Improved Life Cycle Performance for Construction of Big Box Retail

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IIT Masters Project
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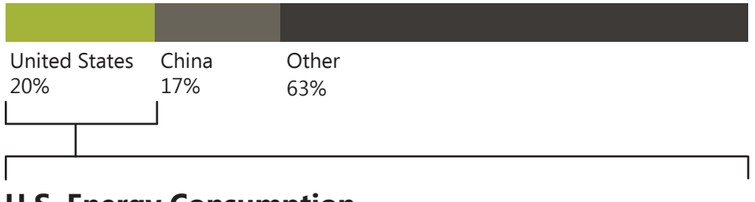
Environmental Impact Statistics

Global Energy Consumption



U.S. Energy Consumption

U.S. Building Sector Energy Sources

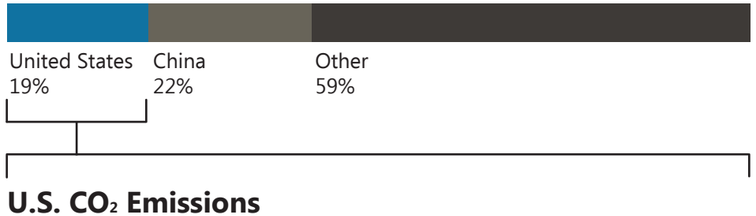
The U.S. building industry was responsible for 8% of the world's primary energy consumption in 2008. We consume more energy than any other country, but we are not even in the top five in terms of population size. Within the United States, the building industry accounted for 40% of the primary energy consumption, making the building sector a larger consumer than any other sector.

1 American house uses approximately

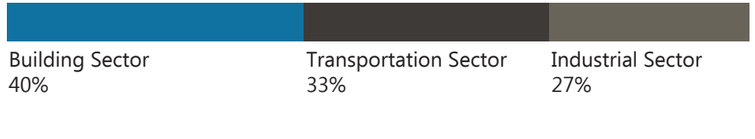
41,000 MJ

annually

Global CO_2 Emissions



U.S. CO_2 Emissions



Many people would be surprised to learn that the transportation sector is actually not the largest producer of CO_2 emissions. At 40%, the building sector is responsible for more CO_2 emissions than any other sector in the United States. The U.S. is the second largest producer of emissions in the world, and our building industry alone accounts for 7.5% of the global total.

1 passenger car emits approximately

7.5 tonnes of CO_2

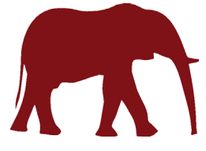
annually

U.S. Building Waste

U.S. Building Sector Waste

30 to 35 million tons
annually

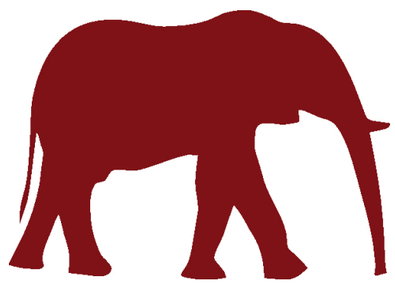
=



X 2,167

There already exist many movements and standards which strive to achieve lower levels of energy consumption and CO2 emissions in the construction and operation of buildings. However, there seems to be less concern about what happens to buildings at the end of their life cycle.

Annual construction and demolition debris currently accounts for roughly 24% of the municipal solid waste stream. Demolition accounts for 85% of that compared to 15% for construction. As much as 95% of building related construction waste is recyclable.



1 adult male elephant weighs

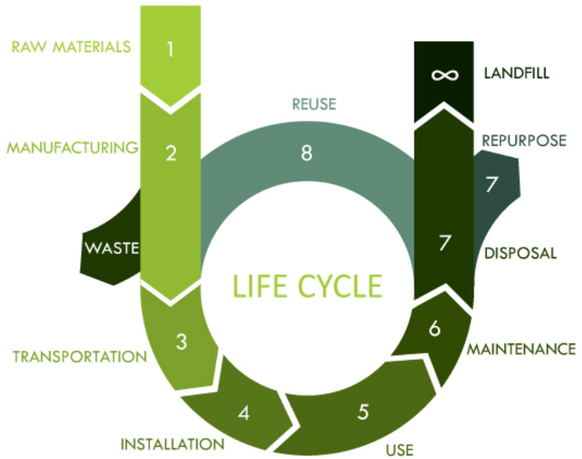
6.8 tonnes

Analysis Methods and Tools

Life Cycle Analysis

The Life Cycle Analysis of a building is the process of accounting for the impacts of the building resulting from the materials and processes associated with the production, use, and recycle/reuse/or disposal of the building at the end of it's life. This includes harvesting raw materials, manufacturing of products, transportation of materials and products, assembly into a structure, maintenance and operations during use, and disposal at the end of it's useful life.

LCA is a way of quantifying and analyzing many different factors which affect the human environment, one of which is embodied energy. **Embodied Energy** of a building is defined as the total energy input consumed during the life cycle of the materials and products of the building. A life cycle analysis could also include factors like CO2 emissions, ozone depletion, and/or human respiratory effects to name a few. Currently, there are a number of sources which are producing life cycle data. Unfortunately, there is no standard by which these values are weighted so conflicting data exists.



Source: apartmenttherapy.com

Athena Sustainable Materials Institute

The Athena Sustainable Materials Institute (www.athenamsi.ca) is a Canadian not-for profit whose objective is "to foster sustainability of the built environment, by meeting the building community's need for better information and tools that allow environmental considerations to be factored into the design process."

Athena has created two software tools, both of which analyze construction assemblies for 8 different impact measurements. They reference data that the Athena institute has compiled as well as the National Renewable Energy Laboratory's (NREL) research and data.

The EcoCalculator Software, used in this project, was created by the Athena Institute as a free spreadsheet available by download on their website. The second software created by Athena is the Building Impact Estimator software. This software may be downloaded from their website for a cost and is much more custumizable.

I have chosen to use this the EcoCalculator because it offers easily comparable data. There are many sources and softwares where similar data can be found. Unfortunately, there is a lot of debate about how these different factors should be weighted. Therefore, much of the data from different sources is conflicting.

Athena Impact Estimator for Buildings

Athena EcoCalculator for Commercial Assemblies

This project will compare multiple construction materials and assemblies in order to find options which will improve the life cycle performance of retail big box structures, using Walmart Supercenters as a specific case study. It will utilize the Athena EcoCalculator to accomplish this task.

Athena EcoCalculator

The Athena Sustainable Materials Institute (www.athenamsi.ca) is a Canadian not-for profit whose objective is "to foster sustainability of the built environment, by meeting the building community's need for better information and tools that allow environmental considerations to be factored into the design process."

The EcoCalculator Software, used in this project, was created by the Athena Institute as a free spreadsheet software available by download on their website. The software analyzes 7 assembly categories for 8 different impact measurements (see right). It references data that the Athena institute has completed as well as the National Renewable Energy Laboratory's (NREL) research and data. For each category, the user inputs the area or volume associated with that assembly. The software summarizes the results with graphs for each impact measurement.

