

Environmental Effects of Wood Substitution in Commercial Construction

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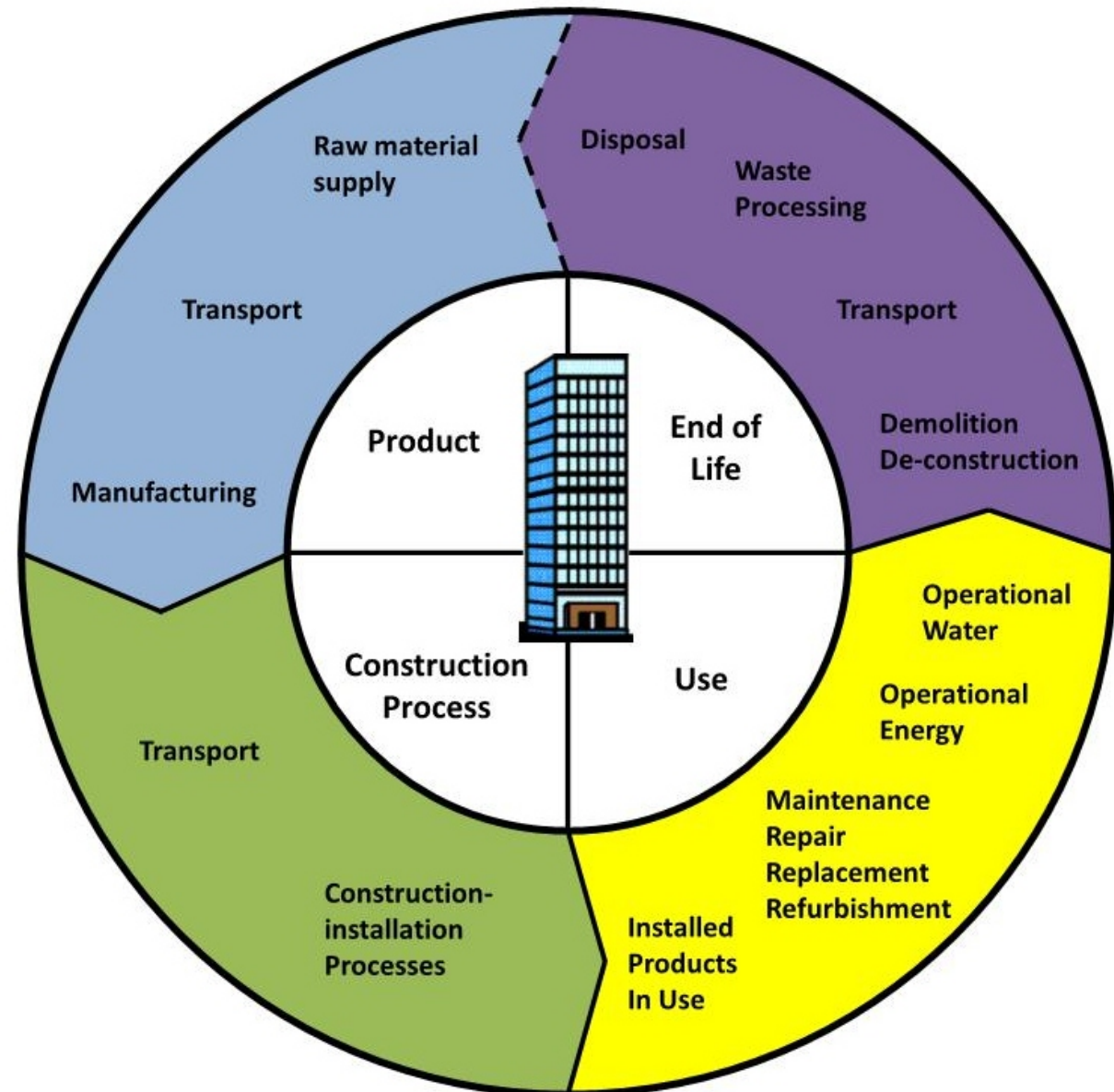
Background

- Wood in Residential vs. Commercial
- Oregon Wood Production
- Research Gap on Literature



Scope

- Cradle-to-Gate LCA
- Athena IE4B
- Structural System
- Six Commercial Bldgs.

