

Project Report

LCA results from the Athena Impact Estimator for Buildings

Project name:

Case Study - R2000 House Design

Date created:

May 07, 2019 at 12:42 AM



Athena
Impact Estimator
for Buildings

www.athenasmi.org

About the Athena Institute

The Athena Institute is a non-profit life cycle assessment (LCA) research organization and the North American leader in carbon footprinting of construction and its materials. Since 1997, the Athena Institute has been advocating for LCA practice in the construction sector and working to make LCA accessible to architects and engineers, to serve our mandate of reducing environmental impacts of materials, buildings and infrastructure. Headquartered in Ottawa, Canada with a US affiliate in Pennsylvania, the Athena Institute has played a leading role on both sides of the border in advancing sustainability practices through a variety of projects, often publicly-funded. Our advocacy, education, and provision of free LCA resources like the Impact Estimator software tool has enabled the uptake of LCA in green building policy and programs across Canada and the US. Our public service work is made possible through the generous support of our members and other funders. Please consider joining our family of supporters at www.athenasmi.org.

About the Impact Estimator for Buildings (IE4B)

The Impact Estimator is a software tool that delivers environmental life cycle-based performance information about buildings, to provide decision support during design and to document life-cycle performance afterwards. Life cycle assessment is the science behind the IE4B and is typically practiced by experts. The IE4B software package is a simplified LCA-based tool that has been developed specifically for architects, engineers and sustainable design consultants. The tool provides access to sophisticated life cycle inventory data and life cycle assessment methods without requiring advanced LCA skills. The software was first released in 2002 and has been continually updated ever since. The Athena Institute provides the Impact Estimator to the sustainable design community for free.

About this report

This report was automatically generated by the Impact Estimator at the request of a user. It provides background information about the software and the inputs and results for the user's project.

How to learn more about LCA, the IE4B, and LCA in green building programs

Learn about life cycle assessment, get the free Impact Estimator and Pavement LCA software tools, access the software User Manual/Transparency documents, find our guide on achieving the LCA credits in green building programs and much more, on our web site: www.athenasmi.org.

How to get in touch with comments about this report format

Have some thoughts on how this report feature in the Impact Estimator can be improved? Let us know: send an email to info@athenasmi.org.

Disclaimer

The Athena Institute provides no warranty for the Impact Estimator software and does not assume any liability for the accuracy, completeness or usefulness of the software. In addition, the Athena Institute has not reviewed the results reported in this document and does not attest as to the accuracy or completeness of the study.

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Software information

This report was generated by the Athena Impact Estimator for Buildings.

Software version and data sources

Software version:	Athena Impact Estimator for Buildings version 5.4.0101
Date this report was created:	May 07, 2019 at 12:42 AM
Life cycle inventory (LCI):	LCI data used in this assessment is from the Athena LCI database and is compliant with ISO 14040, 14044 and 21930.
Life cycle scenarios:	Scenarios used in this assessment come from databases developed by the Athena Sustainable Materials Institute.
Geographic relevance:	Canada and the United States. All data is regionally-specific for various Canadian and US cities or regions.
Life cycle impact assessment method:	TRACI v2.1. The software is in accordance with ISO 21930/21931 and EN 15804/15978.
Green program compliance:	The Athena Institute certifies that the Impact Estimator for Buildings complies with the LCA requirements of multiple green building programs, including the following: LEED, Green Globes, CalGreen, Living Building Challenge, CaGBC Zero Carbon Building, ILFI Zero Carbon, City of Vancouver Green Buildings Policy for Rezonings, and Minnesota B3.

Software scope

The Impact Estimator conforms to the EN 15804/15978 system boundary and reporting format.

Building elements

The Impact Estimator can model **any part** of a building where users have provided a bill of materials. Where users don't have a bill of materials, the Impact Estimator can create one, based on simple user inputs, for the following elements:

- Foundations, footings and slabs
- All below and above grade structure and envelope
- Windows and doors
- Interior partitions

IMPORTANT NOTE: The results shown in this report may not reflect a complete building model; the software has no way of knowing. The software user should declare what was included in the model.

System boundary

Capacity of the Impact Estimator per EN 15804/15978 modules:

Information Module	Processes Included
A1 Raw material supply	Primary resource harvesting and mining
A2 Transport	All transportation of materials up to manufacturing plant gate
A3 Manufacturing	Manufacture of raw materials into products
A4 Transport	Transportation of materials from manufacturing plant to site, and construction equipment to site
A5 Construction-installation process	Construction equipment energy use, and A1-A4, C1, C2, C4 effects of construction waste
B1 Installed product in use	n/a (currently insufficient consensus in methodology and data for this module to be addressed)
B2 Maintenance	Painted surfaces are maintained (i.e. repainted periodically), but no other maintenance aspects are included
B3 Repair	n/a (not currently well-supported with data)
B4 Replacement	A1-A5 effects of replacement materials, and C1, C2, C4 effects of replaced materials
B5 Refurbishment	n/a (this module applies to known future refurbishment and needs to be addressed on a case-by-case basis if applicable)
B6 Operational energy use	Energy primary extraction, production, delivery, and use are addressed, if user inputs energy consumption data
B7 Operational water use	This module is not addressed
C1 De-construction demolition	Demolition equipment energy use
C2 Transport	Transportation of materials from site to landfill
C3 Waste Processing	Most material data do not include waste processing effects, therefore this module is not addressed; however, the newer “avoided burden” methodology data for metals does include waste processing effects, but it is not separated into its own C3 module
C4 Disposal	Disposal facility equipment energy use and landfill site effects
D Benefits and loads beyond the system boundary	Carbon sequestration and metals recycling

For further detail on the data and methodology underlying the software, please see the Impact Estimator User Manual and Transparency Document, available for download from the Athena Institute web site www.athenasmi.org.

Project information

Project name: Case Study - R2000 House Design

Location used for analysis: Toronto

Building type used for analysis: Single Family Residential

Building lifetime assumed in analysis (years): 60

Units of measure: SI

Building floor area input: 207.40 m²

Building height input: 6.10 m

Project Number: (not specified)

Project Description: -difference between 1970 & R2000 house design
 electricity usage < 5%. -difference between 1970 and R2000 heating fuel usage >65%.
 Ottawa Heating Values for N.Gas
 ---- UPDATE HISTORY ----20091005 - pcg : Build 62
 updates due to constraint validations:Floor - Main Floor :
 Span changed from 5.5m to 4.5m, Floor Width changed from 17.55m to 21.45m to preserve the Floor Area.
 -----20090311 - pcg :
 updates due to constraint validations : Floor - Main Floor :
 : Span changed from 5.5 m to 4.5 m Foundation - Strip footing : Thickness changed from 150 mm to 190 mm

Operating energy inputs, if any:

Energy	Unit	Annual	Total
Electricity	kWh	0.00	0.00
Natural Gas	m ³	2,401.29	144,077.14
Liquified Petroleum Gas	Litre	0.00	0.00
Heavy Fuel	Litre	0.00	0.00
Diesel	Litre	0.00	0.00
Gasoline	Litre	0.00	0.00

Results

This section reports results for the user inputs. The Impact Estimator can provide extensive results in reports of varying formats. This section contains key results only; more detail and other reports are available within the software.

