A METHODOLOGY FOR CALCULATING THE CARBON FOOTPRINT OF A BUILDING

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THESIS PRESENTATION

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WHAT DROVE MY THESIS TOPIC?

- HOW CAN I PERSONALLY MAKE AN ENVIRONMENTAL IMPACT THROUGH MY DESIGNS?
- ENVIRONMENTALISM
  - UNTOUCHED EXISTING ENVIRONMENT
  - FUTURE FOR OUR WORLD
- CLIMATE CHANGE
  - CO2 EMISSIONS
  - MAKING CHANGES
  - WHO IS RESPONSIBLE?

WHAT IS MY GOAL?

MY GOAL IS TO FIND A WAY THAT COULD DIRECTLY IMPACT MY RESPONSIBILITY FOR CLIMATE CHANGE.

ABOUT CARBON EMISSIONS

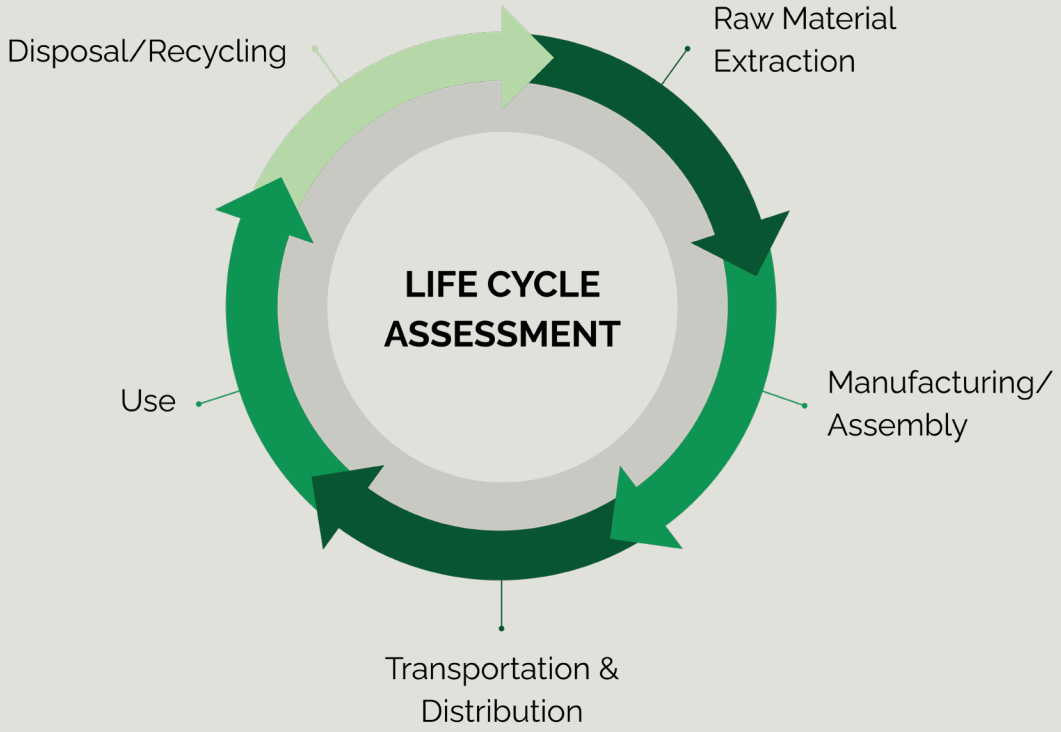
WHAT IS EMBODIED CARBON?

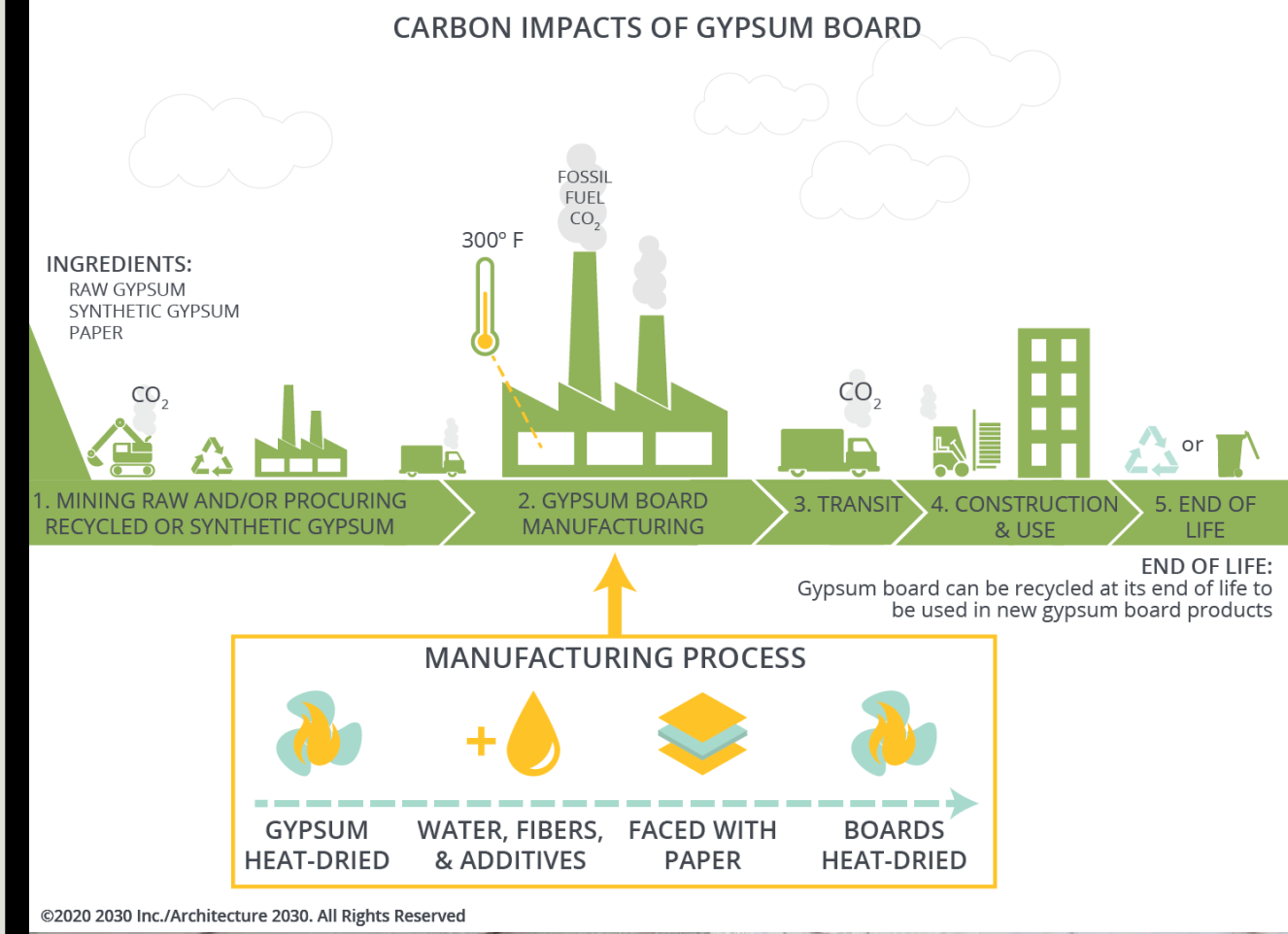
- EMBODIED CARBON REPRESENTS THE CARBON EMISSIONS THAT GO WITH MAKING BUILDING PRODUCTS AND CONSTRUCTION
- RAW MATERIAL EXTRACTION TO MANUFACTURING, TRANSPORTATION, AND END OF LIFE DISPOSAL OR RECYCLING.
- EMBODIED CARBON PLAYS A SIGNIFICANT AMOUNT OF IMPACT OF THE ANNUAL GLOBAL CARBON EMISSIONS.
- MATERIAL SELECTION AND SPECIFICATION THROUGH DESIGN ALLOWS MANY OPPORTUNITIES FOR CARBON REDUCTION.