Impact Measurements

Energy Consumption
Material Resource Use
Global Warming Potential
Acidification Potential
Human Health Respiratory Effect Potential
Aquatic Eutrophication Potential
Ozone Depletion Potential

Assembly Types

Foundations and Footings
Columns and Beams
Intermediate Floors
Exterior Walls
Windows
Interior Walls
Roofs
Smog Potential

ATHENA®
EcoCalculator
for commercial assemblies

TOTAL IMPACTS BY BUILDING COMPONENT	Fossil Fuel Consumption (MJ) TOTAL	Weighted Resource Use (tonnes) TOTAL	GWP (tonnes CO2eq) TOTAL	Acidification Potential (moles of H+ eq) TOTAL
INTERIOR WALLS	1,265,013	85	94	17,860
WHOLE BUILDING TOTAL	127,755,397	24,191	8,684	3,563,301

F. INTERIOR WALLS

IN THE YELLOW CELLS BELOW, ENTER THE AMOUNT OF SQUARE FOOTAGE THAT EACH ASSEMBLY USES IN Y

	ASSEMBLY TYPE (gypboard and paint are on BOTH SIDES of the interior walls)	Square footage	Percentage of total	Fossil Fuel Consumption per ft2 (MJ)	Weighted Resource Use per ft² (kg)	Global Warming Potential per ft² (kg CO2 eq)	Acidification Potential per ft² (moles of H+ eq)
Average across interior walls:				**75.07**	**9.11**	**4.96**	**1.42**
1	**2x4 Wood stud wall 16" o.c.** 5/8" Gypsum board + 2 coats Latex paint	0.0		31.41	5.8369	1.45	0.64
2	**2x4 Wood stud wall 24"o.c.** 5/8" Gypsum board + 2 coats Latex paint	0.0		30.84	5.2729	1.41	0.63
3	**2x4 Wood stud wall 24" o.c.** 2 x 5/8" Gypsum board + 2 coats Latex paint	0.0		44.45	7.9259	2.30	1.06
4	**1-5/8" x 3-5/8" Steel stud 16" o.c.** 5/8" Gypsum board + 2 coats Latex paint	0.0		37.47	4.5814	1.94	0.75
5	**1-5/8" x 3-5/8" Steel stud 24" o.c.** 5/8" Gypsum board + 2 coats Latex paint	0.0		35.40	4.3300	1.78	0.71
6	**1-5/8" x 3-5/8" Steel stud 24" o.c.** 2 x 5/8" Gypsum board + 2 coats Latex paint	0.0		49.03	6.0830	2.67	1.14

How-To | Foundations & Footings | Columns & Beams | Intermediate Floors | Exterior Walls | Windows | Interior Walls | Roofs | Summary

Software Assumptions

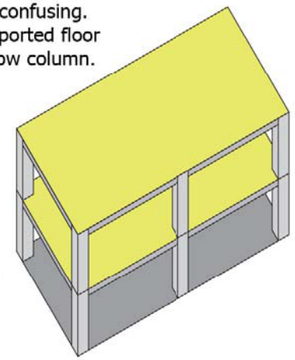
The software does have some limitations. It is limited in the types of materials and construction assemblies to choose from. Any material that is relatively new or unique is not included. You can not edit/add assemblies to the spreadsheet; you may only use what they provide. The software also makes a number of assumptions. For example, column heights are set to 10 ft with bays of 30' x 30'.

Global Assumptions:
60 year useful life
All concrete (except floor topping) is 4000 psi
Cast-in-place concrete contains 25% fly ash
Concrete masonry contains 0% fly ash
Precast concrete contains 10% silica fume

Column and Beam Assumptions:
Bay sizes are set at 30'x30'
Column heights are set at 10'
Glulam beams are 24F grade
HSS steel columns are 5" x 5" x 1/4" steel tube
Softwood columns are 6" x 6" built up

Roof Assumptions:
Live load for roofs are set at 45 psf
Spacing of structural members are set based on system

Columns and beams can be confusing. You need only enter the supported floor and/or roof areas in the yellow column. (In yellow in this diagram) Note: This models a 10 ft. floor-to-floor height, therefore the columns are included.

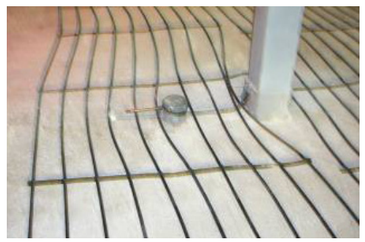


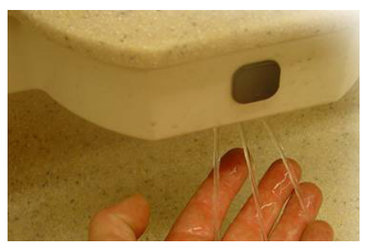
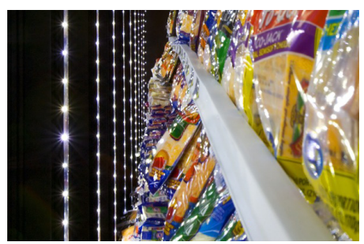
To hide or view this pop-up, select View>Comments, or click the Show/Hide comments box above:

Walmart





Walmart's Sustainability Plan

Launched in 2005

1. Be supplied 100 percent by renewable
2. energy.
3. Create zero waste. Sell products that sustain people and the environment .

Walmart has a huge amount of influence in the commercial sector and claim to be a leader for sustainability practices. However, when you look closely at the numbers, things don't quite add up.

<2% of Walmart's U.S. electricity consumption that currently comes from its solar projects and specially purchased wind energy

3.7 million metric tons of CO_2 emitted annually by stores built since 2006

1.5 million metric tons of CO_2 saved annually by energy efficiency improvements to stores built before 2006

Some of what Walmart is doing:

- daylight harvesting system
- daylight sensors which dim sales floor lighting
- solar arrays on roofs
- T-8 fluorescent lamps and electronic ballasts
- centralized energy management system
- LED lighting in exterior building signage
- LED lighting and occupancy sensors in refrigerated/freezer cases
- no more open air refrigerated cases
- occupancy sensors in non-sales areas
- "super" high efficiency HVAC units (6% more efficient than required by California Title 24
- dehumidification allows more efficient cooling
- radiant floors in some stores
- white membrane roofs (no PVC)
- 70% of water heated by reclaiming waste heat from refrigeration equipment
- low-flow plumbing fixtures

641 million
total square footage of the island of Manhattan

Walmart by the numbers

2011 Sales in the U.S.:

$307.7 billion Walmart

$78.3 billion The Kroger Co.

$65.8 billion Target

698 million
total square footage of Walmart's U.S. stores in **2011**

3,029
number of supercenters in the U.S. in **2011**

185,000
average square footage of a Walmart supercenter

146
number of **abandoned** Walmart stores in the U.S. listed as available for lease or sale as of **2011**

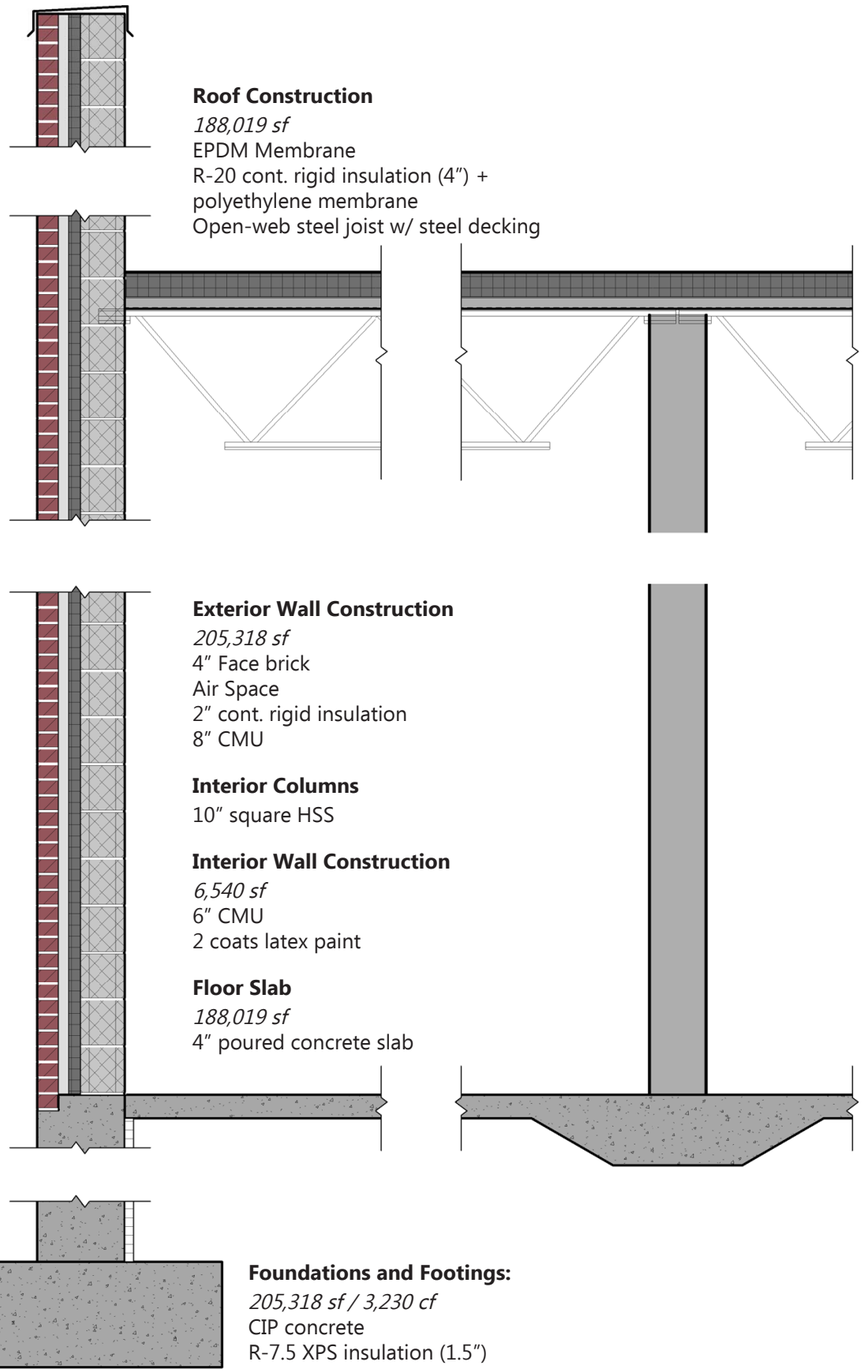
110
number of **new supercenters** Walmart plans to open in the U.S. **in 2012** (210 total stores)