The following reports are included here:

1. LCA results by life cycle stage – Condensed table
2. LCA results by life cycle stage – Detailed table
3. LCA results by assembly – table, modules A-C
4. LCA results by assembly – table, modules A-D
5. Global Warming Potential by assembly – graph and table, modules A-C
6. Acidification Potential by assembly – graph and table, modules A-C
7. Eutrophication Potential by assembly – graph and table, modules A-C
8. Smog Potential by assembly – graph and table, modules A-C
9. Ozone Depletion Potential by assembly – graph and table, modules A-C
10. Human Health Particulate by assembly – graph and table, modules A-C
11. Non-renewable Primary Energy by assembly – graph and table, modules A-C
12. Embodied carbon
13. Operating vs embodied GWP – graph and table, modules A-C
14. Operating vs embodied TPE – graph and table, modules A-C

For the types and quantities of materials used in the model, see the bill of materials section at the back of this report.

The Athena Institute is not responsible for user errors and cannot attest to the scope of the model (what elements of the building are included).

LCA results by life cycle stage – Condensed table

		PRODUCT (A1 to A3)	CONSTRUCTION PROCESS (A4 to A5)	USE (B2, B4 & B6)			END OF LIFE (C1 to C4)	BEYOND BUILDING LIFE (D)	TOTAL EFFECTS	
LCA Measures	Unit	Total	Total	Replacement Total	Operational Energy Use Total	Total	Total	Total	A to C	A to D
Global Warming Potential	kg CO2 eq	3.08E+004	4.43E+003	5.93E+003	3.46E+005	3.52E+005	2.08E+003	-8.21E+003	3.89E+005	3.81E+005
Acidification Potential	kg SO2 eq	1.91E+002	4.31E+001	5.13E+001	2.97E+003	3.02E+003	2.57E+001	1.74E+000	3.28E+003	3.28E+003
HH Particulate	kg PM2.5 eq	4.25E+001	2.99E+000	9.42E+000	1.77E+002	1.86E+002	1.22E+000	7.62E-001	2.33E+002	2.34E+002
Eutrophication Potential	kg N eq	1.23E+001	2.82E+000	1.19E+000	2.92E+001	3.03E+001	1.60E+000	8.93E-002	4.70E+001	4.71E+001
Ozone Depletion Potential	kg CFC-11 eq	3.31E-004	2.32E-005	1.56E-004	1.39E-007	1.56E-004	8.43E-008	0.00	5.10E-004	5.10E-004
Smog Potential	kg O3 eq	2.23E+003	1.18E+003	4.11E+002	7.45E+003	7.86E+003	8.41E+002	1.76E+001	1.21E+004	1.21E+004
Total Primary Energy	MJ	4.13E+005	6.65E+004	1.13E+005	6.04E+006	6.15E+006	3.07E+004	3.48E+003	6.66E+006	6.66E+006
Non-Renewable Energy	MJ	3.77E+005	6.33E+004	1.13E+005	6.03E+006	6.15E+006	3.07E+004	3.48E+003	6.62E+006	6.62E+006
Fossil Fuel Consumption	MJ	3.37E+005	5.62E+004	1.09E+005	6.03E+006	6.14E+006	3.07E+004	6.98E+003	6.56E+006	6.57E+006

LCA results by life cycle stage – Detailed table

		PRODUCT (A1 to A3)		CONSTRUCTION PROCESS (A4 to A5)		USE (B2, B4 & B6)			END OF LIFE (C1 to C4)		BEYOND BUILDING LIFE (D)	
LCA Measure	Unit	Manufacturing	Transport	Construction Installation Process	Transport	Replacement Manufacturing	Replacement Transport	Operational Energy Use Total	De-construction Demolition Disposal & Waste Processing	Transport	BBL Material	BBL Transport
Global Warming Potential	kg CO2 eq	2.99E+004	8.98E+002	2.08E+003	2.34E+003	5.67E+003	2.65E+002	3.46E+005	1.33E+003	7.48E+002	-8.21E+003	0.00
Acidification Potential	kg SO2 eq	1.82E+002	8.76E+000	1.58E+001	2.73E+001	4.84E+001	2.87E+000	2.97E+003	1.85E+001	7.20E+000	1.74E+000	0.00
HH Particulate	kg PM2.5 eq	4.21E+001	4.79E-001	1.80E+000	1.19E+000	9.28E+000	1.43E-001	1.77E+002	8.21E-001	3.99E-001	7.62E-001	0.00
Eutrophication Potential	kg N eq	1.17E+001	5.44E-001	1.13E+000	1.69E+000	1.01E+000	1.78E-001	2.92E+001	1.16E+000	4.47E-001	8.93E-002	0.00
Ozone Depletion Potential	kg CFC-11 eq	3.31E-004	3.16E-008	2.31E-005	8.61E-008	1.56E-004	1.00E-008	1.39E-007	5.82E-008	2.61E-008	0.00	0.00
Smog Potential	kg O3 eq	1.96E+003	2.77E+002	3.00E+002	8.76E+002	3.20E+002	9.12E+001	7.45E+003	6.14E+002	2.27E+002	1.76E+001	0.00
Total Primary Energy	MJ	4.00E+005	1.31E+004	3.32E+004	3.33E+004	1.10E+005	3.86E+003	6.04E+006	1.98E+004	1.09E+004	3.48E+003	0.00
Non-Renewable Energy	MJ	3.64E+005	1.31E+004	3.00E+004	3.33E+004	1.09E+005	3.85E+003	6.03E+006	1.98E+004	1.09E+004	3.48E+003	0.00
Fossil Fuel Consumption	MJ	3.24E+005	1.31E+004	2.30E+004	3.32E+004	1.05E+005	3.85E+003	6.03E+006	1.98E+004	1.09E+004	6.98E+003	0.00