EMBODIED CARBON GLOBAL IMPACT

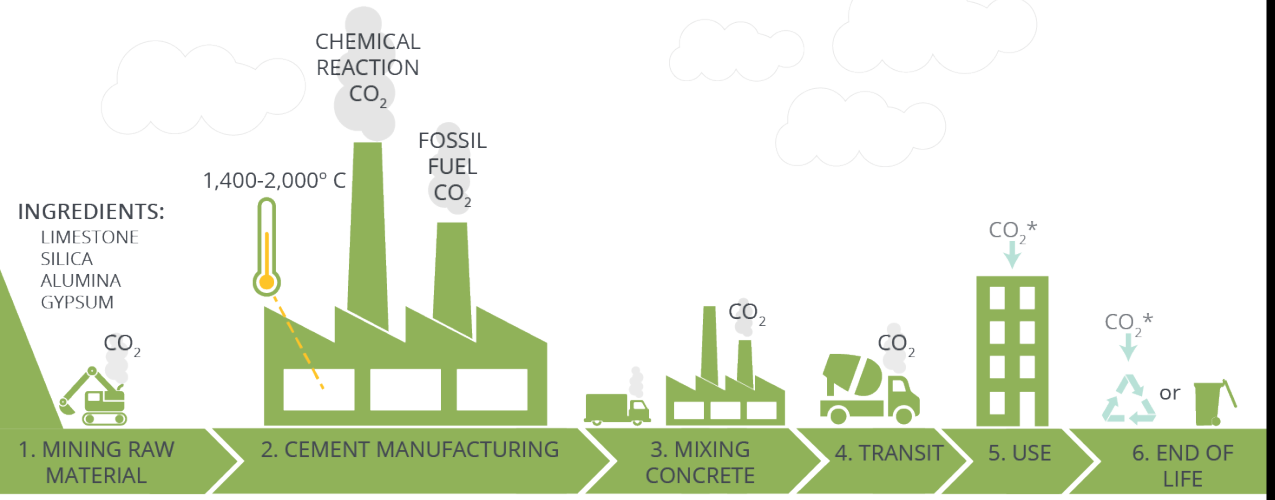
- "ANNUALLY, EMBODIED CARBON IS RESPONSIBLE FOR 11% OF GLOBAL GHG EMISSIONS AND 28% OF GLOBAL BUILDING SECTOR EMISSIONS."
- "IT IS ANTICIPATED THAT EMBODIED CARBON WILL BE RESPONSIBLE FOR 72% OF THE CARBON EMISSIONS ASSOCIATED WITH GLOBAL NEW CONSTRUCTION BETWEEN NOW AND 2030."

INFORMATION BASED FROM HTTPS://MATERIALSPALETTE.ORG/

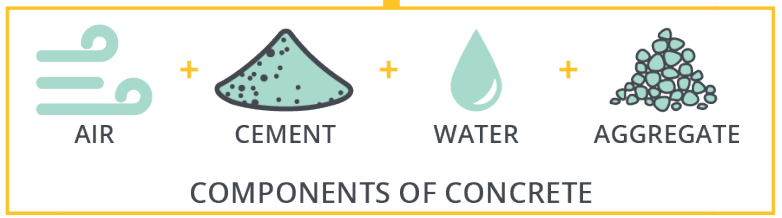


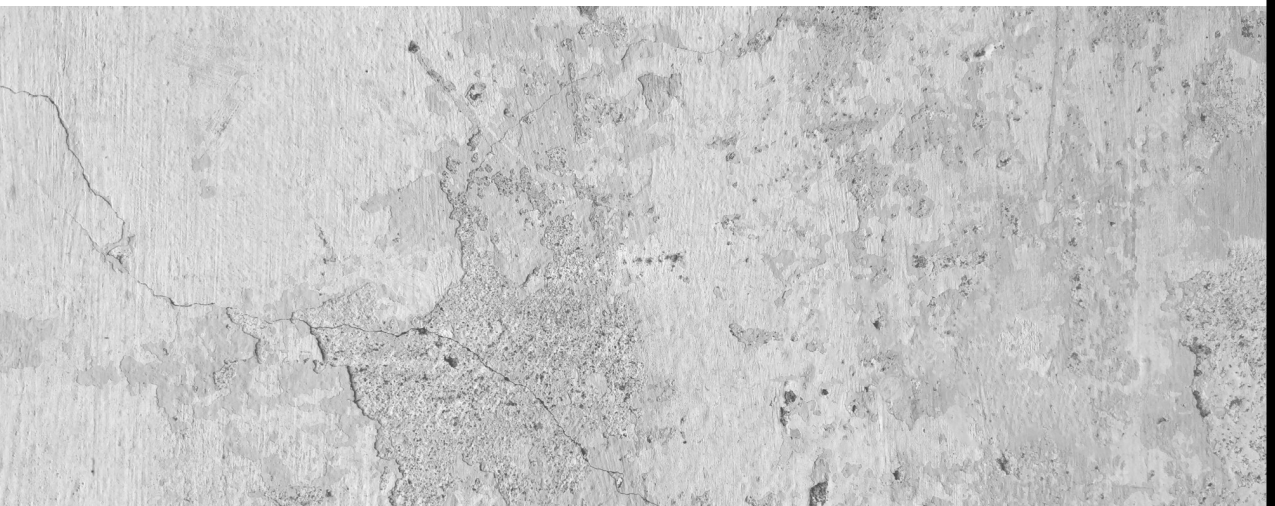


CARBON IMPACTS OF CONCRETE

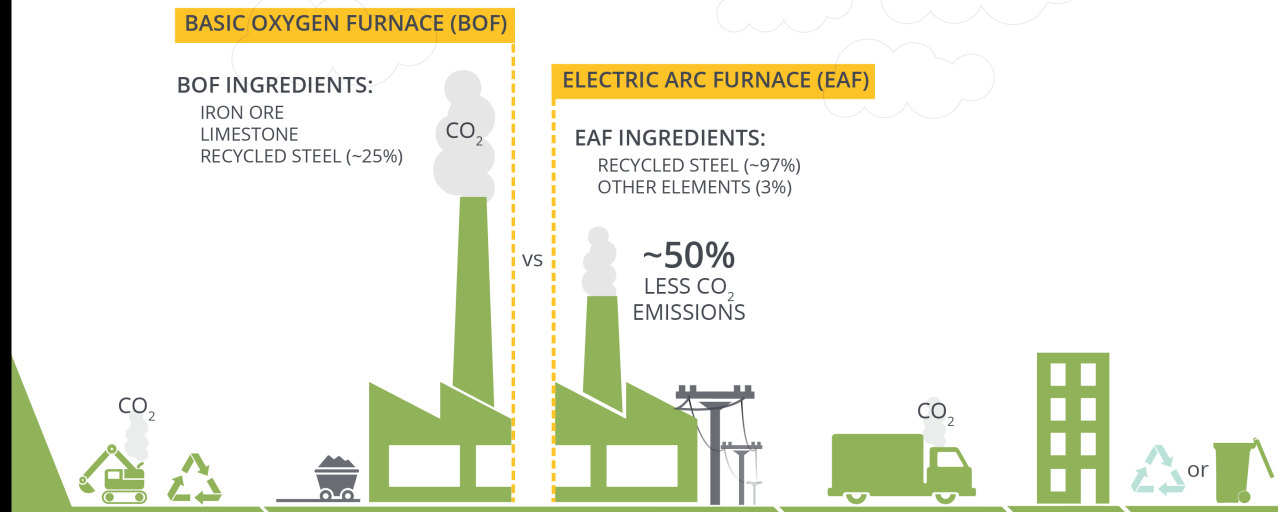


END OF LIFE:
Concrete can be ground up at the end of its useful life to make aggregate for new concrete.
* If exposed to air, concrete will absorb some CO_2