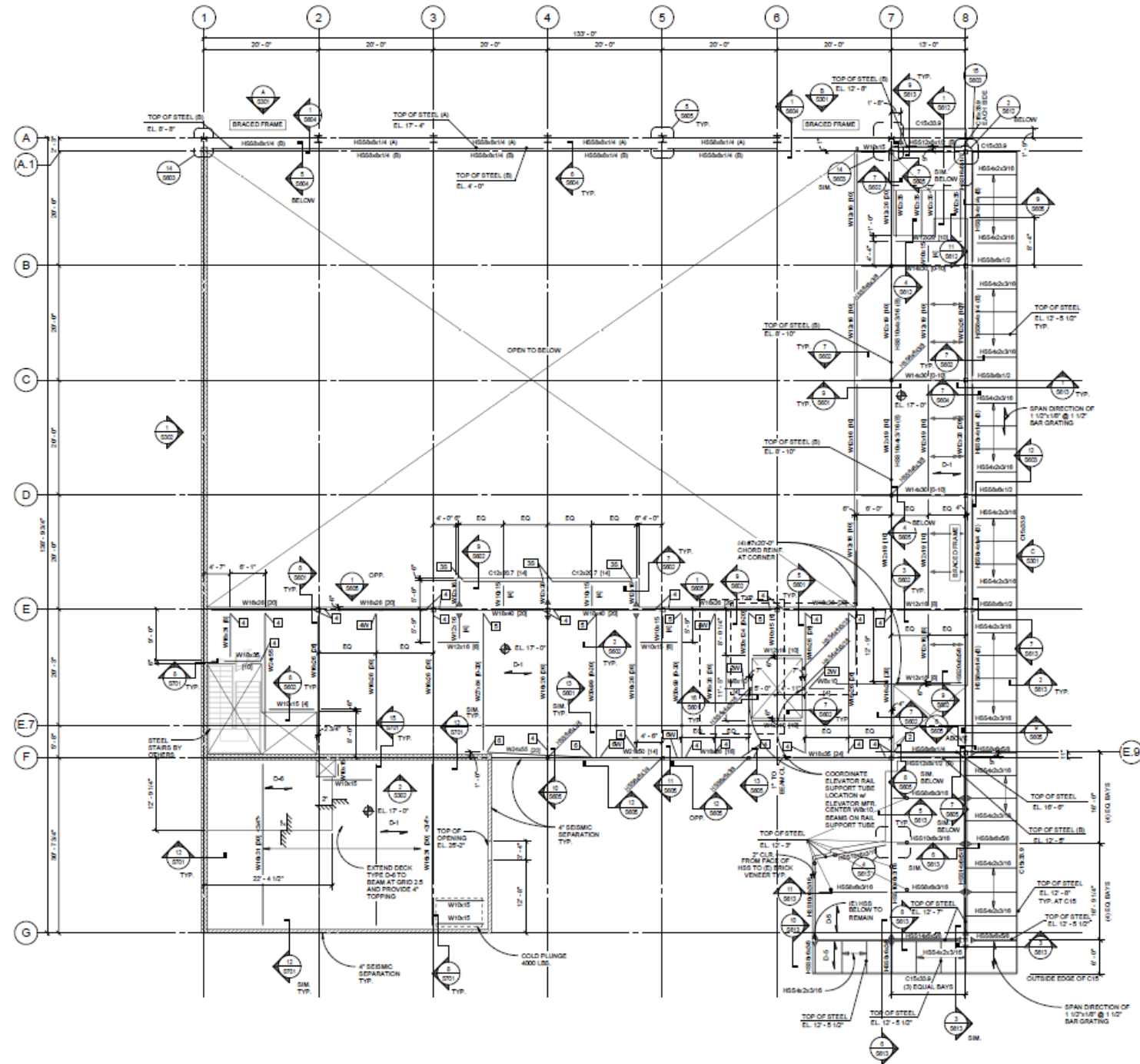


Methodology

Case Study Selection



- Location, type, area, loads
- Steel, concrete, masonry



Methodology

Case Study
Selection



Assumptions



- Include: floors, roofs, walls, foundations & LFRS
- Non: doors, windows, partitions, stairs, entrances



Methodology

The screenshot displays the Athena Impact Estimator for Buildings software interface. The main window shows a project tree on the left with the following structure:

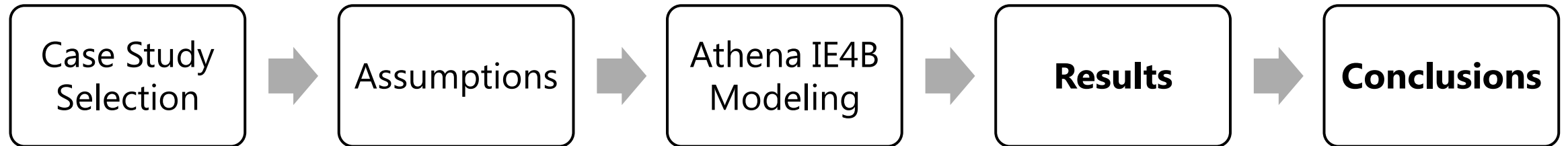
- Impact Estimator for Buildings
 - Basketball ORIGINAL (693.01 Tonnes of Global Warming Potential)
 - Columns and Beams (2.75 Tonnes)
 - Columns Only HSS D-4 (S103) (537.55 KiloGrams)
 - Columns Only HSS D-2 (S102) (747.03 KiloGrams)
 - Columns Only D-3E (S103) (147.49 KiloGrams)
 - Columns Only D-1E (S102) (209.99 KiloGrams)
 - Columns Only D-3S (S103) (77.02 KiloGrams)
 - Columns Only D-1S (S102) (108.87 KiloGrams)
 - Columns Only D-1E (S102M) (172.24 KiloGrams)
 - Columns Only D-1E (S101M) (172.24 KiloGrams)
 - Columns Only D-1S (S102M) (286.89 KiloGrams)
 - Columns Only D-1S (S101M) (286.89 KiloGrams)
 - Floors (225.16 Tonnes)
 - Composite Metal D-1E (S102M) (10.5 Tonnes)**
 - Composite Metal D-1S (S102M) (32.13 Tonnes)
 - Composite Metal D-2 (S102) (97.23 Tonnes)
 - Composite Metal D-1E (S102) (10.52 Tonnes)
 - Composite Metal D-1S (S102) (32.13 Tonnes)
 - Composite Metal D-1E (S101M) (10.5 Tonnes)
 - Composite Metal D-1S (S101M) (32.13 Tonnes)
 - Roofs (92.89 Tonnes)
 - Composite Metal D-4 (S103) (64.78 Tonnes)
 - Composite Metal D-3E (S103) (6.94 Tonnes)
 - Composite Metal D-3S (S103) (21.16 Tonnes)
 - Foundations (194.72 Tonnes)
 - Slab on Grade (S101) (56.16 Tonnes)
 - Braced Frame (S101) (95.43 Tonnes)
 - Strip Footing (S101) (27.99 Tonnes)
 - Footing G (S101) (8.73 Tonnes)
 - Footing E (S101) (3.35 Tonnes)
 - Footing D (S101) (3.06 Tonnes)
 - Walls (221.52 Tonnes)
 - Level 1 EAST (S604) (7.35 Tonnes)
 - Level 1M EAST (S604) (7.41 Tonnes)
 - Level 2 EAST (S604) (6.07 Tonnes)
 - Level 2M EAST (S604) (6.13 Tonnes)
 - Level 1 SOUTH (6.03 Tonnes)

The 'Basketball ORIGINAL-Modify' dialog box is open, showing the 'Envelope' tab. The 'Name' field is set to 'Composite Metal D-1E (S102M)'. The 'Number of Bays per Row' is 1, 'Number of Rows' is 4, 'Bay Size (ft)' is 13, and 'Span (ft)' is 20. The 'Concrete Flyash %' is set to 'average'. The 'Live Load' is set to '100 psf'. The 'Concrete' strength is set to '4000 psi'. The 'Units' are set to 'Imperial'. The 'Floor area (ft²)' is 1040.00. A note at the bottom of the dialog box states: 'The Composite Floor assembly includes Wide Flange Sections for beams and for support of the floor deck, but it does not include the columns. Make sure that you do not include any beams in the Columns and Beams assembly that you have modeled to support this floor assembly. In the Columns and Beams assembly, enter the correct number of columns, and the rest of the inputs, but make sure that Number of Beams is zero, otherwise you will be double counting materials.'