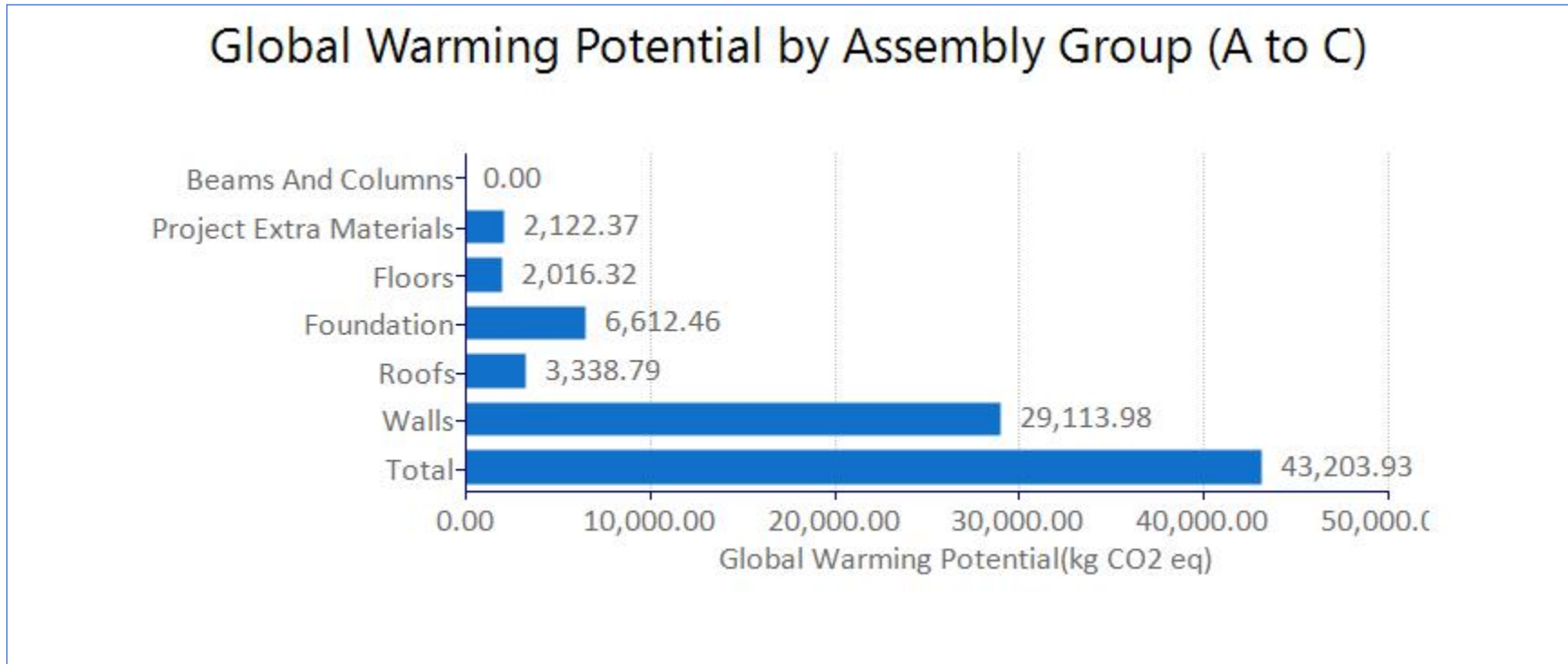
LCA results by assembly– table, modules A-C

LCA Measure	Unit	Columns & Beams	Floors	Foundations	Roofs	Walls	Project Extra Materials	Total
Global Warming Potential	kg CO2 eq	0.00	2.02E+003	6.61E+003	3.34E+003	2.91E+004	2.12E+003	4.32E+004
Acidification Potential	kg SO2 eq	0.00	2.06E+001	3.37E+001	2.61E+001	2.20E+002	9.96E+000	3.11E+002
HH Particulate	kg PM2.5 eq	0.00	2.35E+000	6.44E+000	6.27E+000	3.12E+001	9.87E+000	5.62E+001
Eutrophication Potential	kg N eq	0.00	1.54E+000	2.94E+000	1.83E+000	1.13E+001	2.98E-001	1.79E+001
Ozone Depletion Potential	kg CFC-11 eq	0.00	4.94E-006	5.65E-005	6.49E-005	3.84E-004	1.01E-007	5.10E-004
Smog Potential	kg O3 eq	0.00	4.23E+002	6.90E+002	5.66E+002	2.85E+003	1.28E+002	4.66E+003
Total Primary Energy	MJ	0.00	4.06E+004	6.43E+004	1.38E+005	3.41E+005	4.00E+004	6.24E+005
Non-Renewable Energy	MJ	0.00	3.16E+004	6.05E+004	1.30E+005	3.22E+005	4.00E+004	5.84E+005
Fossil Fuel Consumption	MJ	0.00	2.92E+004	5.24E+004	1.20E+005	3.08E+005	2.30E+004	5.33E+005

LCA results by assembly – table, modules A-D

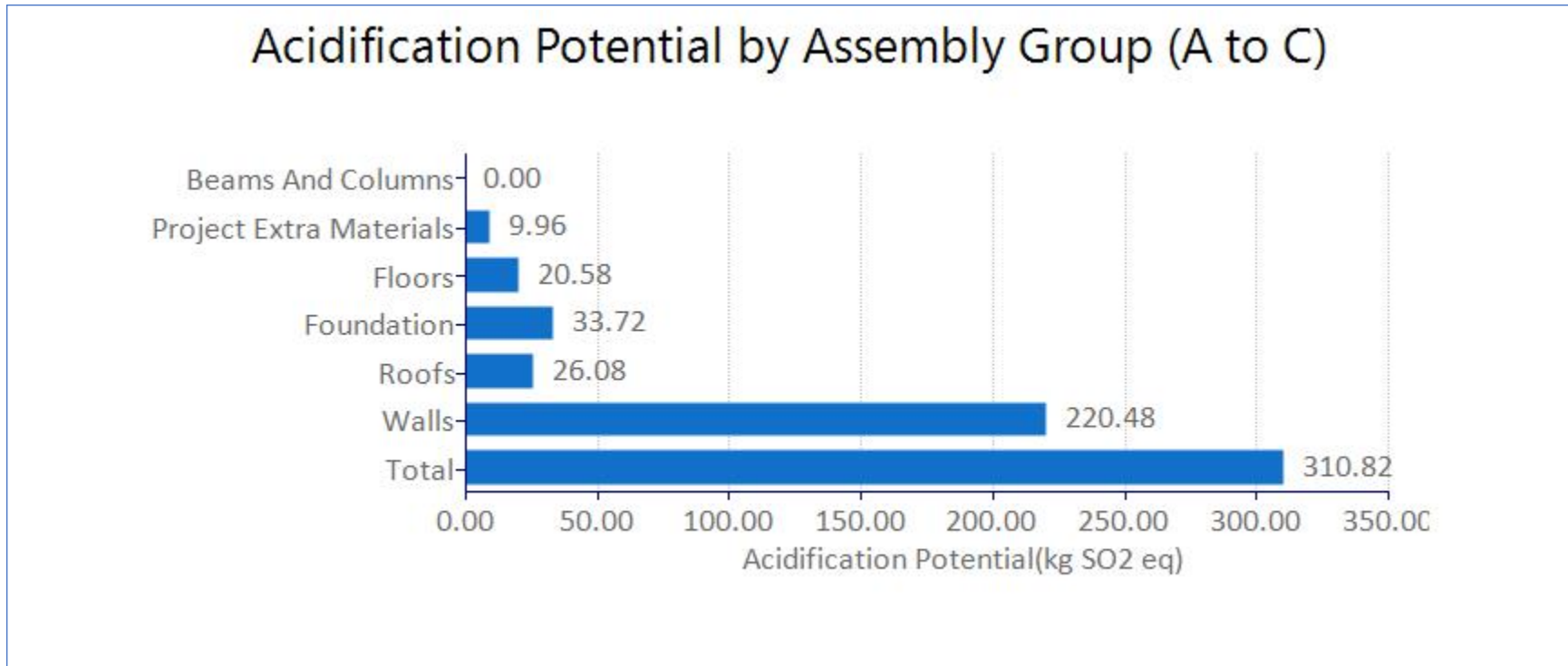
LCA Measure	Unit	Columns & Beams	Floors	Foundations	Roofs	Walls	Project Extra Materials	Total
Global Warming Potential	kg CO2 eq	0.00	-1.02E+003	6.91E+003	1.10E+003	2.56E+004	2.36E+003	3.50E+004
Acidification Potential	kg SO2 eq	0.00	2.06E+001	3.44E+001	2.58E+001	2.21E+002	1.05E+001	3.13E+002
HH Particulate	kg PM2.5 eq	0.00	2.34E+000	6.74E+000	6.14E+000	3.16E+001	1.01E+001	5.69E+001
Eutrophication Potential	kg N eq	0.00	1.54E+000	2.97E+000	1.82E+000	1.13E+001	3.26E-001	1.80E+001
Ozone Depletion Potential	kg CFC-11 eq	0.00	4.94E-006	5.65E-005	6.49E-005	3.84E-004	1.01E-007	5.10E-004
Smog Potential	kg O3 eq	0.00	4.23E+002	6.97E+002	5.63E+002	2.86E+003	1.34E+002	4.68E+003
Total Primary Energy	MJ	0.00	4.05E+004	6.56E+004	1.37E+005	3.43E+005	4.11E+004	6.27E+005
Non-Renewable Energy	MJ	0.00	3.15E+004	6.18E+004	1.29E+005	3.23E+005	4.11E+004	5.87E+005
Fossil Fuel Consumption	MJ	0.00	2.91E+004	5.51E+004	1.19E+005	3.12E+005	2.53E+004	5.40E+005