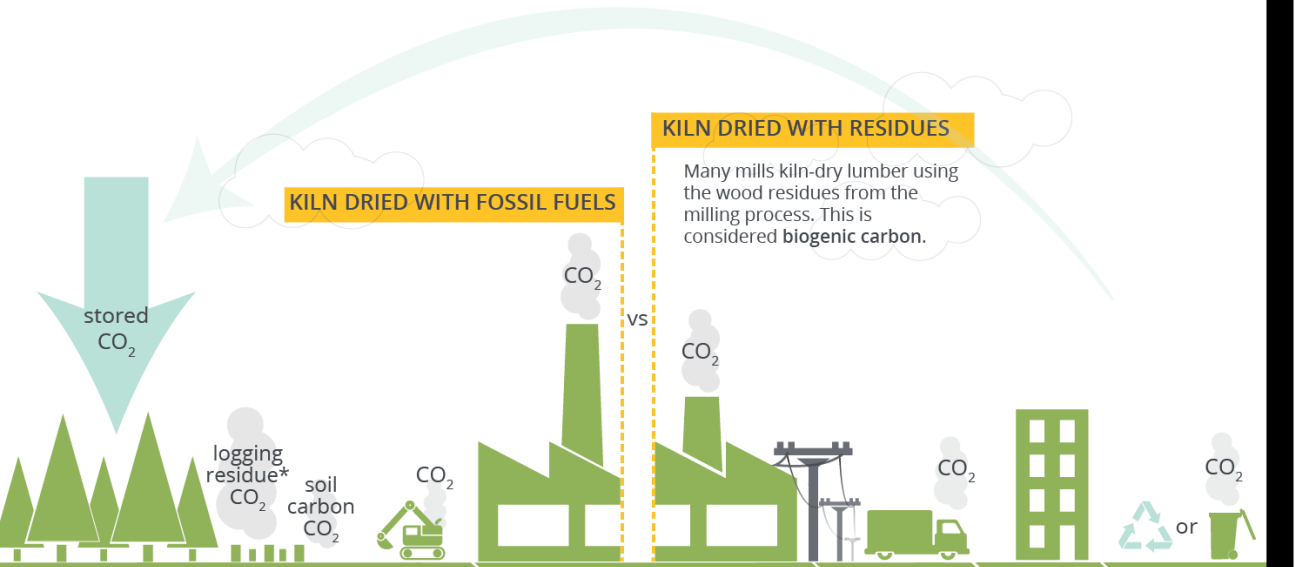
CARBON IMPACTS OF STEEL



MOST STEEL MEMBERS ARE RECYCLED AT THE END OF THE BUILDING'S LIFE

TYPICALLY 25% RECYCLED CONTENT	TYPICALLY 97% RECYCLED CONTENT
71% OF GLOBAL STEEL PRODUCTION	29% OF GLOBAL STEEL PRODUCTION

CARBON IMPACTS OF WOOD PRODUCTS



MILLING PROCESS: (ELECTRICITY) (COMBUSTION)

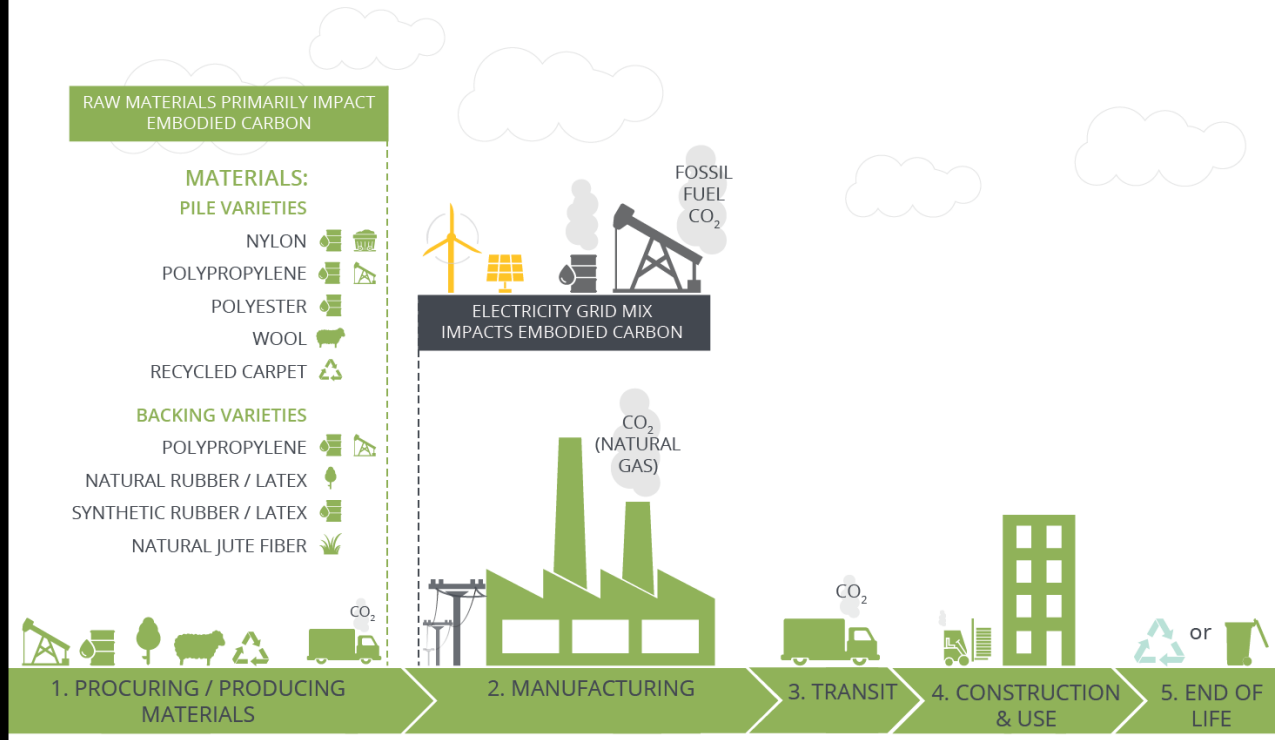
END OF LIFE:

Most wood products are disposed of at the end of the building's life, at which point any stored CO_2 is released through decomposition or incineration. Some wood members can be recycled or reused.

*** logging residue** = branches, stumps that get left behind, releasing $C0_2$ or CH_4

*** mill residue** = Wood and bark residues produced in processing logs into lumber and plywood, releasing $C0_2$ or CH_4

CARBON IMPACTS OF CARPET



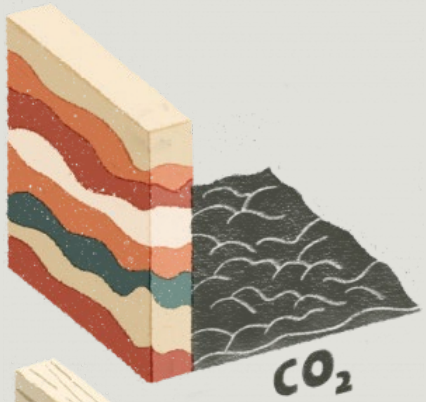
END OF LIFE:

Nearly all types of carpet are recyclable

AVERAGE EMBODIED CARBON PER CUBIC METER

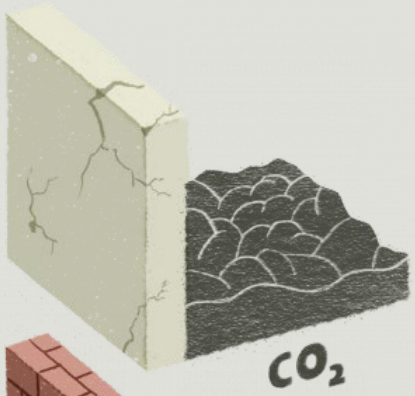
RAMMED EARTH

48 KG



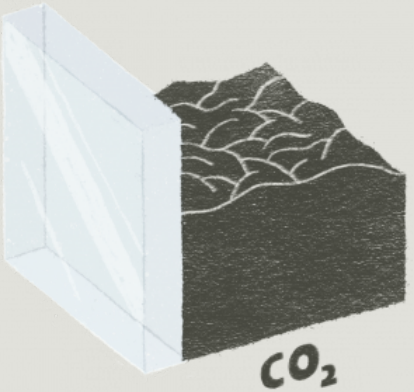
STONE

237 KG



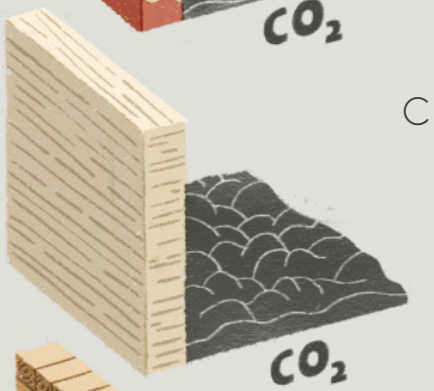
GLASS

3,600 KG



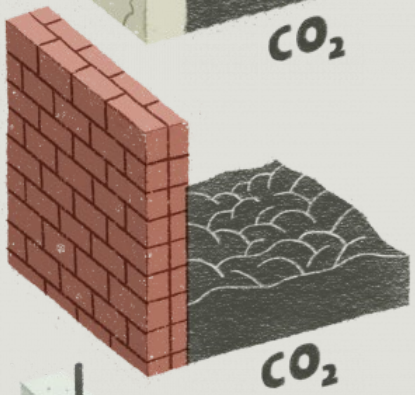
SOFTWOOD TIMBER

110 KG



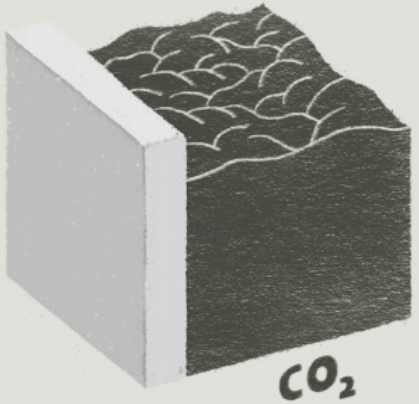
CLAY BRICK WALL

345 KG



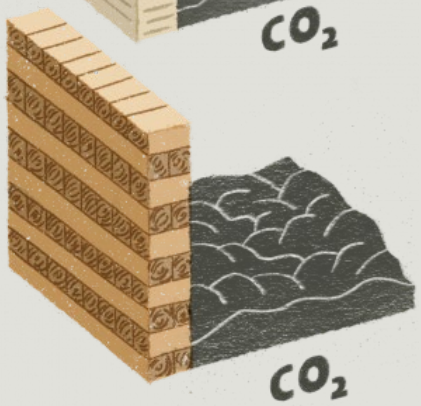
STEEL SECTION

12,090 KG



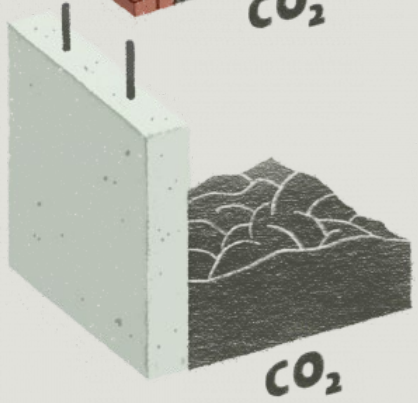
CROSS LAMINATED TIMBER

219 KG



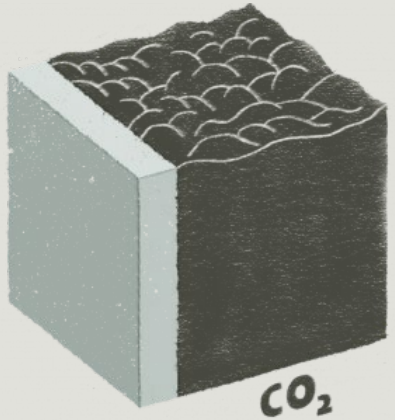
REINFORCED CONCRETE

635 KG



ALUMINUM

18,009 KG

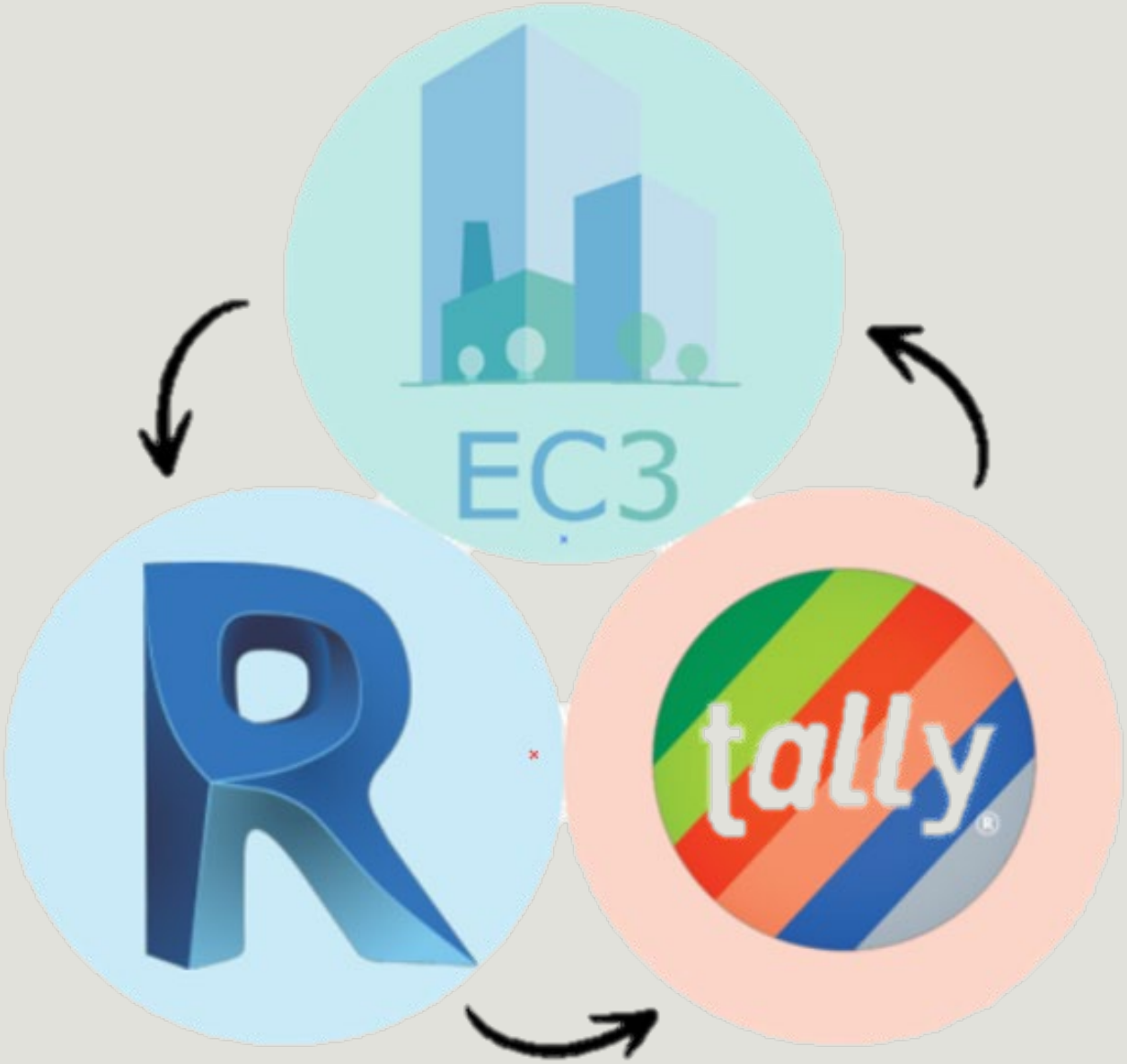


PLITEQ

INFORMATION BASED FROM HTTPS://PLITEQ.COM/NEWS/BUILDING-VS-CARBON-FOOTPRINT/#:~:TEXT=LAST%20BUT%20NOT%20LEAST%2C%20THE,AN%20ABUNDANTLY%20AVAILABLE%20NATURAL%20RESOURCE

INITIAL PROCESS

- REVIT
- TALLY EXTENSION
- EC3



1

TALLY EXTENSION

DOWNLOAD TALLY EXTENTION FOR REVIT

2

REVIT MODEL

OPEN EXISTING OR CREATE A NEW MODEL THAT WILL BE ANALYZED

3

TALLY MATERIAL IDENTITY

IDENTIFY ALL MATERIALS USED WITHIN THE REVIT MODEL FOR TALLY TO EXPORT

4

EXPORT TO EC3

EXPORT MATERIAL IDENTITIES TO BUILDING TRANSPARENCY'S EC3 TOOL

5

EC3 ANALYSIS

ANALYZE IMPORTED DATA TO REVIEW AND LEARN FROM

METHODOLOGY

IN MY THESIS PROCESS, I CHOSE TO CREATE MY OWN YOUTUBE VIDEO THAT WALKS THROUGH THE PROCESS OF USING THE THREE SOFTWARE TOGETHER. I WANTED TO SHARE WHAT I HAD LEARNED WITH OTHERS WHO MAY BENEFIT FROM MY RESEARCH.


EC3
R
jolly

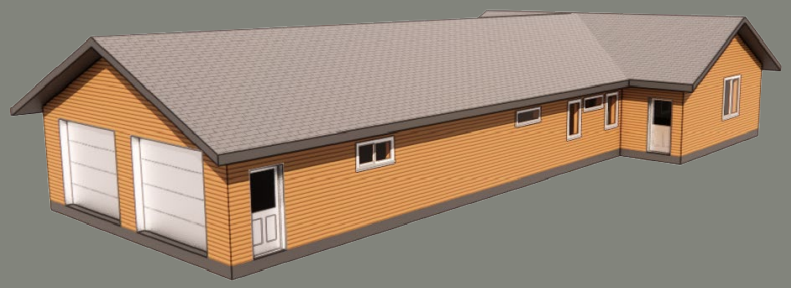
EXISTING DESIGN

THE EXISTING DESIGN THAT I CHOSE TO USE AS A RESEARCH MODEL IS MY PARENTS' CABIN. I CHOSE THIS DESIGN BECAUSE I AM FAMILIAR WITH THE DESIGN AND LAYOUT. ANOTHER REASON WHY I CHOSE THIS IS BECAUSE I WAS ABLE TO FOCUS ON A SMALLER DESIGN THAT DID NOT COMPLICATE THE MATERIAL IMPORTING SO THAT I COULD SEE RESULTS IN A FOCUSED WAY.