Walmart is by far the largest retailer both in terms of sales and physical store space. In sales, Walmart makes nearly four times in sales compared to the next largest retail company.

Walmart has more stores nationwide than any other retailer, which together cover more area than the island of Manhattan.

The average size of a Walmart Supercenter is 185,000 square feet. In 2012 they plan to build approximately 110 new supercenters in the US which works out to just over 20 million square feet.

Current Supercenter Construction
(Baseline)



Roof Construction
188,019 sf
EPDM Membrane
R-20 cont. rigid insulation (4″) +
polyethylene membrane
Open-web steel joist w/ steel decking

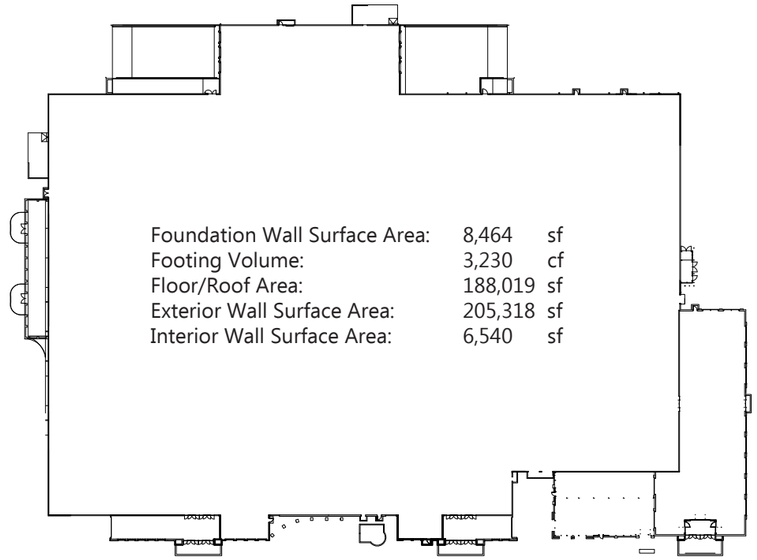
Exterior Wall Construction
205,318 sf
4″ Face brick
Air Space
2″ cont. rigid insulation
8″ CMU

Interior Columns
10″ square HSS

Interior Wall Construction
6,540 sf
6″ CMU
2 coats latex paint

Floor Slab
188,019 sf
4″ poured concrete slab

Foundations and Footings:
205,318 sf / 3,230 cf
CIP concrete
R-7.5 XPS insulation (1.5″)



Foundation Wall Surface Area:	8,464	sf
Footing Volume:	3,230	cf
Floor/Roof Area:	188,019	sf
Exterior Wall Surface Area:	205,318	sf
Interior Wall Surface Area:	6,540	sf

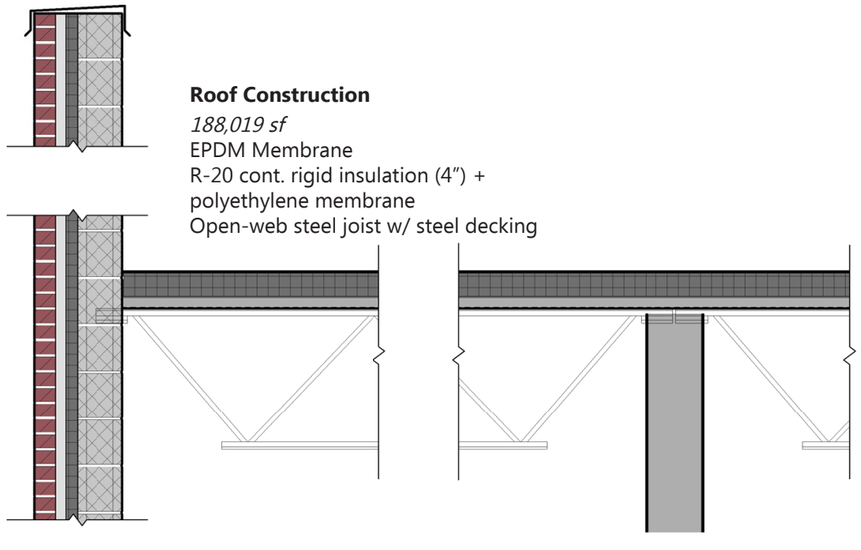
Floor Plan

This is an example of the current design of a typical Walmart Supercenter. These values will be used to establish a baseline comparison using the Athena EcoCalculator software.

FRONT PERSPECTIVE (N.T.S.)

FRONT ELEVATION

Baseline Analysis



Roof Construction
188,019 sf
EPDM Membrane
R-20 cont. rigid insulation (4") +
polyethylene membrane
Open-web steel joist w/ steel decking

Exterior Wall Construction
205,318 sf
4" Face brick
Air Space
2" cont. rigid insulation
8" CMU

Interior Columns
10" square HSS

Interior Wall Construction
6,540 sf
6" CMU
2 coats latex paint

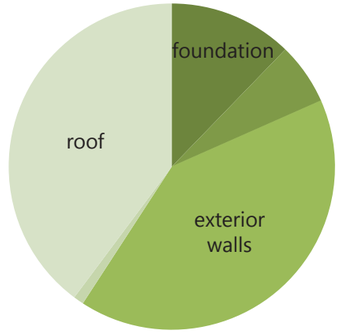
Floor Slab
188,019 sf
4" poured concrete slab

Foundations and Footings:
205,318 sf / 3,230 cf
CIP concrete
R-7.5 XPS insulation (1.5")

FOSSIL FUEL CONSUMPTION

125,350,941 MJ

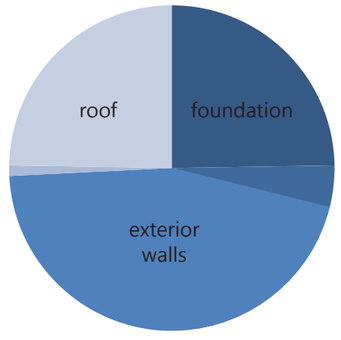
39%	roof
1%	interior walls
41%	exterior walls
6%	columns (and beams)
13%	foundations



GLOBAL WARMING POTENTIAL

8,472 tonnes CO_2

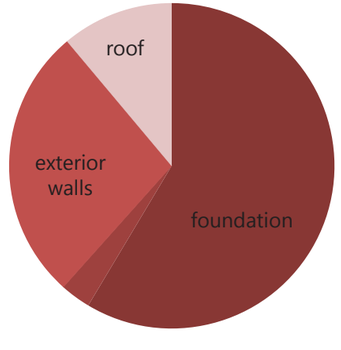
25%	roof
1%	interior walls
45%	exterior walls
4%	columns (and beams)
25%	foundations