Global Warming Potential by assembly – graph and table, modules A–C



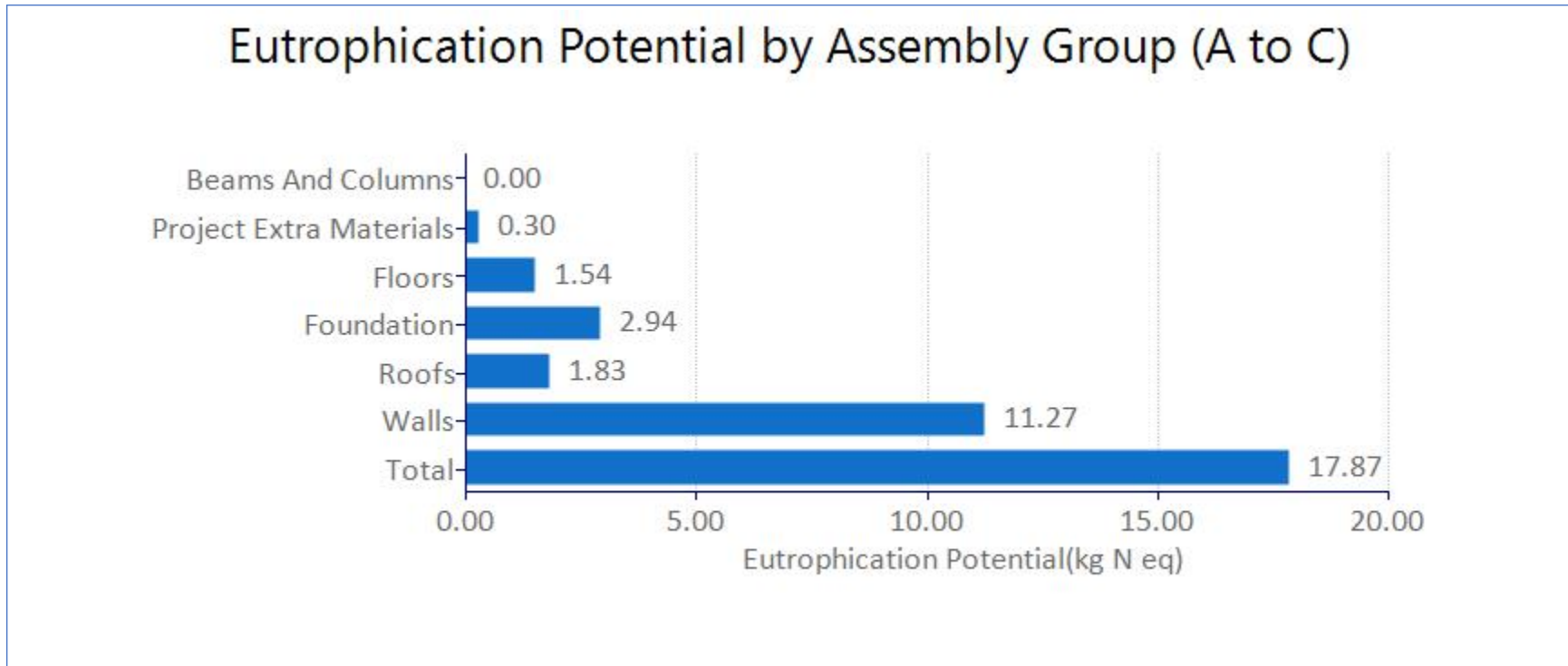
Global Warming Potential		
Assembly Group	Unit	Total
Beams & Columns	kg CO2 eq	0.00
Floors	kg CO2 eq	2,016.32
Foundations	kg CO2 eq	6,612.46
Roofs	kg CO2 eq	3,338.79
Walls	kg CO2 eq	29,113.98
Project Extra Materials	kg CO2 eq	2,122.37
Global Warming Potential Total	kg CO2 eq	43,203.93