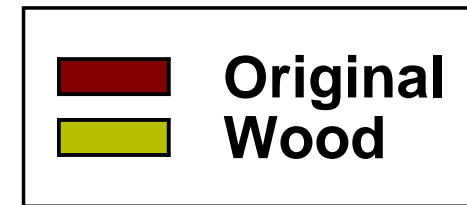
Athena IE4B
Modeling

Methodology



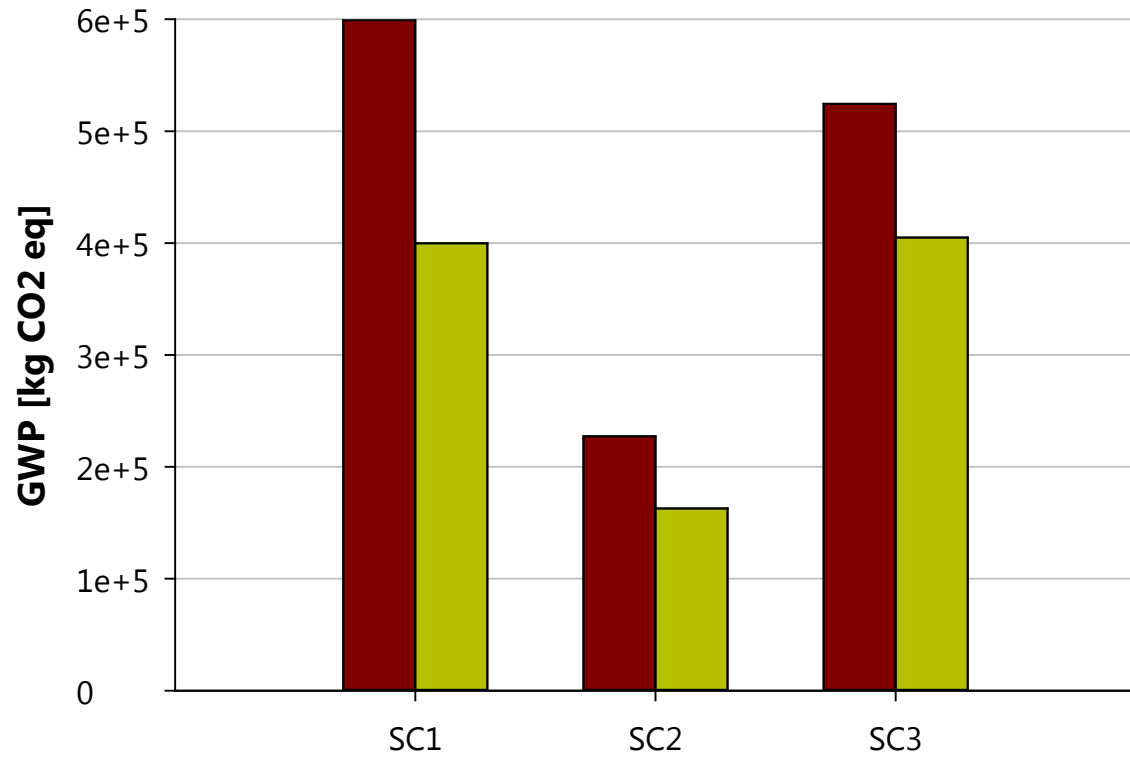
Results

- Global Warming Potential—GWP [kg CO₂ eq]
- Fossil Fuel Consumption—FFC [MJ]
- Other Impact Categories
 - Non-Renewable Energy (NRE)
 - Acidification Potential (AP)
 - Smog Potential (SP)
 - HH Particulates (HHP)
 - Ozone Depletion Potential (ODP)
 - Eutrophication Potential (EP)
- Construction Effects