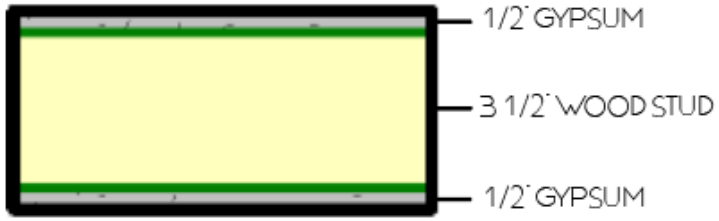
- FAMILIAR WITH THE DESIGN
- SMALLER SCALE TO SHAPE FOCUS

REVIT

- FAMILIAR WITH THE SOFTWARE
- EXISTING MODEL TO WORK FROM

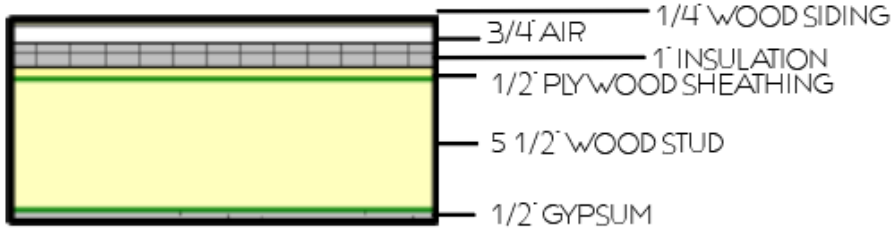


INTERIOR WALL



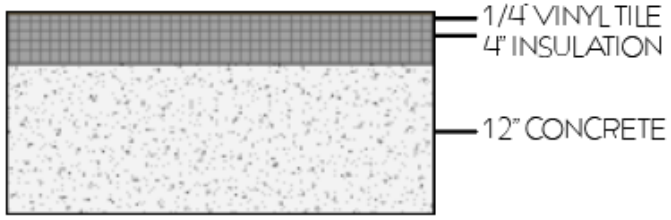
2X4 WOOD STUD

EXTERIOR WALL

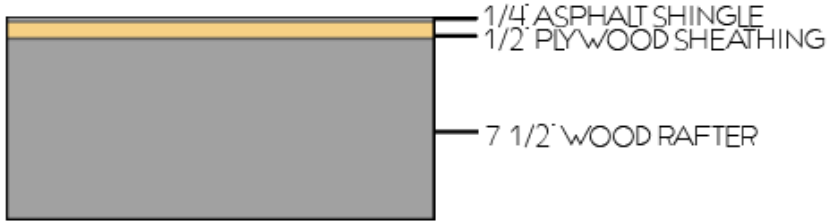


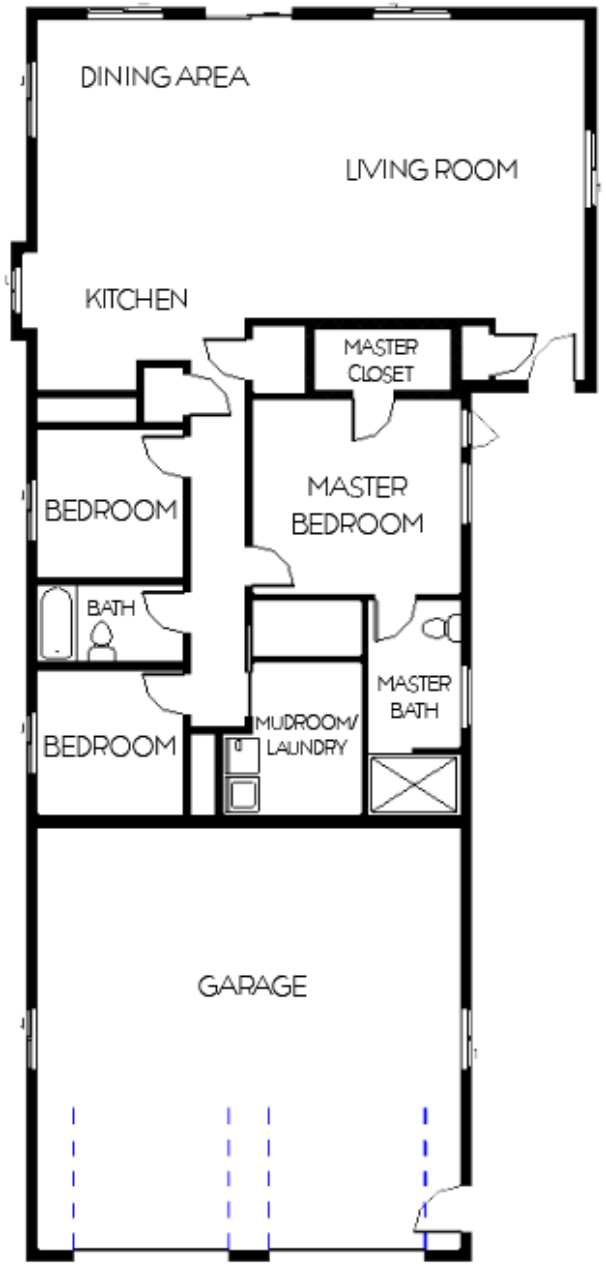
2X6 WOOD STUD

FLOOR SECTION



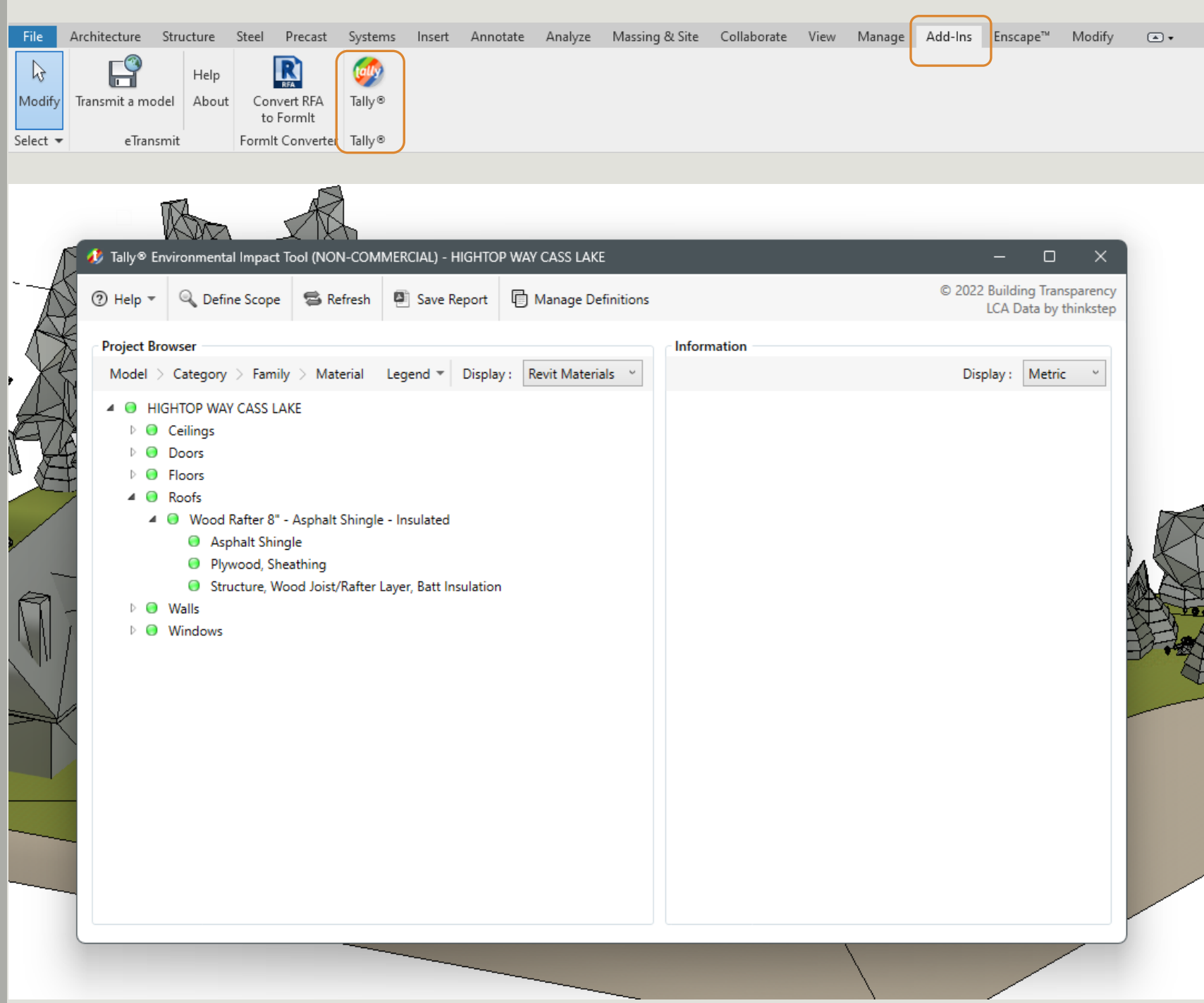
ROOF SECTION





TALLY

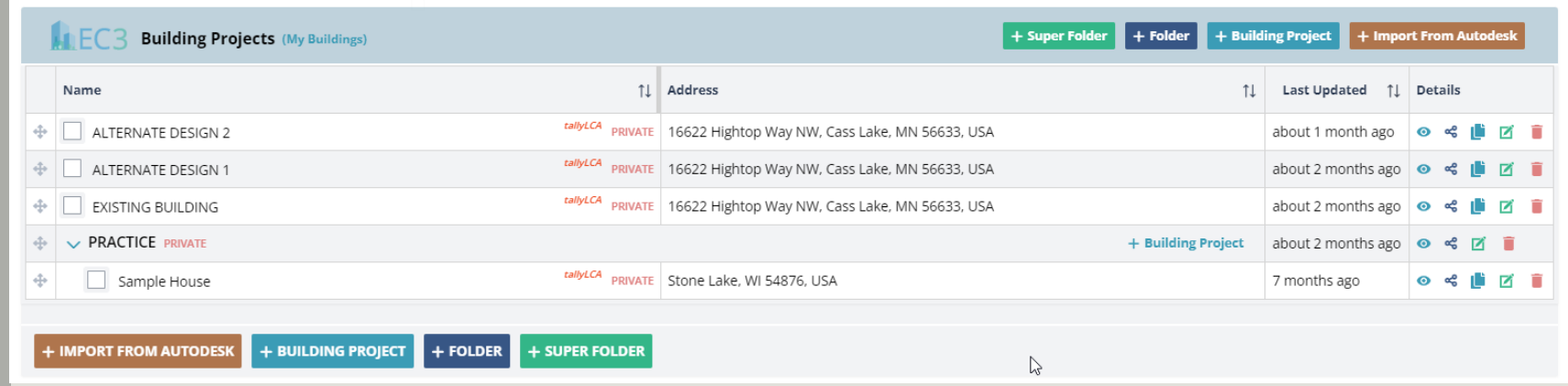
- REVIT EXTENSION
- DEFINE MATERIALS
- USE WITH WORKING MODEL
- EXPORTS TO EC3



Building Transparency

EC3 TOOL

- CREATED BY BUILDING TRANSPARENCY
  - "OUR CORE MISSION IS TO PROVIDE THE OPEN ACCESS DATA AND TOOLS NECESSARY TO ENABLE **BROAD AND SWIFT ACTION** ACROSS THE BUILDING INDUSTRY IN ADDRESSING EMBODIED CARBON'S ROLE IN **CLIMATE CHANGE**."
- ANALYZE AND COMPARE PROJECTS
- VIEW MATERIAL CARBON IMPACTS



ALTERNATE DESIGN 1

	Achievable	Realized	Conservative
EC Building Total	19.5k kgCO2e	36k kgCO2e	36k kgCO2e

EXISTING DESIGN

	Achievable	Realized	Conservative
EC Building Total	39.7k kgCO2e	71.7k kgCO2e	71.7k kgCO2e