Acidification Potential by assembly – graph and table, modules A–C



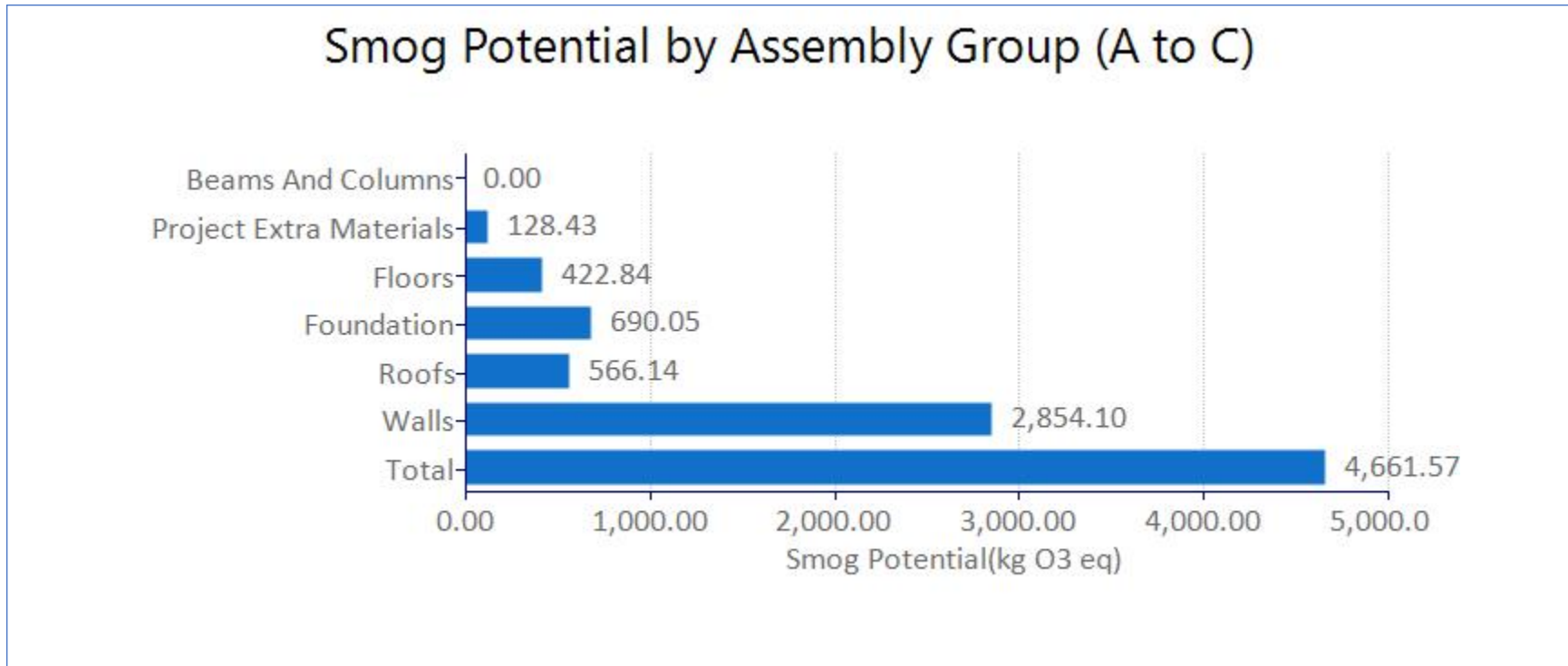
Acidification Potential		
Assembly Group	Unit	Total
Beams & Columns	kg SO2 eq	0.00
Floors	kg SO2 eq	20.58
Foundations	kg SO2 eq	33.72
Roofs	kg SO2 eq	26.08
Walls	kg SO2 eq	220.48
Project Extra Materials	kg SO2 eq	9.96
Acidification Potential Total	kg SO2 eq	310.82

Eutrophication Potential by assembly – graph and table, modules A–C



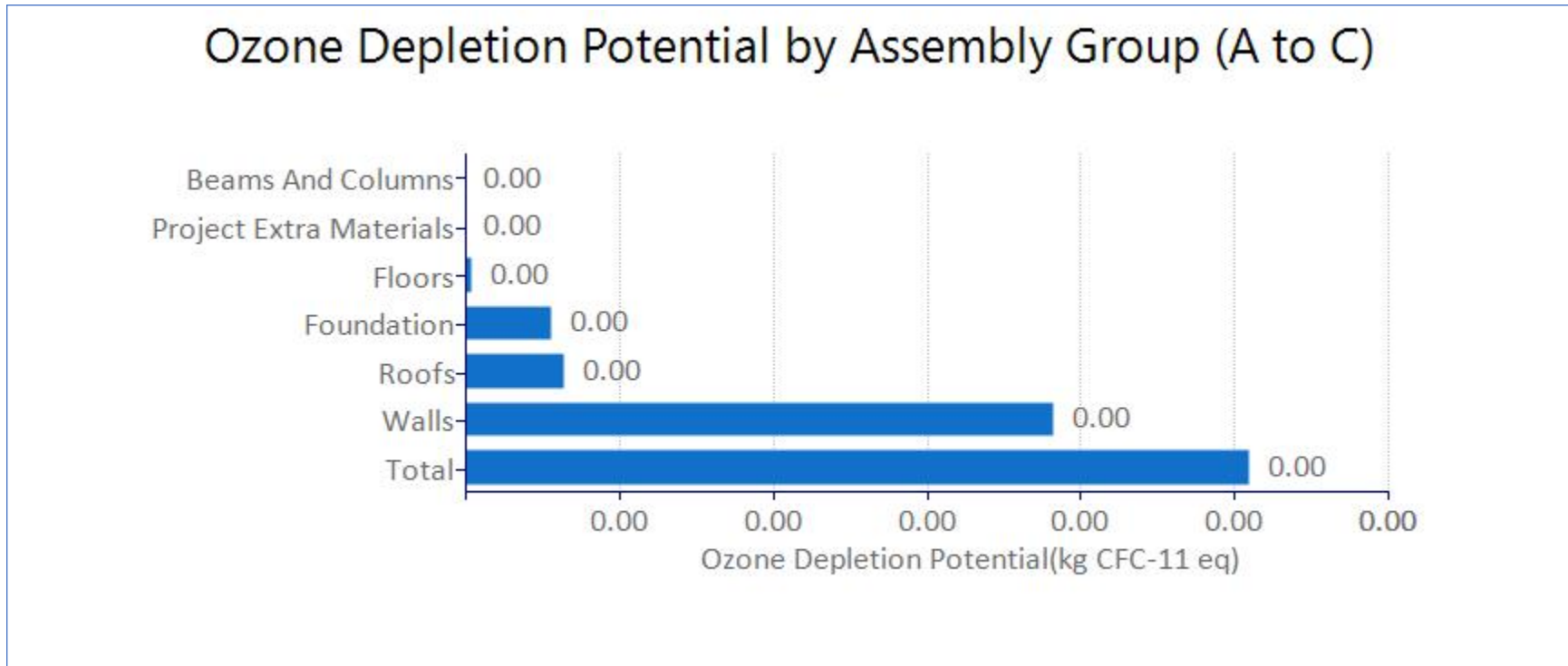
Eutrophication Potential		
Assembly Group	Unit	Total
Beams & Columns	kg N eq	0.00
Floors	kg N eq	1.54
Foundations	kg N eq	2.94
Roofs	kg N eq	1.83
Walls	kg N eq	11.27
Project Extra Materials	kg N eq	0.30
Eutrophication Potential Total	kg N eq	17.87

