

Used in the following Tally entries:
Cast-in-place concrete, reinforced structural concrete, 3000 psi (20 Mpa)

Description:
Structural concrete, 3000 psi, 50% fly ash

Life Cycle Inventory:
6.5% cement
6.5% fly ash
40% gravel
39% sand
7% water

Manufacturing Scope:
Cradle to gate
excludes mixing and pouring impacts

Transportation Distance:
By truck: 24 km

End of Life Scope:
50% recycled into coarse aggregate (includes grinding energy and avoided burden credit)
50% landfilled (inert material)

Entry Source:
US: Portland cement, at plant USLCI/PE (2009)
US: Tap water from groundwater PE (2012)
EU-27: Gravel 2/32 PE (2012)
DE: Fly ash (EN15804 A1-A3) PE (2012)
US: Silica sand (Excavation and processing) PE (2012)

Stucco, latex **2,147.0 kg**

Used in the following Revit families:
Exterior - EIFS on Mtl. Stud 2,147.0 kg

Used in the following Tally entries:
Exterior insulation and finish system (EIFS)

Description:
Acrylic stucco

Life Cycle Inventory:
90% acrylic resin, 10% quartz sand
2.2% NMVOC emissions during application

Manufacturing Scope:
Cradle to gate, including emissions during application

Transportation Distance:
By truck: 642 km

End of Life Scope:
97.8% solids to landfill (plastic waste)

Entry Source:
DE: Application paint emulsion (building, exterior, white) PE (2011)

Terracotta **3,265.9 kg**

Used in the following Revit families:
Exterior - Mosaic on Mtl. Stud 3,265.9 kg

Used in the following Tally entries:
Terracotta tile

Description:
Terracotta tile

Life Cycle Inventory:
Terracotta stoneware (unglazed)

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 1250 km

End of Life Scope:
50% recycled into coarse aggregate (includes grinding energy and avoided burden credit)
50% landfilled (inert material)

Entry Source:
DE: Stoneware tiles, unglazed (EN15804 A1-A3) PE (2012)

Titanium zinc sheet, prePATINA blue-grey/graphite-grey, EPD - Rhein... **914.2 kg**

Used in the following Revit families:
Exterior - Iron on Mtl. Stud 490.5 kg
Exterior - Iron on Wood Stud 423.6 kg

Used in the following Tally entries:
Titanium zinc sheet

Description:
Titanium zinc sheets for roofing and facade cladding, roof drainage systems. EPD representative of German (DE) conditions.

Life Cycle Inventory:
99.835% Special High-Grade Zinc
Copper 0.08-1%
Titanium 0.07-1.2%

Manufacturing Scope:
Cradle to gate, including packaging

Transportation Distance:
By truck: 663 km

End of Life Scope:
Includes 96% recycling rate for zinc with no quality loss

Entry Source:
DE: Titanium zinc sheet prePatine blue-grey/graphite-grey - Rheinzink (A1-A3) PE-EPD (2011)
DE: Titanium zinc scrap - Rheinzink (D out A5) PE-EPD (2011)

Vinyl siding **422.9 kg**

Used in the following Revit families:
Exterior - Polyvinyl on Mtl. Stud 211.4 kg
Exterior - Vinyl on Mtl. Stud 211.4 kg

Used in the following Tally entries:
Plastic siding, vinyl

Description:
Rigid vinyl siding, (0.04" thickness) factory formed and cut. Entry inclusive of siding material, exclusive of wood stud or other support material.

Life Cycle Inventory:
PVC

Manufacturing Scope:
Cradle to gate, excluding any coatings

LCA Metadata (continued)

Transportation Distance:
By truck: 1299 km

End of Life Scope:
100% landfilled (plastic waste)

Entry Source:
US: Polyvinylchloride granulate (E-PVC) PE (2012)
GLO: Plastic Extrusion PE (2012)
US: Electricity grid mix PE (2010)
US: Thermal energy from natural gas PE (2010)
US: Lubricants at refinery PE (2010)

Wall board, gypsum, natural	**27,184.2 kg**
Used in the following Revit families:	
Exterior - Aluminum on Mtl. Stud	1,510.2 kg
Exterior - Aluminum on Wood Stud	1,510.2 kg
Exterior - Brick on Mtl. Stud	1,510.2 kg
Exterior - Brick on Wood Stud	1,510.2 kg
Exterior - CMU on Mtl. Stud	1,510.2 kg
Exterior - EIFS on Mtl. Stud	1,510.2 kg
Exterior - Iron on Mtl. Stud	1,510.2 kg
Exterior - Iron on Wood Stud	1,510.2 kg
Exterior - Laminate on Mtl. Stud	1,510.2 kg
Exterior - Laminate on Wood Stud	1,510.2 kg
Exterior - Mosaic on Mtl. Stud	1,510.2 kg
Exterior - Polyvinyl on Mtl. Stud	1,510.2 kg
Exterior - Porcelain on Mtl. Stud	1,510.2 kg
Exterior - Porcelain on Wood Stud	1,510.2 kg
Exterior - Steel Carbon on Mtl. Stud	1,510.2 kg
Exterior - Steel Chrome on Mtl. Stud	1,510.2 kg
Exterior - Steel on Mtl. Stud	1,510.2 kg
Exterior - Vinyl on Mtl. Stud	1,510.2 kg

Used in the following Tally entries:
Wall board, gypsum

Description:
Natural gypsum board

Life Cycle Inventory:
1 kg gypsum wallboard

Manufacturing Scope:
Cradle to gate

Transportation Distance:
By truck: 172 km

End of Life Scope:
54% recycled into gypsum stone (includes grinding and avoided burden credit)
46% landfilled (inert waste)

Entry Source:
DE: Gypsum wallboard (EN15804 A1-A3) PE (2012)