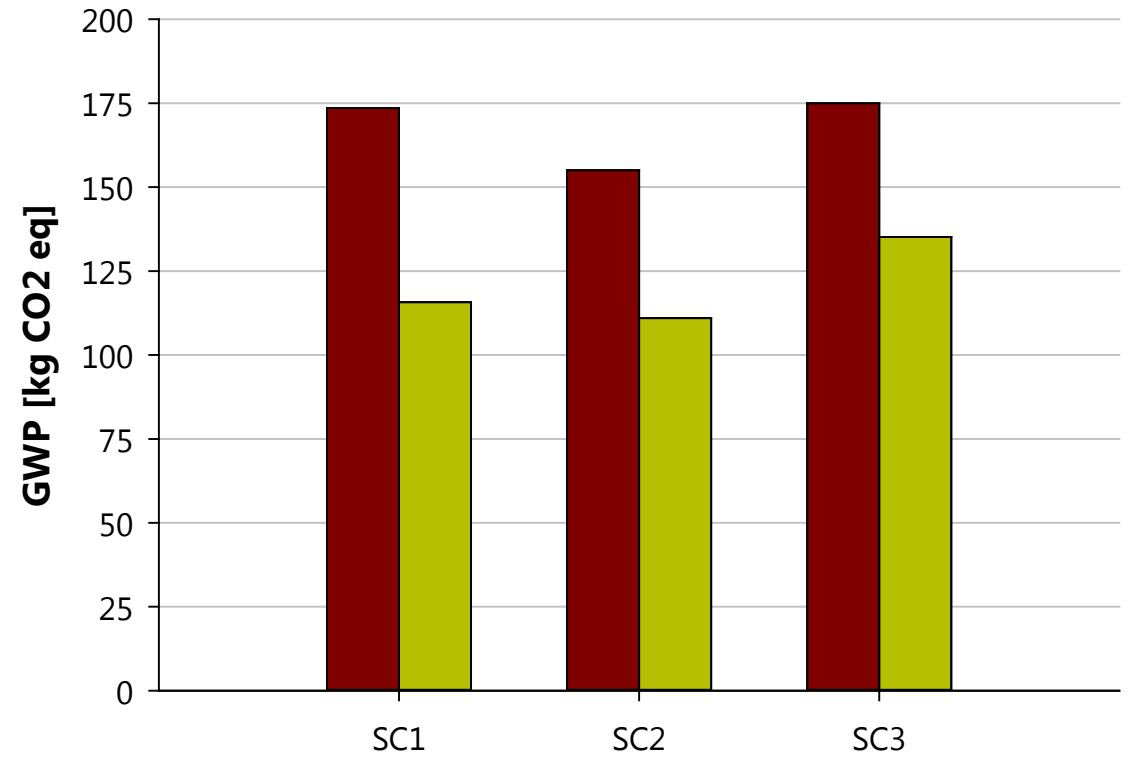


Results

Global Warming Potential

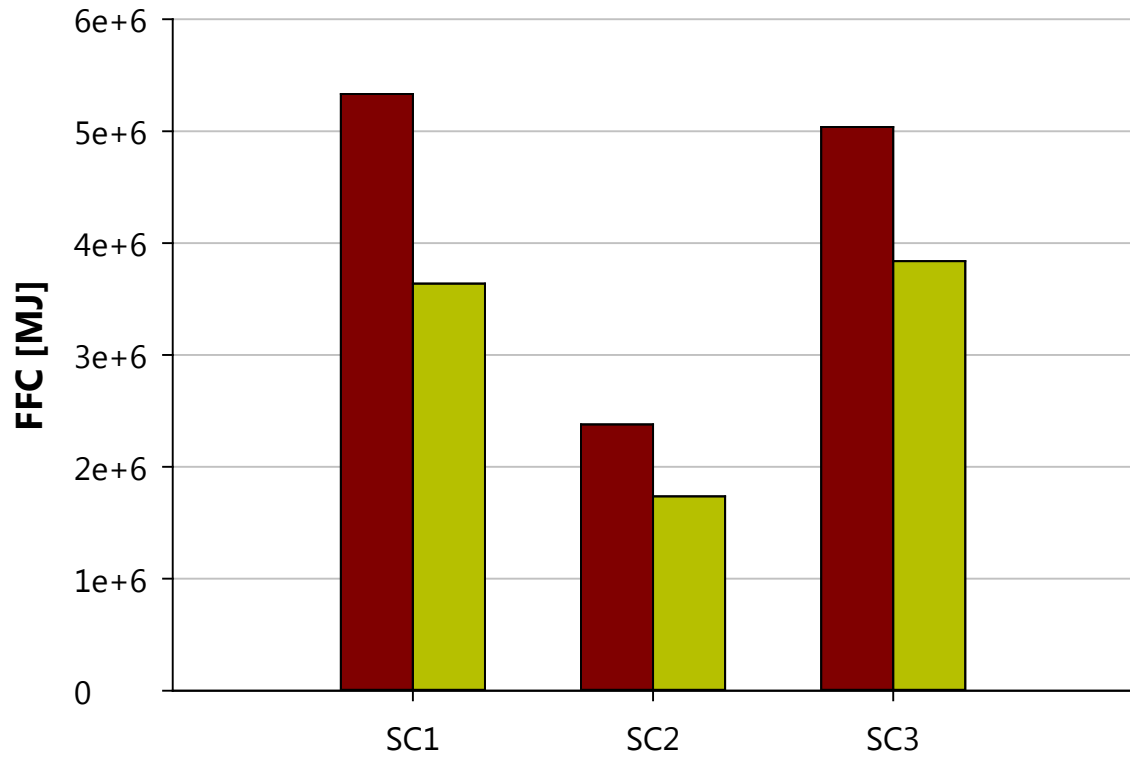


Global Warming Potential [Per ft²]