Smog Potential by assembly – graph and table, modules A–C



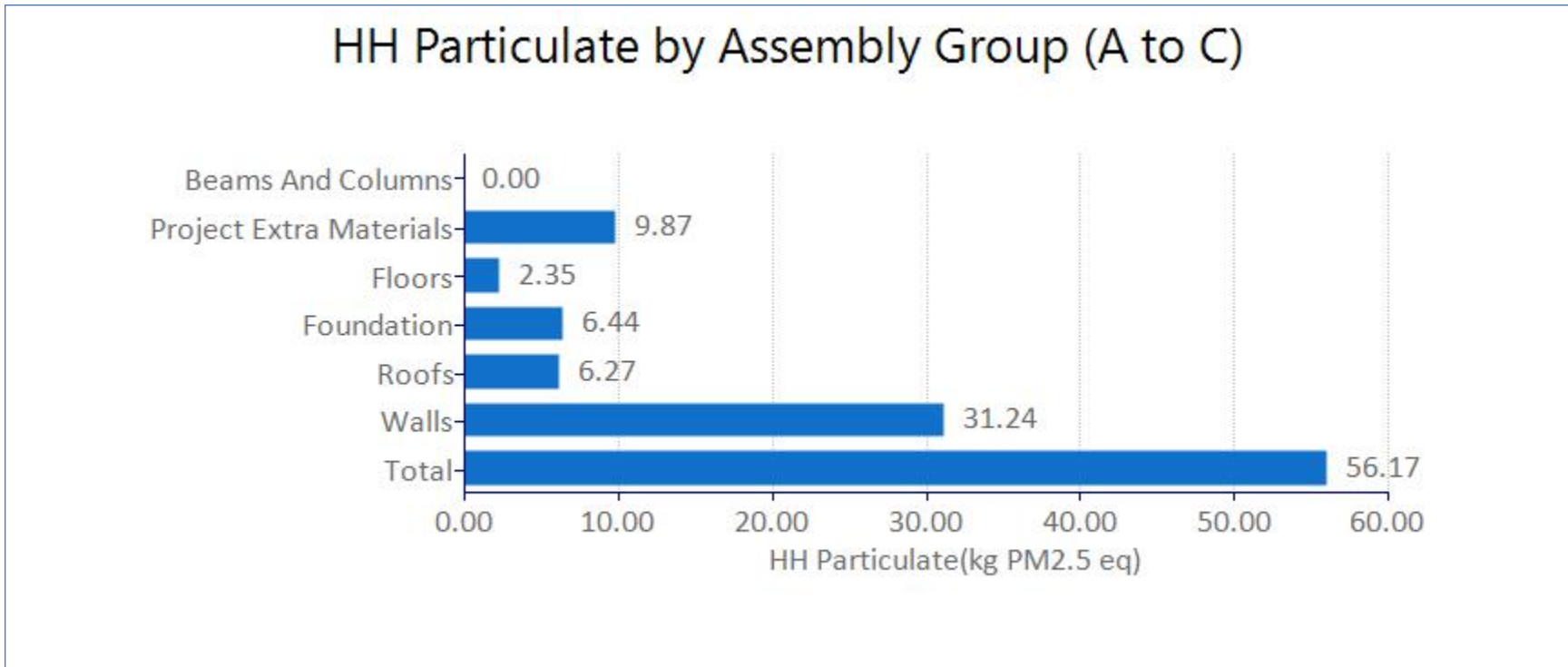
Smog Potential		
Assembly Group	Unit	Total
Beams & Columns	kg O3 eq	0.00
Floors	kg O3 eq	422.84
Foundations	kg O3 eq	690.05
Roofs	kg O3 eq	566.14
Walls	kg O3 eq	2,854.10
Project Extra Materials	kg O3 eq	128.43
Smog Potential Total	kg O3 eq	4,661.57

Ozone Depletion Potential by assembly – graph and table, modules A–C



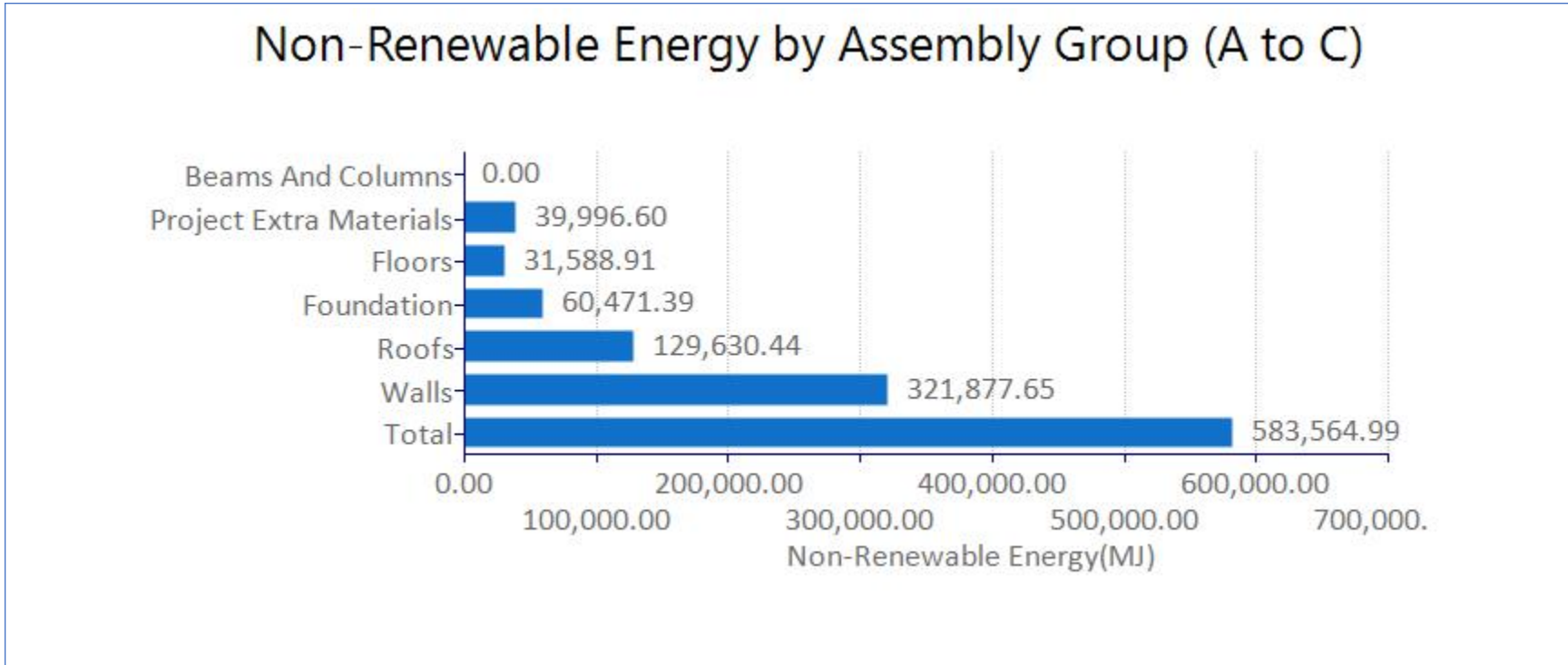
Ozone Depletion Potential		
Assembly Group	Unit	Total
Beams & Columns	kg CFC-11 eq	0.00
Floors	kg CFC-11 eq	4.94E-006
Foundations	kg CFC-11 eq	0.000057
Roofs	kg CFC-11 eq	0.000065
Walls	kg CFC-11 eq	0.000384
Project Extra Materials	kg CFC-11 eq	1.01E-007
Ozone Depletion Potential Total	kg CFC-11 eq	0.000510