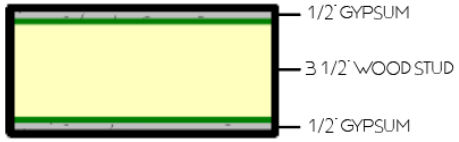
ALTERNATE DESIGN 2

	Achievable	Realized	Conservative
EC Building Total	69.5k kgCO2e	115k kgCO2e	115k kgCO2e

NAME	QUANTITY	UNIT	Collection: Selected (0/20) *	Realized
03 00 00 Concrete				42.8k kgCO2e
04 20 00 Unit Masonry				1.2k kgCO2e
06 00 00 Wood, Plastics & Composites				5.87k kgCO2e
07 00 00 Thermal and Moisture				3.53k kgCO2e
08 00 00 Openings				4.41k kgCO2e
09 00 00 Finishes				5.47k kgCO2e
Not mapped yet				

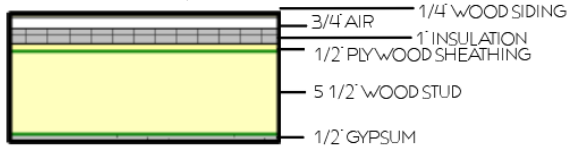
EXISTING DESIGN

INTERIOR WALL SECTION



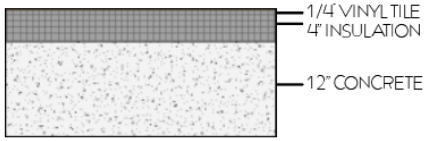
2X4 WOOD STUD WALL

EXTERIOR WALL SECTION

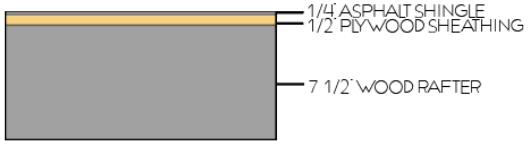


2X6 WOOD STUD WALL

FLOOR SECTION

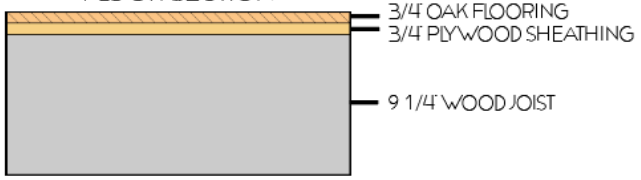


ROOF SECTION

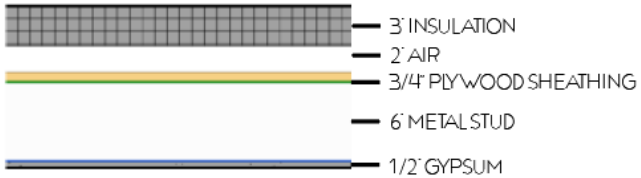


ALTERNATE DESIGN 1

FLOOR SECTION



EXTERIOR WALL SECTION



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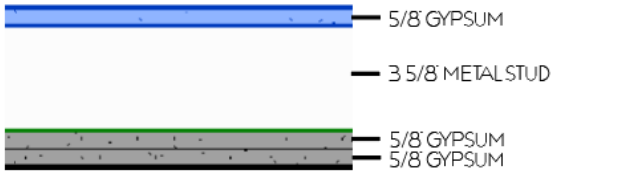

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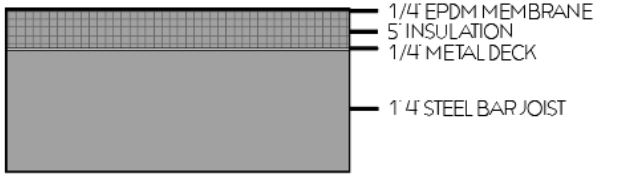
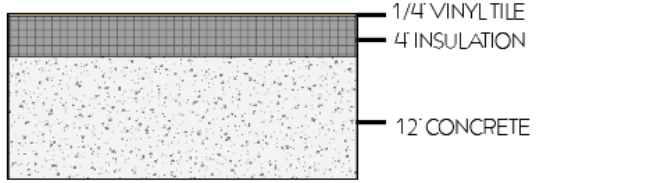
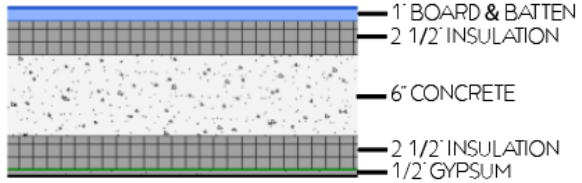