RESOURCE CONSUMPTION

23,990 tonnes

11%	roof
0%	interior walls
27%	exterior walls
3%	columns (and beams)
59%	foundations

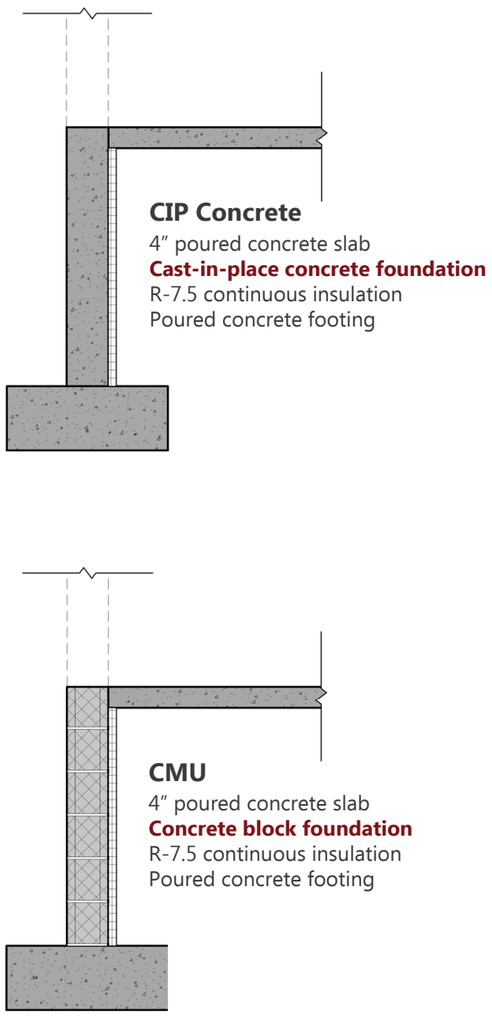


After entering the construction assembly information into the Athena EcoCalculator software, it generates a summary of the information first by assembly type and then by impact measurement. Here I have shown the three impact values that are significant to this project: energy, emissions and waste. As you can see, the roof, exterior walls, and the foundations are the biggest contributors in all three categories.

From here I decided the best method to evaluate the multiple combinations of assemblies would be to analyze each assembly individually.

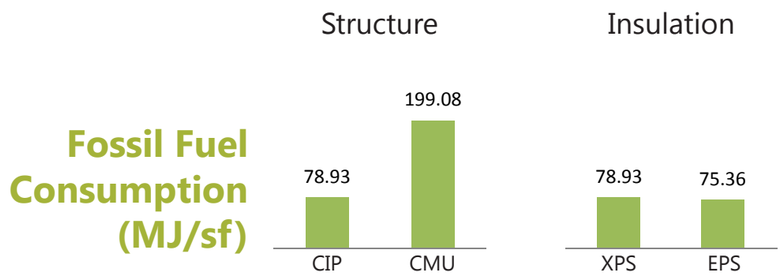
Foundation Assemblies

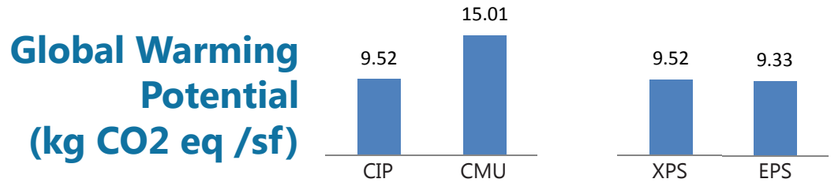
NOTES:
Insulation data based on CIP foundation.

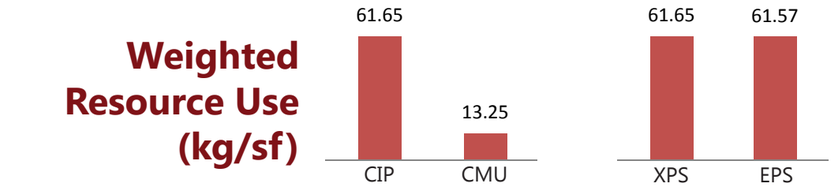


CIP Concrete
4" poured concrete slab
Cast-in-place concrete foundation
R-7.5 continuous insulation
Poured concrete footing

CMU
4" poured concrete slab
Concrete block foundation
R-7.5 continuous insulation
Poured concrete footing

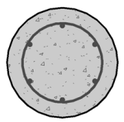




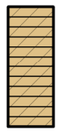


Columns

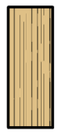
NOTES:
Data based on load bearing exterior wall values



1 - Concrete



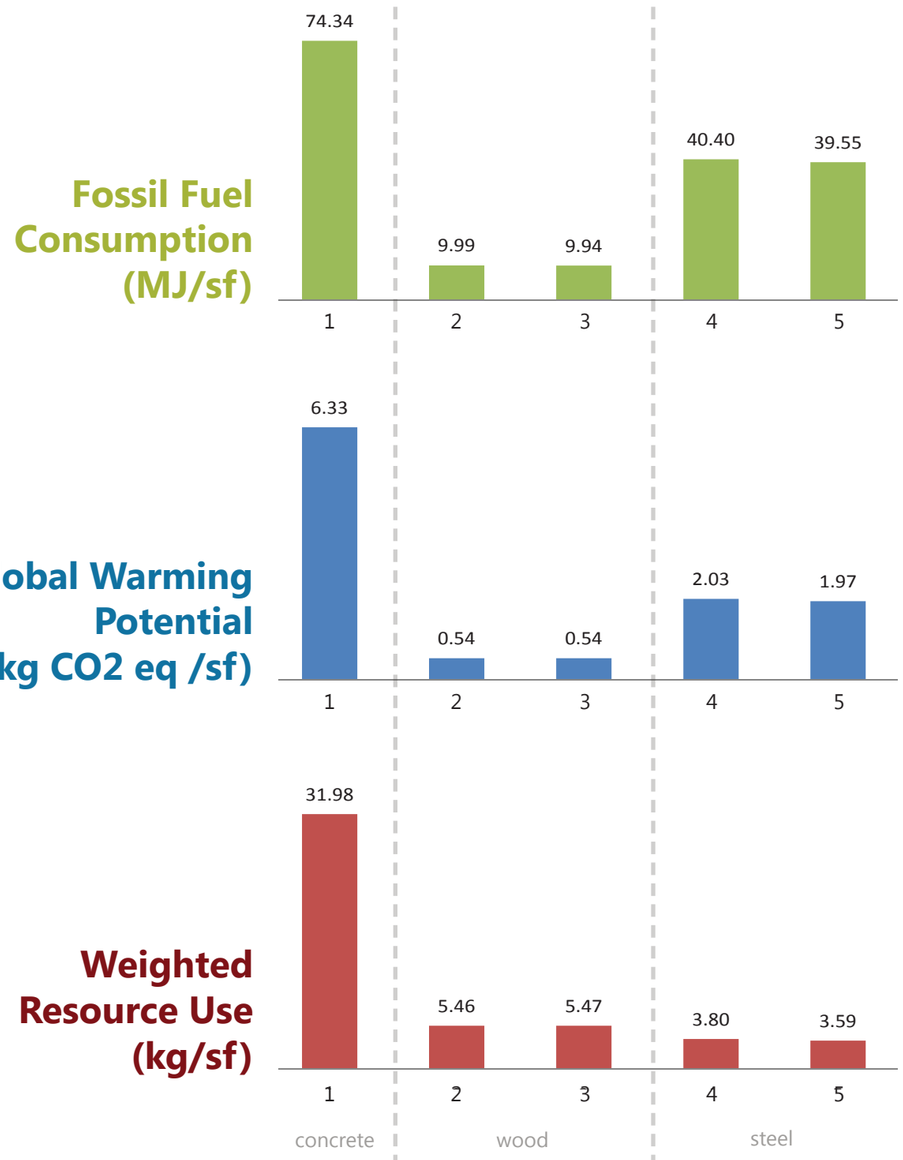
2 - Glulam



3 - LVL

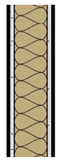
4 - Hollow Structural Section

5 - Wide Flange

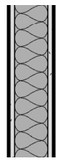


Interior Wall Assemblies

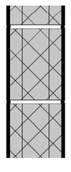
NOTES:
*Gyp. Bd. + Paint on interior
**studs 16″ o.c.