Human Health Particulate by assembly – graph and table, modules A–C



Human Health Particulate Potential		
Assembly Group	Unit	Total
Beams & Columns	kg PM2.5 eq	0.00
Floors	kg PM2.5 eq	2.35
Foundations	kg PM2.5 eq	6.44
Roofs	kg PM2.5 eq	6.27
Walls	kg PM2.5 eq	31.24
Project Extra Materials	kg PM2.5 eq	9.87
HH Particulate Total	kg PM2.5 eq	56.17

Non-renewable Primary Energy by assembly – graph and table, modules A–C



Non-Renewable Primary Energy		
Assembly Group	Unit	Total
Beams & Columns	MJ	0.00
Floors	MJ	31,588.91
Foundations	MJ	60,471.39
Roofs	MJ	129,630.44
Walls	MJ	321,877.65
Project Extra Materials	MJ	39,996.60
Non-Renewable Energy Total	MJ	583,564.99

Embodied carbon

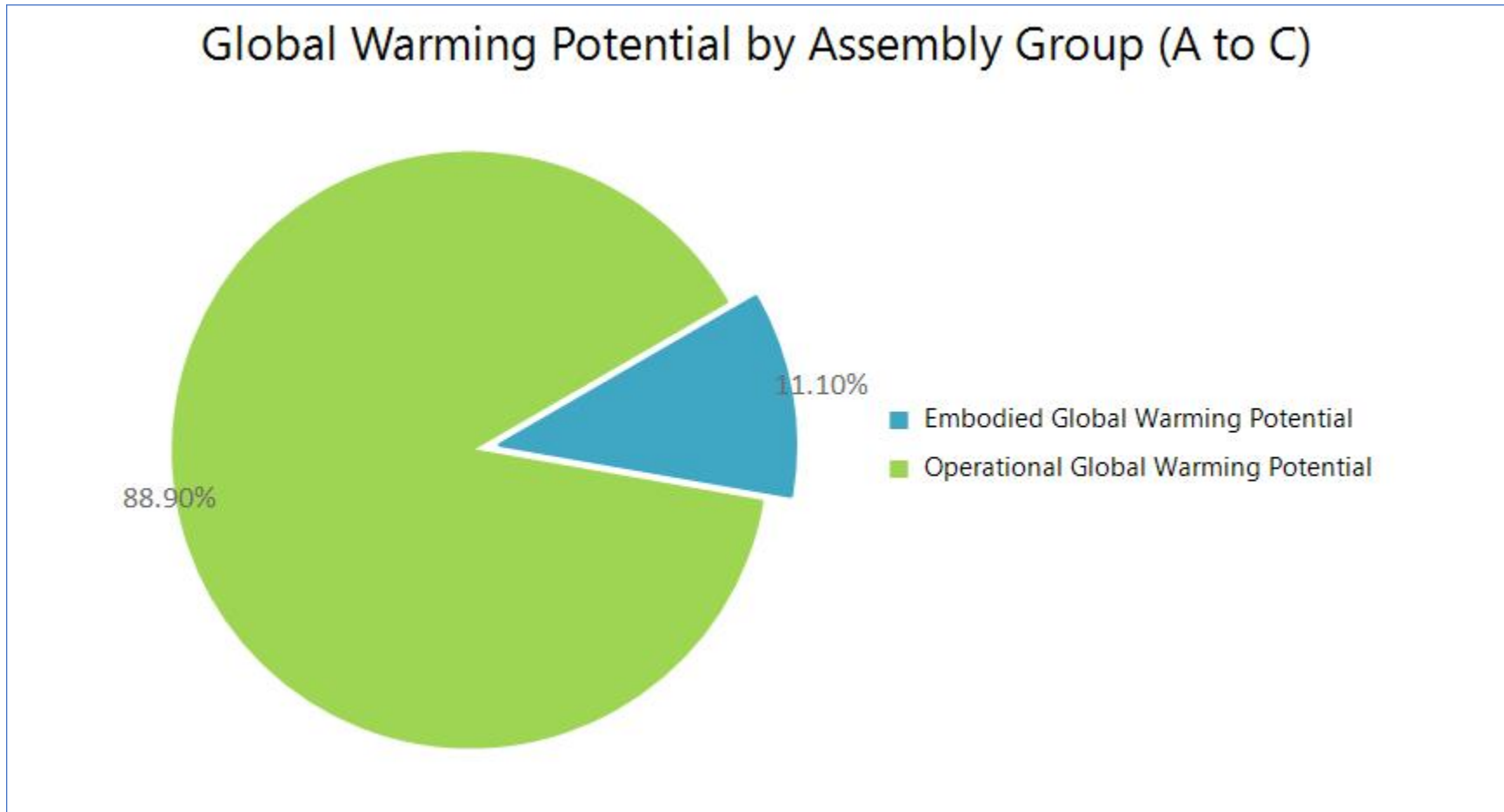
Embodied Carbon		
	Modules A to C	Module D
Lifetime GWP intensity (kg CO2e/m2)	1,876.55	-39.58
Annual GWP intensity (kg CO2e/m2-yr)	31.28	-0.66
Total project lifetime GWP (kg CO2e)	389,195.69	-8,207.86