ALTERNATE DESIGN 2

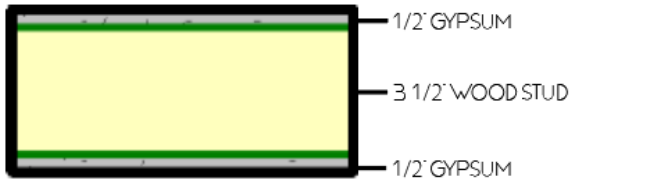
FLOOR SECTION



EXTERIOR WALL SECTION



INTERIOR WALL SECTION



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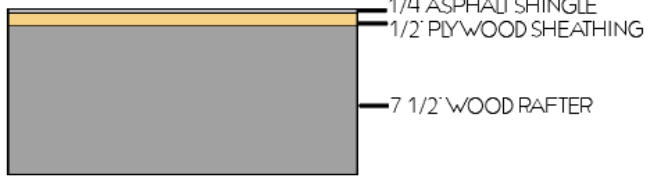
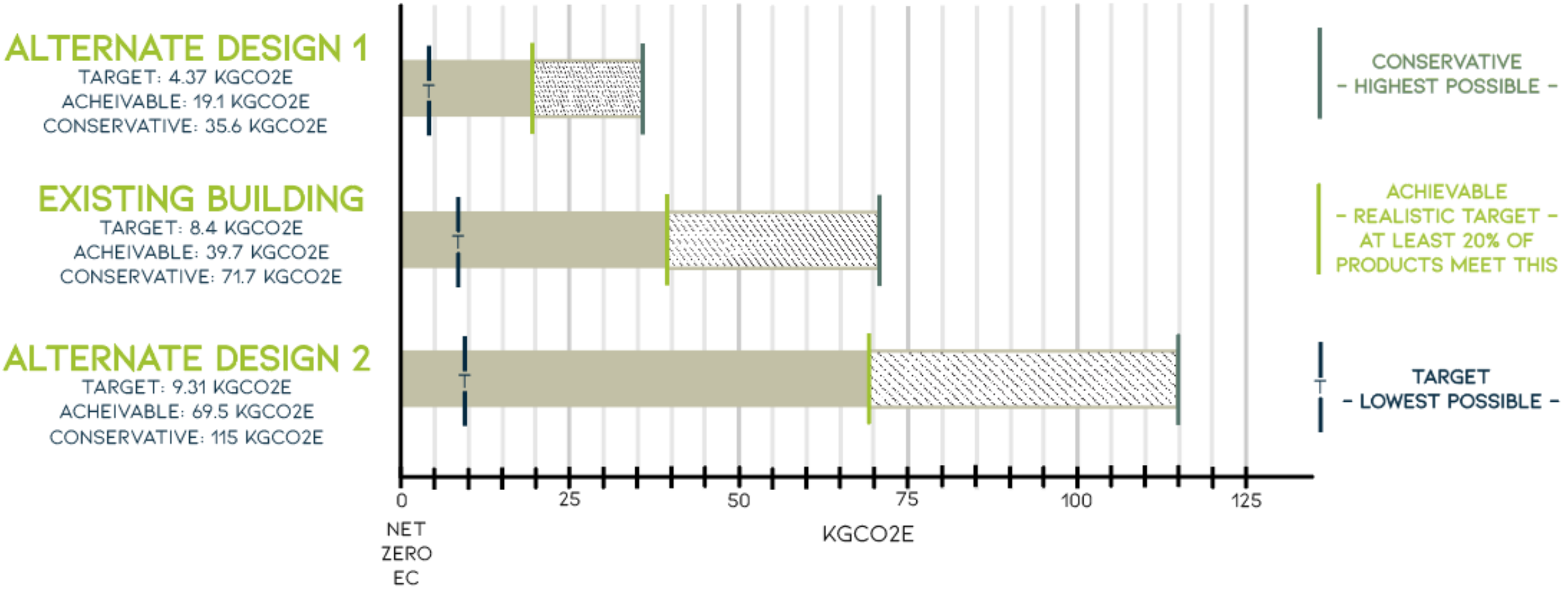
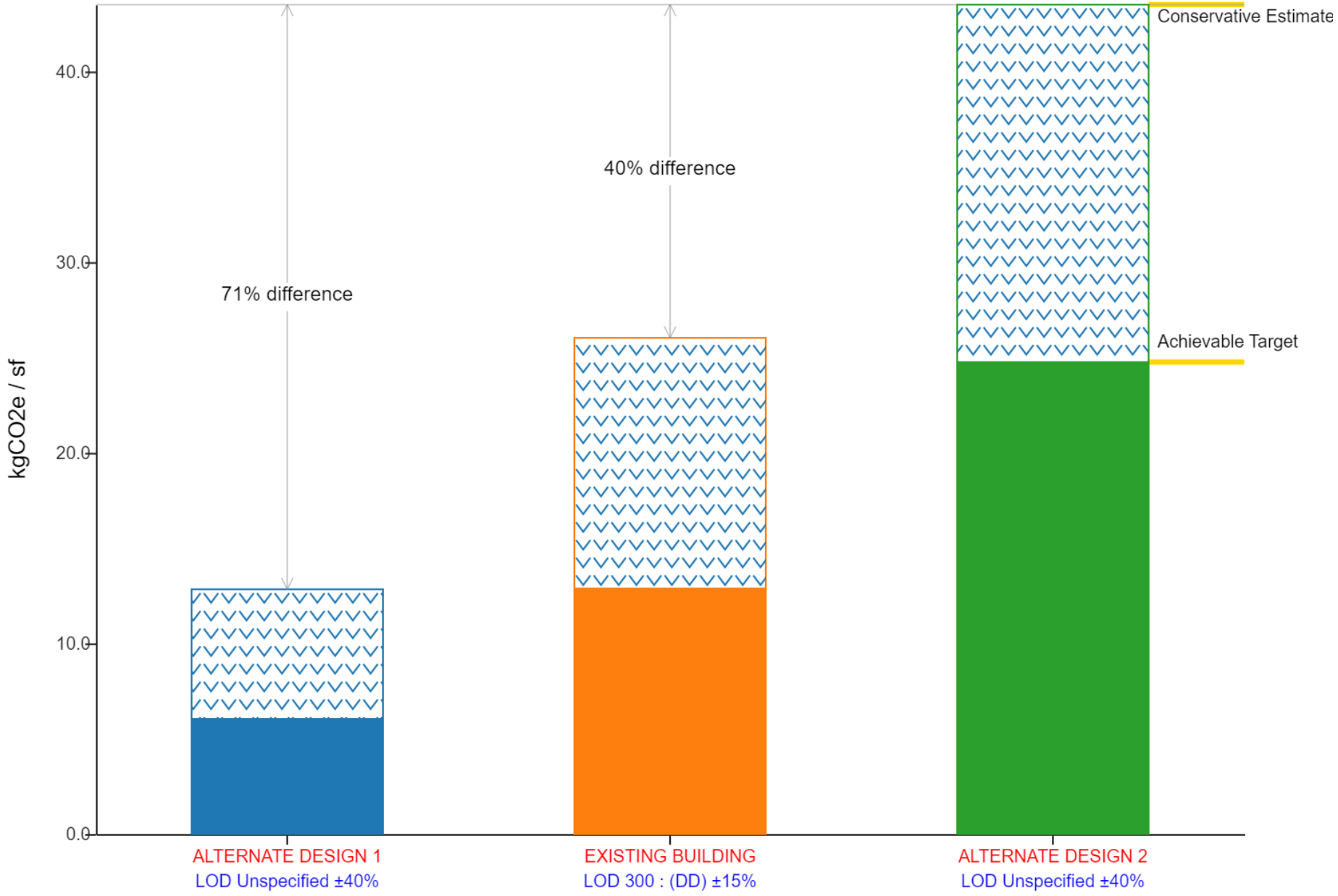