Wood Stud
Gyp. Bd. + Paint
2x4 Wood Stud 24″ o.c.
w/ Cavity Insulation
Gyp. Bd. + Paint

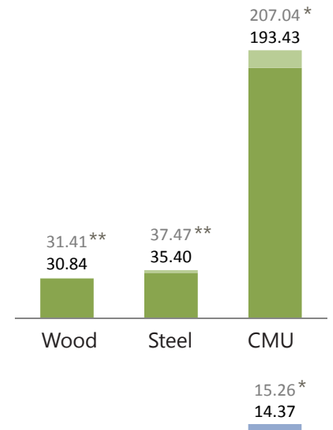


Steel Stud
Gyp. Bd. + Paint
2x4 Steel Stud 24″ o.c.
w/ Cavity Insulation
Gyp. Bd. + Paint

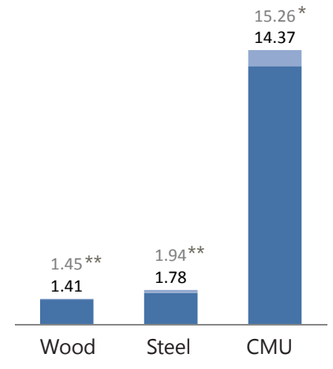


CMU
6″ Concrete Block

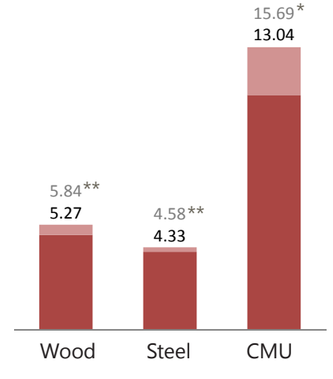
Fossil Fuel Consumption (MJ/sf)



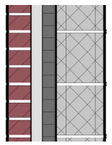
Global Warming Potential (kg CO2 eq /sf)



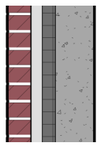
Weighted Resource Use (kg/sf)



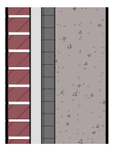
Exterior Wall Assemblies- Structure



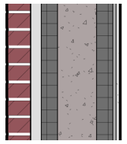
CMU
Brick Cladding
Continuous Insulation
8" CMU



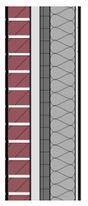
CIP concrete
Brick Cladding
Continuous Insulation
6" Cast-In-Place Concrete



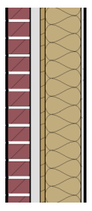
Tilt Up
Brick Cladding
Continuous Insulation
8" Concrete Tilt Up



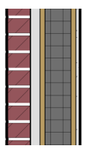
ICF
Brick Cladding
Insulated Concrete Form
Gyp. Bd. + Paint



Steel Stud
Brick Cladding
Continuous Insulation
2x4 Steel Stud, 24" o.c.
Cavity Insulation
Gyp. Bd. + Paint



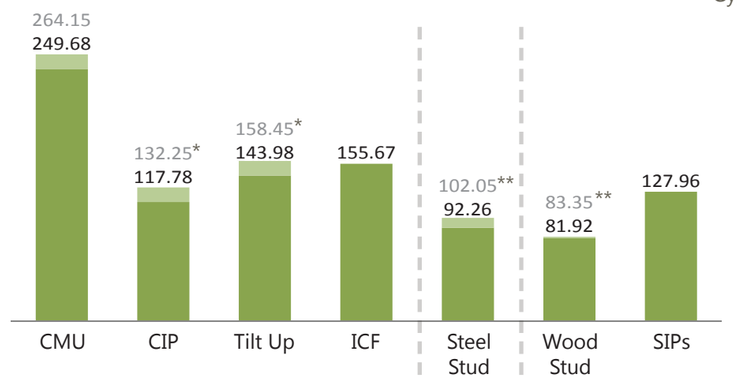
Wood Stud
Brick Cladding
Wood Sheathing
2x6 Wood Stud, 24" o.c
Cavity Insulation
Gyp. Bd. + Paint



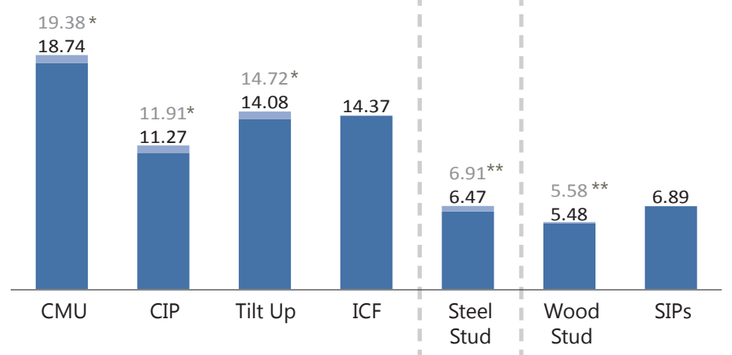
SIPs
Brick Cladding
5.5" SIPs
Gyp. Bd. + Paint

NOTES:
Comparison based on brick cladding values
*Gyp. Bd. + Paint on interior
**studs 16" o.c.

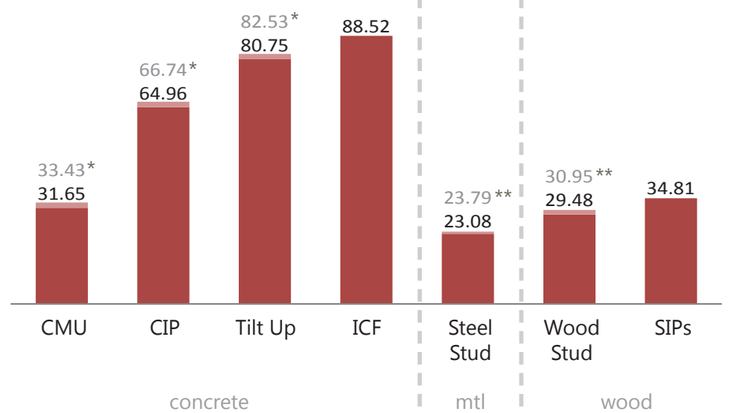
Fossil Fuel Consumption (MJ/sf)



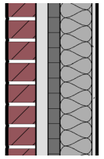
Global Warming Potential (kg CO2 eq /sf)



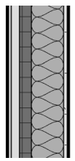
Weighted Resource Use (kg/sf)



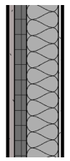
Exterior Wall Assemblies - Cladding



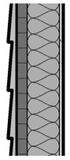
Brick
Brick Cladding
Continuous Insulation
Steel Stud w/ Cavity Insulation
Gyp. Bd. + Paint



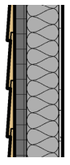
Steel
Steel Cladding
Continuous Insulation
Steel Stud w/ Cavity Insulation
Gyp. Bd. + Paint



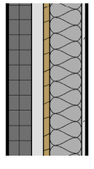
Stucco
Stucco Cladding
Continuous Insulation
Steel Stud w/ Cavity Insulation
Gyp. Bd. + Paint



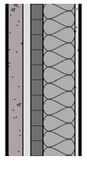
Vinyl Cladding
Vinyl Cladding
Continuous Insulation
Steel Stud w/ Cavity Insulation
Gyp. Bd. + Paint



Wood Cladding
Wood Cladding
Continuous Insulation
Steel Stud w/ Cavity Insulation
Gyp. Bd. + Paint