Project total area (m2): 207.40 m2

Project life (years): 60

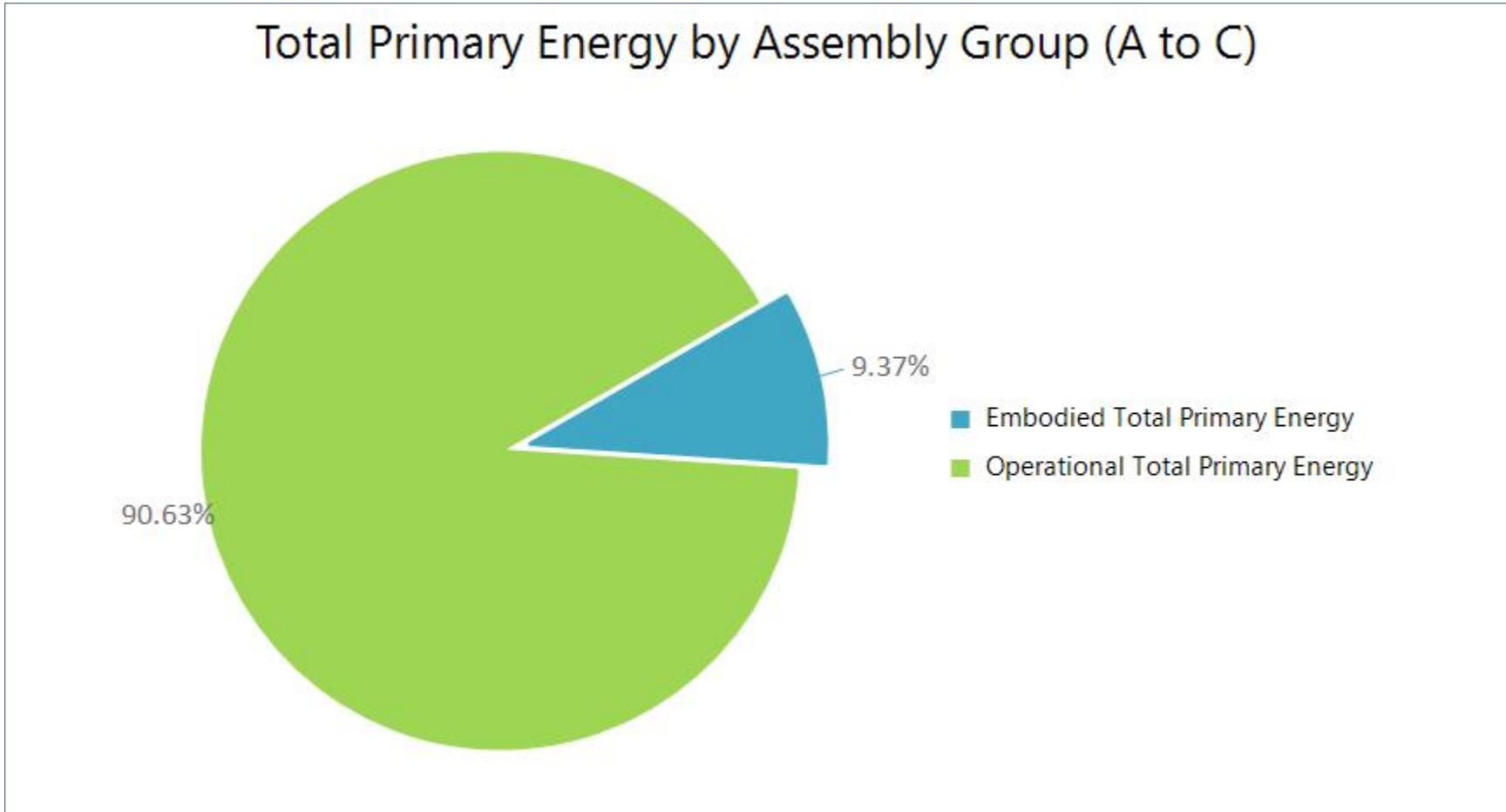
Operating versus embodied impacts

Operating vs embodied GWP – graph and table, modules A-C



Operating versus Embodied Global Warming Potential			
Operational Energy	Embodied Energy	Unit	Total
345,991.76	43,203.93	kg CO2 eq	389,195.69

Operating vs embodied Total Primary Energy Consumption – graph and table, modules A-C



Operating versus Embodied Total Primary Energy Consumption			
Operational GWP	Embodied GWP	Unit	Total
6,035,132.00	623,813.09	MJ	6,658,945.09

Bill of materials

Material	Unit	Total Quantity	Columns & Beams	Floors	Foundations	Roofs	Walls	Project Extra Materials	Mass Value	Mass Unit
#15 Organic Felt	m2	530.46	0.00	0.00	0.00	530.46	0.00	0.00	0.39	Tonnes
1/2" Regular Gypsum Board	m2	974.42	0.00	0.00	0.00	170.61	803.81	0.00	7.85	Tonnes
5/8" Regular Gypsum Board	m2	228.33	0.00	228.33	0.00	0.00	0.00	0.00	2.35	Tonnes
6 mil Polyethylene	m2	573.36	0.00	0.00	0.00	164.53	408.83	0.00	0.09	Tonnes
Cold Rolled Sheet	Tonnes	0.05	0.00	0.00	0.00	0.00	0.05	0.00	0.05	Tonnes
Concrete Benchmark CAN 25 MPa	m3	49.54	0.00	0.00	19.99	0.00	29.54	0.00	115.39	Tonnes
Double Glazed Hard Coated Argon	m2	96.99	0.00	0.00	0.00	0.00	96.99	0.00	1.57	Tonnes
FG Batt R11-15	m2 (25mm)	4,713.70	0.00	0.00	0.00	2,364.02	2,349.68	0.00	1.48	Tonnes
Galvanized Sheet	Tonnes	0.21	0.00	0.03	0.00	0.17	0.00	0.00	0.21	Tonnes
Joint Compound	Tonnes	1.20	0.00	0.23	0.00	0.17	0.80	0.00	1.20	Tonnes
Large Dimension Softwood Lumber, kiln-dried	m3	5.25	0.00	5.25	0.00	0.00	0.00	0.00	2.22	Tonnes
Metric Modular (Modular) Brick	m2	256.44	0.00	0.00	0.00	0.00	256.44	0.00	26.93	Tonnes
Mortar	m3	6.74	0.00	0.00	0.00	0.00	6.74	0.00	12.72	Tonnes
Nails	Tonnes	0.14	0.00	0.03	0.00	0.04	0.07	0.00	0.14	Tonnes
Organic Felt shingles 25yr	m2	488.58	0.00	0.00	0.00	488.58	0.00	0.00	5.59	Tonnes
Paper Tape	Tonnes	0.01	0.00	0.002615	0.00	0.001954	0.009207	0.00	0.01	Tonnes
PVC Window Frame	kg	1,603.81	0.00	0.00	0.00	0.00	1,603.81	0.00	1.60	Tonnes
Rebar, Rod, Light Sections	Tonnes	1.53	0.00	0.00	0.49	0.00	0.78	0.26	1.53	Tonnes
Small Dimension Softwood Lumber, kiln-dried	m3	12.50	0.00	0.00	0.00	4.33	8.17	0.00	5.29	Tonnes
Softwood Plywood	m2 (9mm)	890.91	0.00	344.14	0.00	205.71	341.06	0.00	4.05	Tonnes
Water Based Latex Paint	L	69.76	0.00	0.00	0.00	0.00	69.76	0.00	0.05	Tonnes
Welded Wire Mesh / Ladder Wire	Tonnes	0.12	0.00	0.00	0.12	0.00	0.00	0.00	0.12	Tonnes
Wide Flange Sections	Tonnes	1.88	0.00	0.00	0.00	0.00	0.00	1.88	1.88	Tonnes