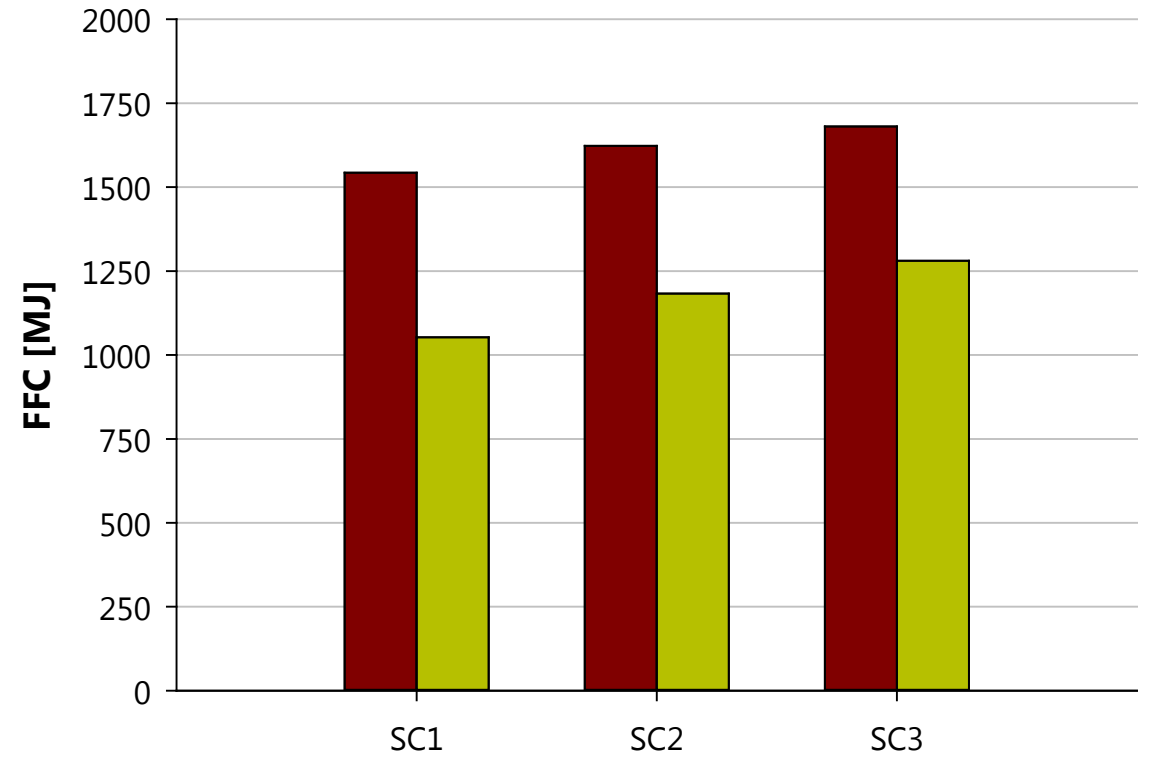


Results

Fossil Fuel Consumption

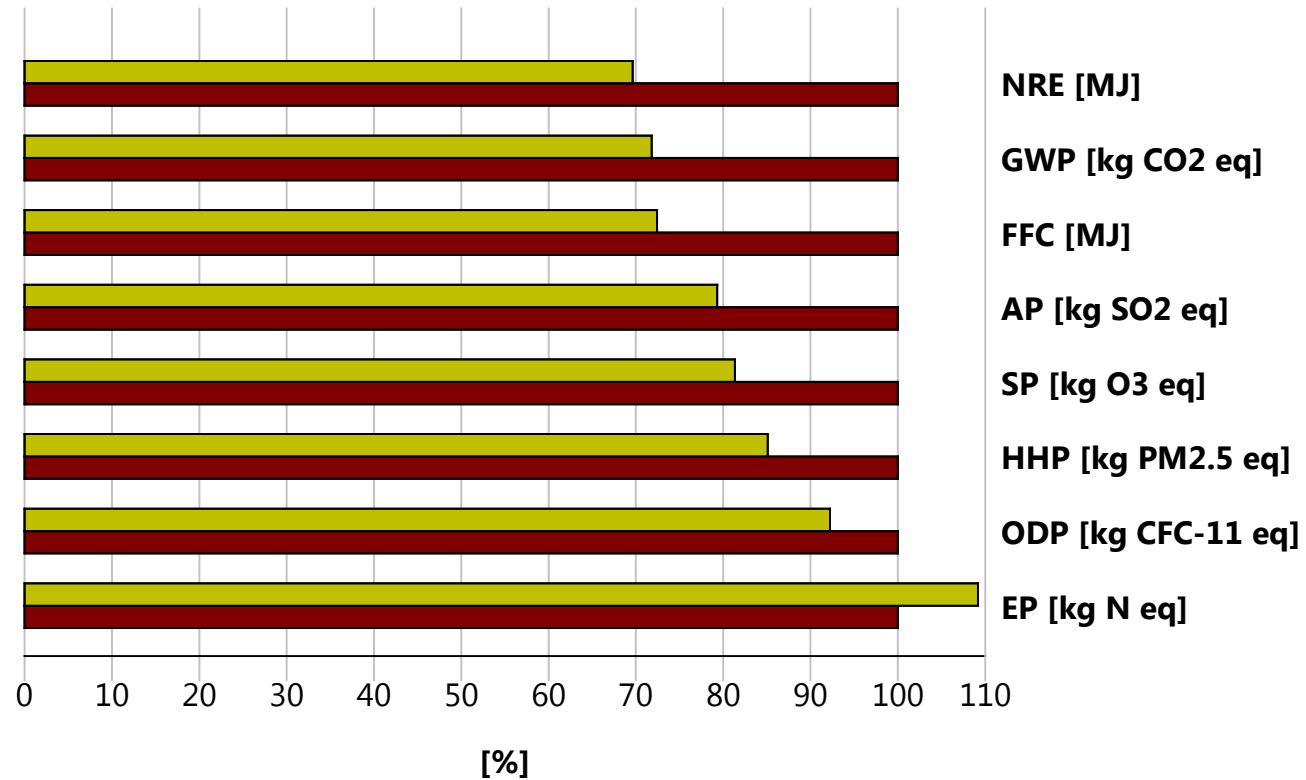


Fossil Fuel Consumption [Per ft²]