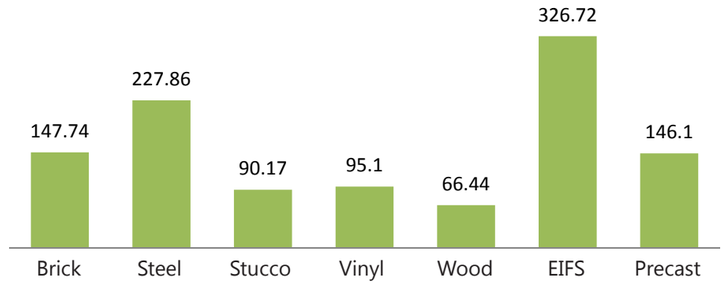
EIFS
EIFS
Continuous Insulation
Steel Stud w/ Cavity Insulation
Gyp. Bd. + Paint



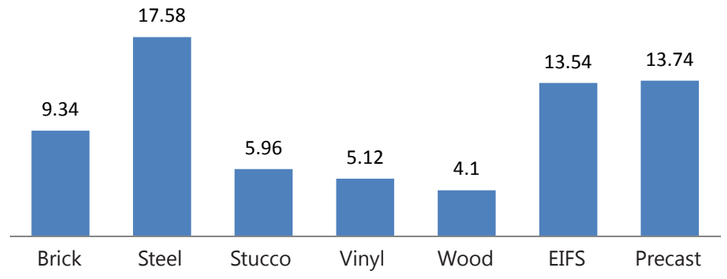
Precast Concrete
Precast Concrete Cladding
Continuous Insulation
Steel Stud w/ Cavity Insulation
Gyp. Bd. + Paint

NOTES:
Comparison based on metal stud values

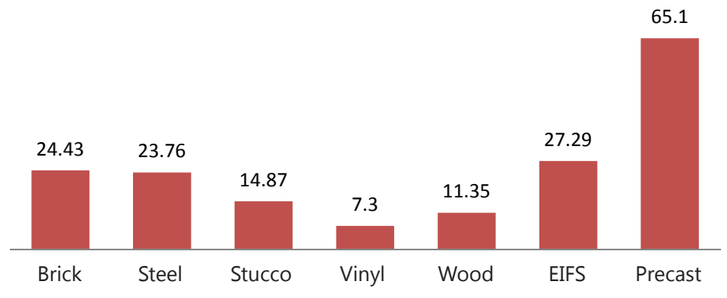
Fossil Fuel Consumption (MJ/sf)



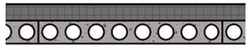
Global Warming Potential (kg CO2 eq /sf)



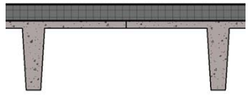
Weighted Resource Use (kg/sf)



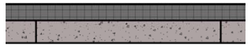
Roof Assemblies - Structure



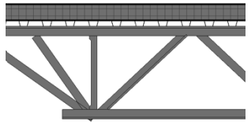
1 - Precast Hollow Core Concrete
EPDM over Continuous Insulation
Precast Hollow Core Concrete
Latex Paint



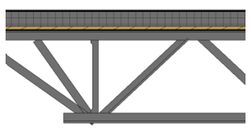
2 - Precast Concrete Double-T
EPDM over Continuous Insulation
Precast Concrete Double T
Latex Paint



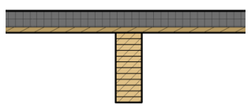
3 - Suspended Concrete Slab
EPDM over Continuous Insulation
Suspended Concrete Slab
Latex Paint



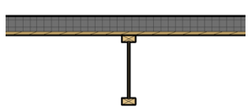
4 - Open Web Stl Joist w/ Stl Deck
EPDM over Continuous Insulation
Open Web Stl Joist w/ Stl Deck



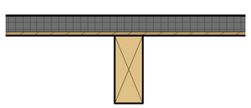
5 - Open Web Stl Joist w/ Wd Deck
EPDM over Continuous Insulation
Open Web Stl Joist w/ Wd Deck



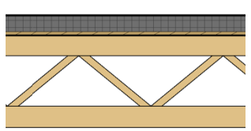
6 - Glulam Joist w/ Plank Deck
EPDM over Continuous Insulation
Glulam Joist w/ Plank Deck



7 - Wood I-Joist w/ Wood Deck
EPDM over Continuous Insulation
Wood I-Joist w/ Wood Deck



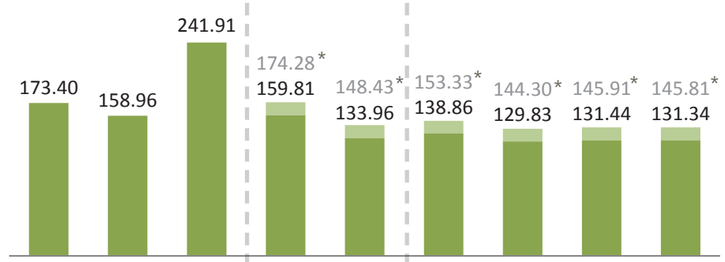
8 - Solid Wood Joist w/ Wood Deck
EPDM over Continuous Insulation
Solid Wood Joist w/ Wood Deck



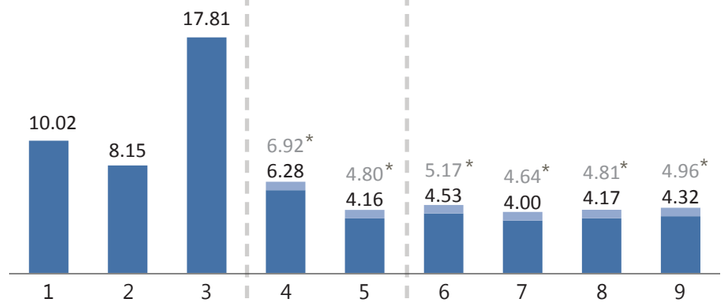
9 - Flat Wood Truss w/ Wood Deck
EPDM over Continuous Insulation
Flat Wood Truss w/ Wood Deck

NOTES:
Comparison based on values for EPDM membrane over continuous rigid insulation
*Gyp. Bd. + Paint on interior

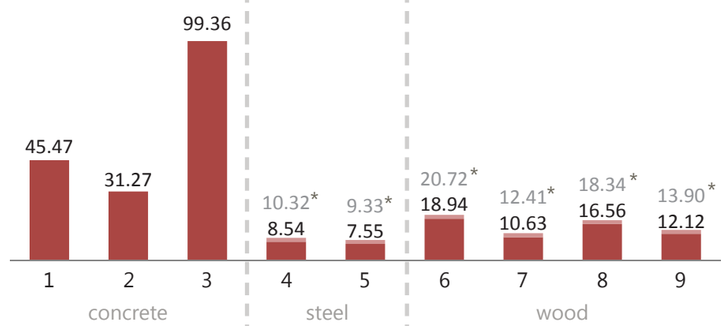
Fossil Fuel Consumption (MJ/sf)



Global Warming Potential (kg CO2 eq /sf)

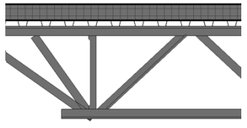


Weighted Resource Use (kg/sf)

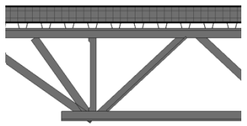


Roof Assemblies - Membranes

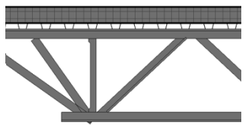
NOTES:
Comparison based on values for rigid insulation on metal decking.
Only flat roof options are considered.