COMPARING RESULTS

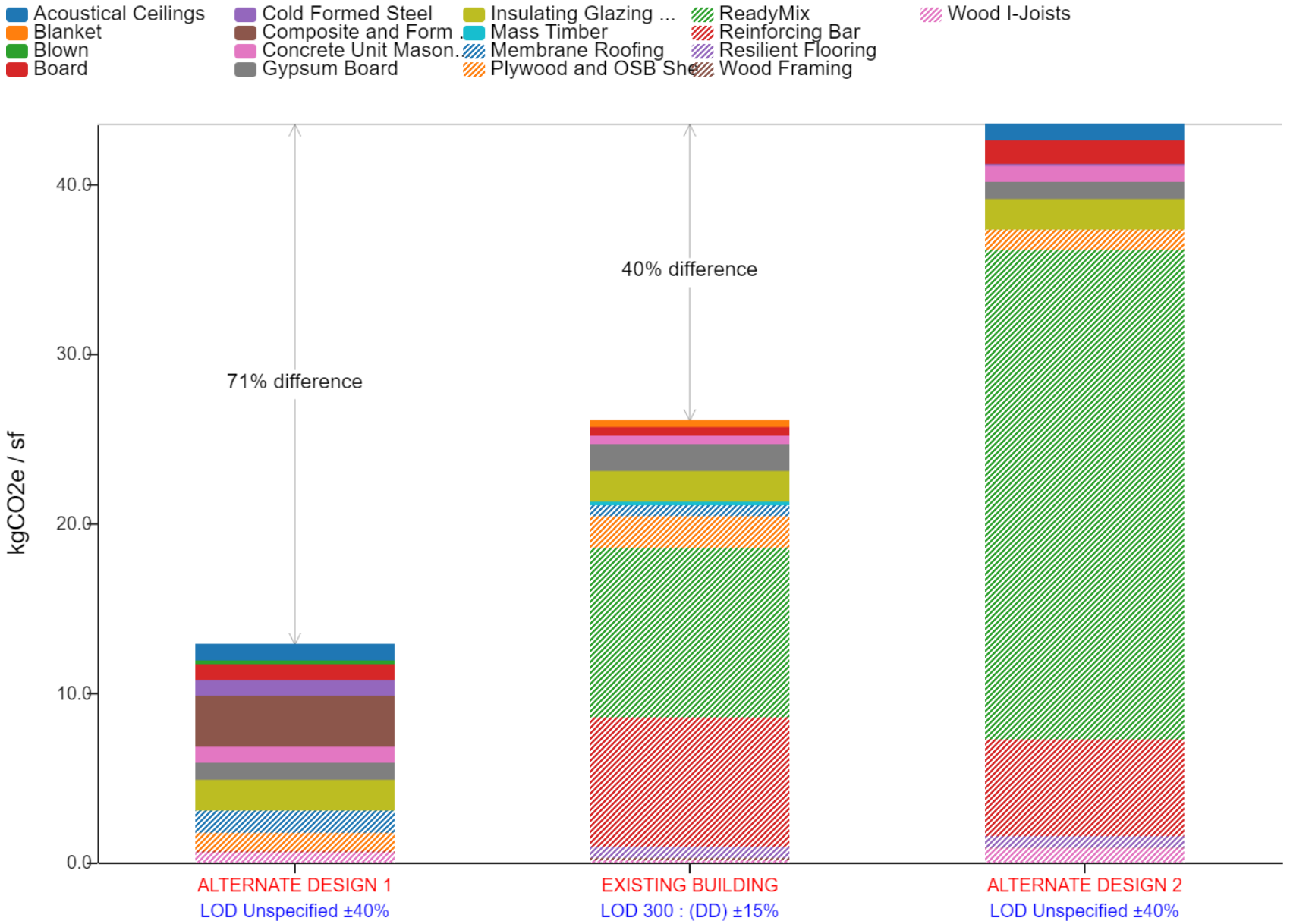
INTERIOR WALLS, EXTERIOR WALLS, FLOOR AND ROOF TYPES



COMPARING RESULTS



EMBODIED CARBON INTENSITY PER UNIT AREA



EMBODIED CARBON INTENSITY PER UNIT AREA

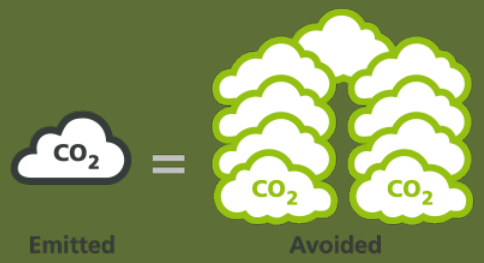
OPTIMIZING CARBON FOOTPRINT

BY UNDERSTANDING WHERE CARBON EMISSIONS COME FROM, WE CAN PIN POINT WHERE THE MOST IMPACTFUL CHANGES CAN OCCUR.

CARBON SEQUESTRATION METHODOLOGY

CARBON FOOTPRINT

REDUCING CARBON FOOTPRINT REFERS TO **REDUCING GREENHOUSE GAS EMISSIONS CAUSED BY HUMAN ACTIVITIES** SUCH AS TRANSPORTATION, ENERGY PRODUCTION, AND INDUSTRIAL PROCESSES. IT INVOLVES REDUCING ENERGY CONSUMPTION, USING RENEWABLE ENERGY SOURCES, AND INCREASING ENERGY EFFICIENCY.



VS

CARBON SEQUESTRATION

CARBON SEQUESTRATION IS THE TERM THAT IS USED TO DESCRIBE THE PROCESS OF **CAPTURING, SECURING AND STORING CARBON DIOXIDE FROM THE ATMOSPHERE.**

THE IDEA IS TO STABILIZE CARBON IN SOLID AND DISSOLVED FORMS SO THAT IT DOESN'T CAUSE THE ATMOSPHERE TO WARM.

INTRODUCING MORE VEGETATION TO A SITE IS ANOTHER WAY OF HELPING TO REDUCE THE AMOUNT OF CARBON DIOXIDE AROUND THE SITE.

CARBON SEQUESTRATION METHODOLOGY

BIOMASS EQUATION

M=ADB

M=ABOVE GROUND BIOMASS (KG)
D=DIAMETER AT BREAST HEIGHT (CM)
A & B=SPECIES SPECIFIC COEFFICIENTS

1

SPECIES SPECIFIC COEFFICIENTS

RESEARCH THE SPECIES SPECIFIC COEFFICIENTS

2

TREE DIAMETER

MEASURE TREE DIAMETER

3

CALCULATE DATA

INSERT DIAMETER (D) AND SPECIES SPECIFIC COEFFICIENTS (A&B) INTO EQUATION

4

CALCULATE CARBON

AVERAGE TREE IS ABOUT 50% CARBON. THEN MULTIPLY BY WEIGHT OF THE CARBON 3.67

5

CARBON SEQUESTRATION COMPARISON

4" TREES

CALCULATING TREE'S BIOMASS

M=ADB

M=TREE BIOMASS

A & B=SPECIES SPECIFIC COEFFICIENTS

D=DIAMETER

1. **WALNUT = .007 KGS OF CARBON**
   - JUGLANS MANDSHURICA: M=0.0001*4^2.63 = 0.0038 KG
   - .0038 KG * 50% * 3.67= *.007 KGS*
2. **ASH = .0068 KGS OF CARBON**
   - FRAXINUS MANDSHURICA: M=0.0001*4^2.61 = .0037 KG
   - .0037 * 50% * 3.67 = *.0068 KGS*
3. **PINE = .0062 KGS OF CARBON**
   - PINUS KORAIENSIS: M=0.0001*4^2.54 = .0034 KG
   - .0034 * 50% * 3.67 = *.0062 KGS*
4. **MAPLE = .00175 KGS OF CARBON**
   - ACER MONO: M=0.0001*4^2.56 = 0.0035 KG
   - .0035 KG * 50% * 3.67= *.00175 KGS*
5. **BIRCH = .00175 KGS OF CARBON**
   - BETULA PLATYPHYLLA: M=0.0001*4^2.57= .0035 KG
   - .0035 * 50% * 3.67 = *.00175 KGS*
6. **LARCH = .00175 KGS OF CARBON**
   - LARIX GMELINII: M=0.0001*4^2.56 = .0035 KG
   - .0035 * 50% * 3.67 = *.00175 KGS*

1

2

3

4

5

6

THE IMPACT OF THIS METHODOLOGY

- CREATES A PATH FOR CHANGE ON A PERSONAL LEVEL
- ALLOWS DESIGNER TO LEARN WHILE CREATING
- CHANGES CAN BE MADE TO PREEXISTING & EXISTING BUILDINGS
- PROVIDES ADDITIONAL TECHNIQUES FOR REDUCING CARBON IN THE ATMOSPHERE THROUGH CARBON SEQUESTRATION
- UNDERSTANDING RESPONSIBILITY & TAKING ACTION FOR THE FUTURE OF OUR ENVIRONMENT




SOURCES

- https://materialspalette.org/
- https://buildingtransparency.org/ec3
- https://www.buildingtransparency.org/
- https://pliteq.com/news/building-vs-carbon-footprint/#:~:text=Last%20but%20not%20least%2C%20the,an%20abundantly%20available%20natural%20resource.




THANK YOU

KAITLYN KANE

THESIS PRESENTATION

PROFESSOR MAHALINGAM

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