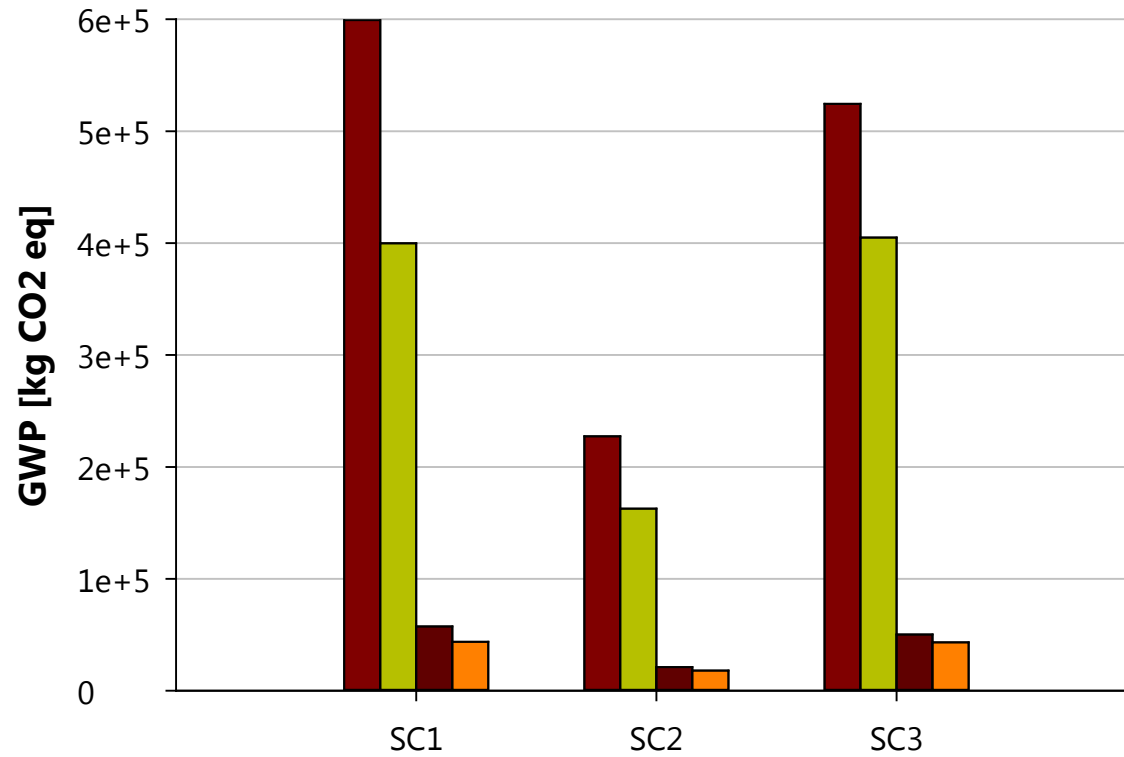
Results

Impact Change - Materials



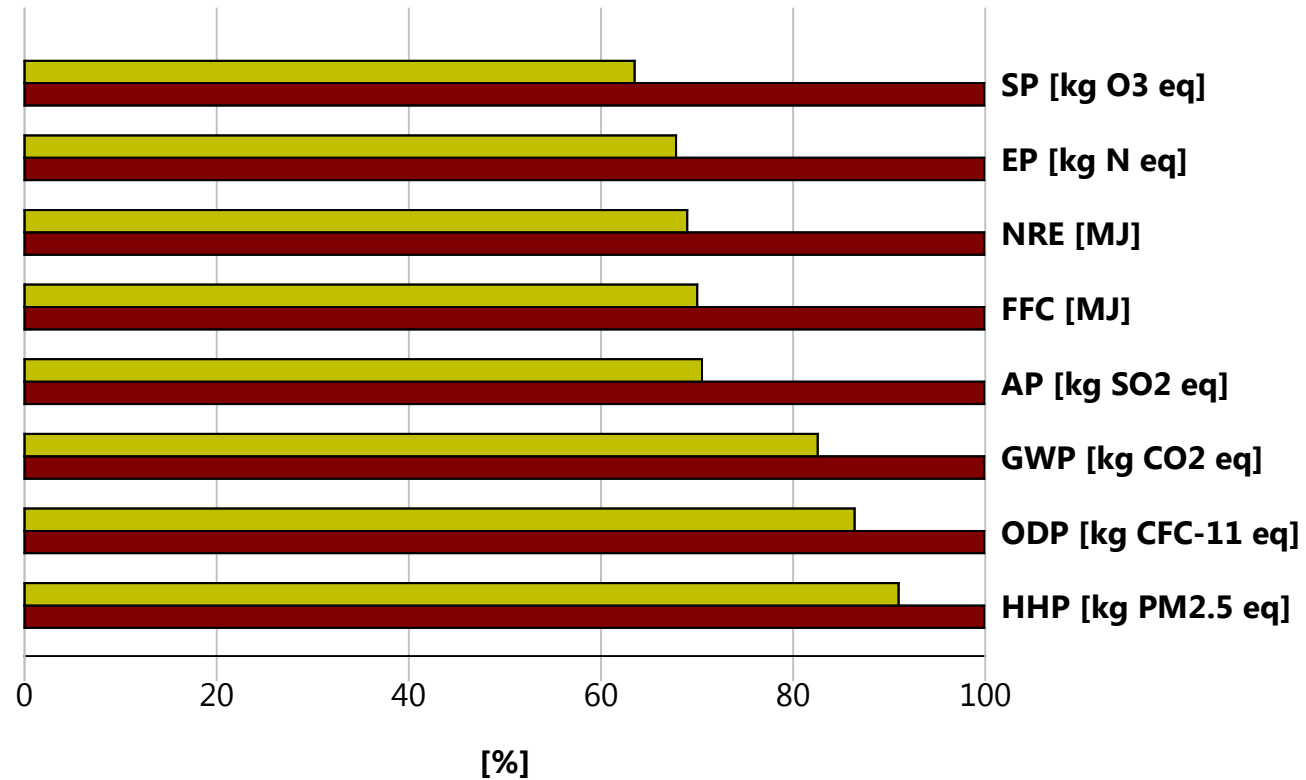
Results

Materials & Construction



Results

Impact Change - Construction



Preliminary Conclusions

- Materials:
 - **GWP~28%** Less CO2 Emission!
 - FFC~28% Less FF Consumption!
- Construction:
 - GWP~17% Less CO2 Emission!
 - FFC~30% Less FF Consumption!
- Future:
 - More case studies (\neq materials, \uparrow buildings)
 - Compare results & analyze the EI4B software
 - Detailed design & LCA of 1 wood building

Thank You!

Questions 😊