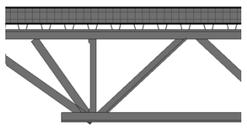
EPDM Membrane
EPDM Membrane
Continuous Insulation
Open Web Stl Joist w/ Stl Deck



PVC Membrane
PVC Membrane
Continuous Insulation
Open Web Stl Joist w/ Stl Deck

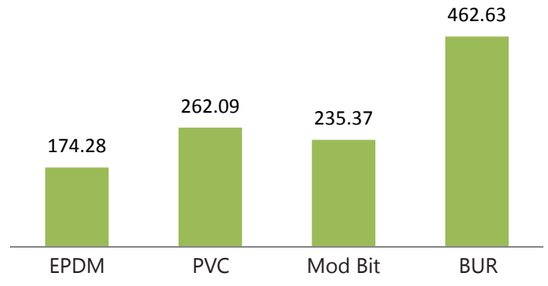


Mod Bitumen Membrane
Mod Bitumen Membrane
Continuous Insulation
Open Web Stl Joist w/ Stl Deck

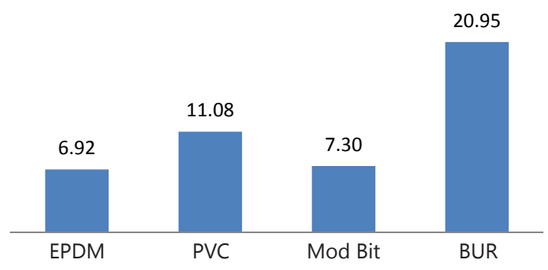


4-Ply Built Up Roof
4-Ply Built Up Roof
Continuous Insulation
Open Web Stl Joist w/ Stl Deck

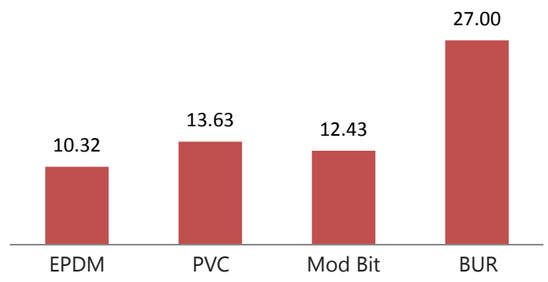
Fossil Fuel Consumption (MJ/sf)

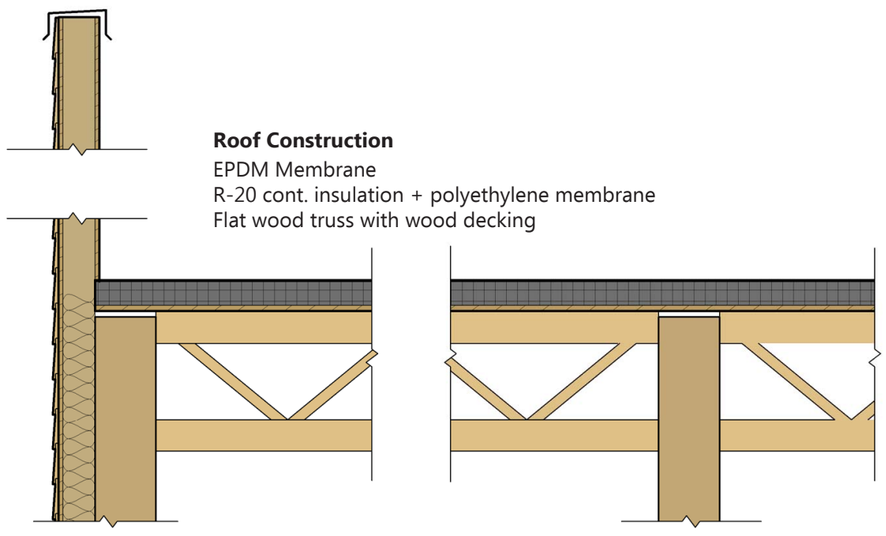


Global Warming Potential (kg CO2 eq /sf)



Weighted Resource Use (kg/sf)





Roof Construction
EPDM Membrane
R-20 cont. insulation + polyethylene membrane
Flat wood truss with wood decking

Exterior Wall Construction
Wood Cladding
Wood structural pnl sheathing
2x6 wood stud, 24" o.c.
R-19 cavity insulation
Gyp bd + latex paint

Interior Columns
LVL

Interior Wall Construction
Gyp bd + latex paint
2x4 wood stud, 24" o.c.
Gyp bd + latex paint

Floor Slab
4" poured concrete slab

Foundations and Footings:
CIP concrete foundation
R-7.5 EPS insulation (1.5")

52,339,762 MJ
FOSSIL FUEL CONSUMPTION
58.2% reduction

3,680 tonnes CO_2
GLOBAL WARMING POTENTIAL
56.6% reduction

21,539 tonnes
RESOURCE CONSUMPTION
10.2% reduction

Lowest EcoCalculator Values Condition
All Wood Construction

This construction is what results from choosing the assemblies with the lowest values (particularly for fossil fuel consumption and global warming potential. It is mostly wood, including wood cladding on the exterior. It reduces these two categories by more than half.

What impact would Walmart have if they switched to this construction?

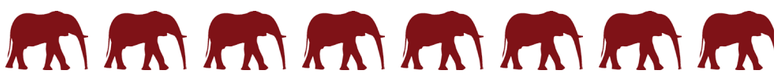
They would be able to...

*based on 110 supercenters per annum
**each icon equals 5,000 units

...power **195,800 houses**
(8 million MJ annually)

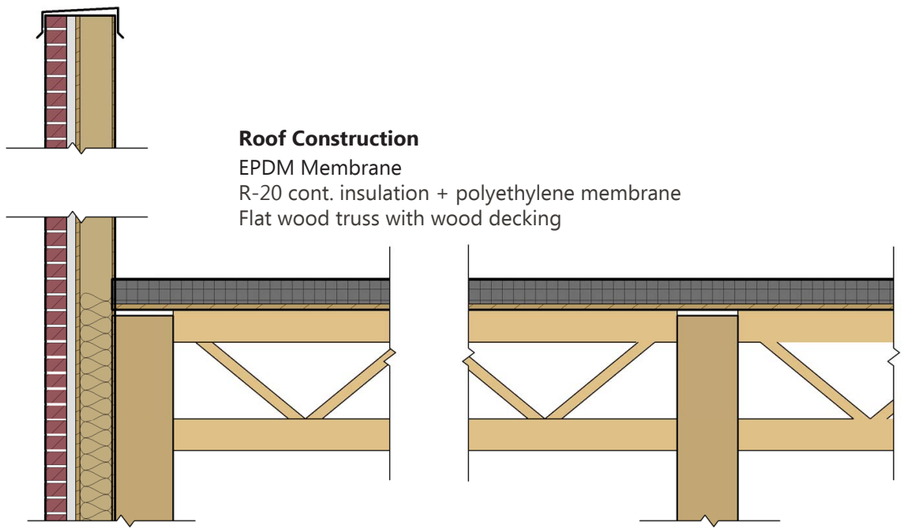
...remove **70,290 cars** from the road
(527,100 tonnes CO2 eq annually)

...reduce waste by the weight of **39,600 elephants**
(269,600 tonnes of waste annually)



Brick retains exterior aesthetic of existing assembly
Interior is wood structure

This construction is a combination the previous assembly with a brick facade. This construction would allow Walmart to keep the exterior aesthetic of their stores relatively similar to the current look. This still results in a major reduction in fossil fuel and global warming potential. However, this system shows an increase in raw resources use according to the EcoCalculator.



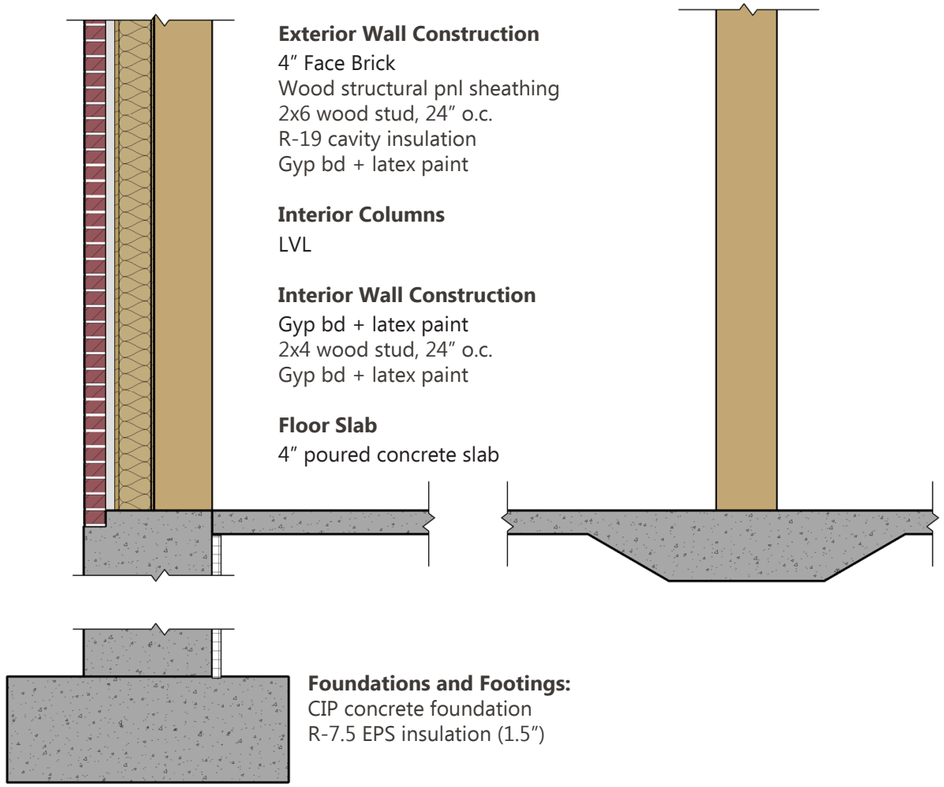
Roof Construction
EPDM Membrane
R-20 cont. insulation + polyethylene membrane
Flat wood truss with wood decking

Exterior Wall Construction
4" Face Brick
Wood structural pnl sheathing
2x6 wood stud, 24" o.c.
R-19 cavity insulation
Gyp bd + latex paint

Interior Columns
LVL

Interior Wall Construction
Gyp bd + latex paint
2x4 wood stud, 24" o.c.
Gyp bd + latex paint

Floor Slab
4" poured concrete slab



Foundations and Footings:
CIP concrete foundation
R-7.5 EPS insulation (1.5")

62,650,978 MJ
FOSSIL FUEL
CONSUMPTION
50% reduction

4,257 tonnes CO_2
GLOBAL WARMING
POTENTIAL
50% reduction

24,092 tonnes
RESOURCE
CONSUMPTION
0.43% increase

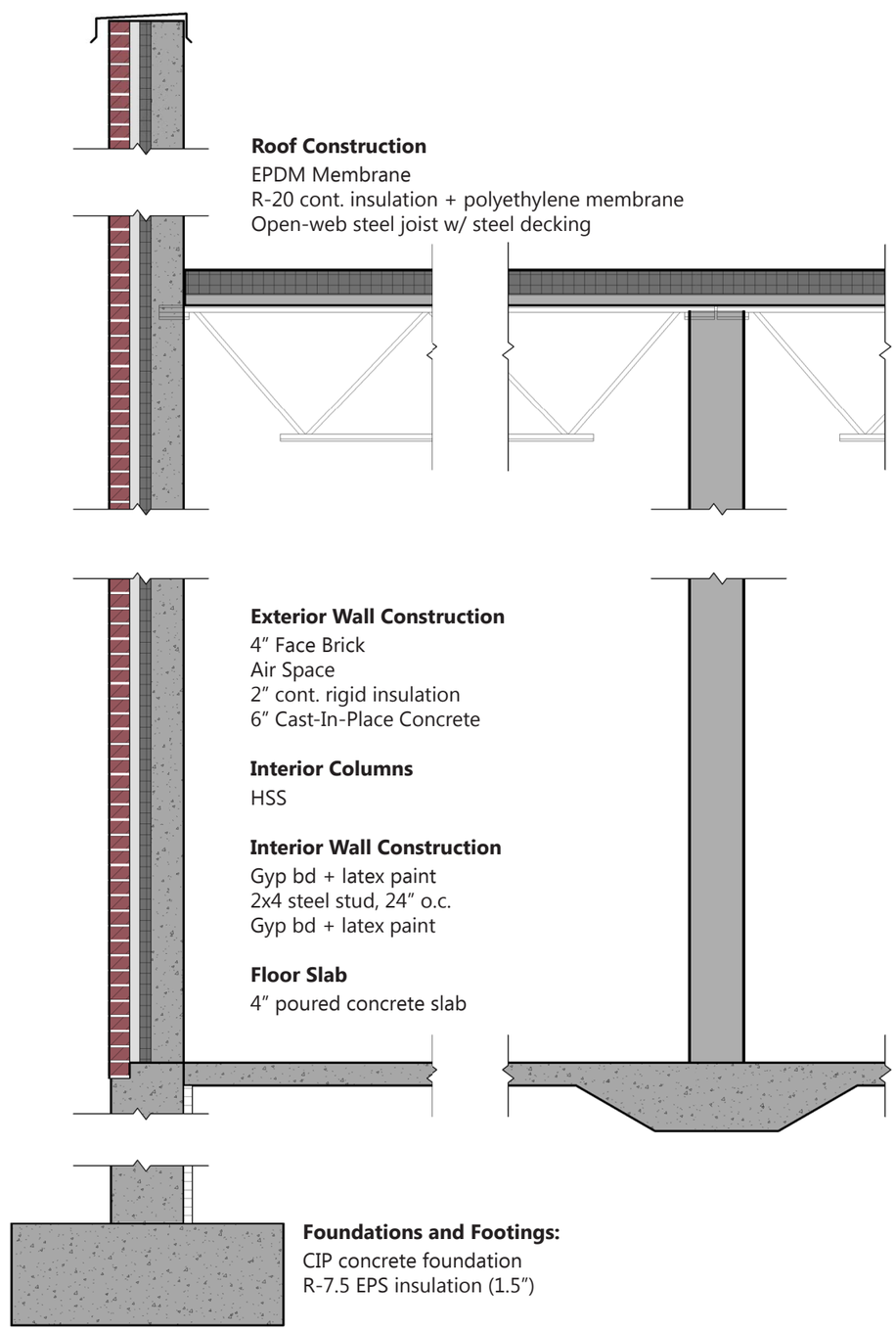
What impact would Walmart have if they switched to this construction?

They would be able to...
*based on 110 supercenters per annum
**each icon equals 5,000 units

...power **168,219 houses**
(6.9 million MJ annually)

...remove **61,820 cars** from the road
(463,650 tonnes CO2 eq annually)

...increase waste by the weight of **1,650 elephants**
(+11,220 tonnes of waste annually)



Roof Construction
EPDM Membrane
R-20 cont. insulation + polyethylene membrane
Open-web steel joist w/ steel decking

Exterior Wall Construction
4" Face Brick
Air Space
2" cont. rigid insulation
6" Cast-In-Place Concrete

Interior Columns
HSS

Interior Wall Construction
Gyp bd + latex paint
2x4 steel stud, 24" o.c.
Gyp bd + latex paint

Floor Slab
4" poured concrete slab

Foundations and Footings:
CIP concrete foundation
R-7.5 EPS insulation (1.5")

80,697,516 MJ
FOSSIL FUEL CONSUMPTION
36% reduction

6,072 tonnes CO_2
GLOBAL WARMING POTENTIAL
28% reduction

30,148 tonnes
RESOURCE CONSUMPTION
26% increase

Retains interior and exterior aesthetic of existing
Metal stud interior walls and CIP exterior structure

This construction is a variation on the original construction. The only change is cast-in place walls instead of concrete block. As expected from the graphs on the exterior wall structure page earlier in this document, this results in a decent reduction in energy and emissions. Unfortunately, it is a significant increase in resource consumption.

What impact would Walmart have if they switched to this construction?

They would be able to...

*based on 110 supercenters per annum
**each icon equals 5,000 units

...power **119,802 houses**
(4.9 million MJ annually)

...remove **35,200 cars** from the road
(264,000 tonnes CO2 eq annually)

...increase waste by the weight of **99,615 elephants**
(+677,400 tonnes of waste annually)