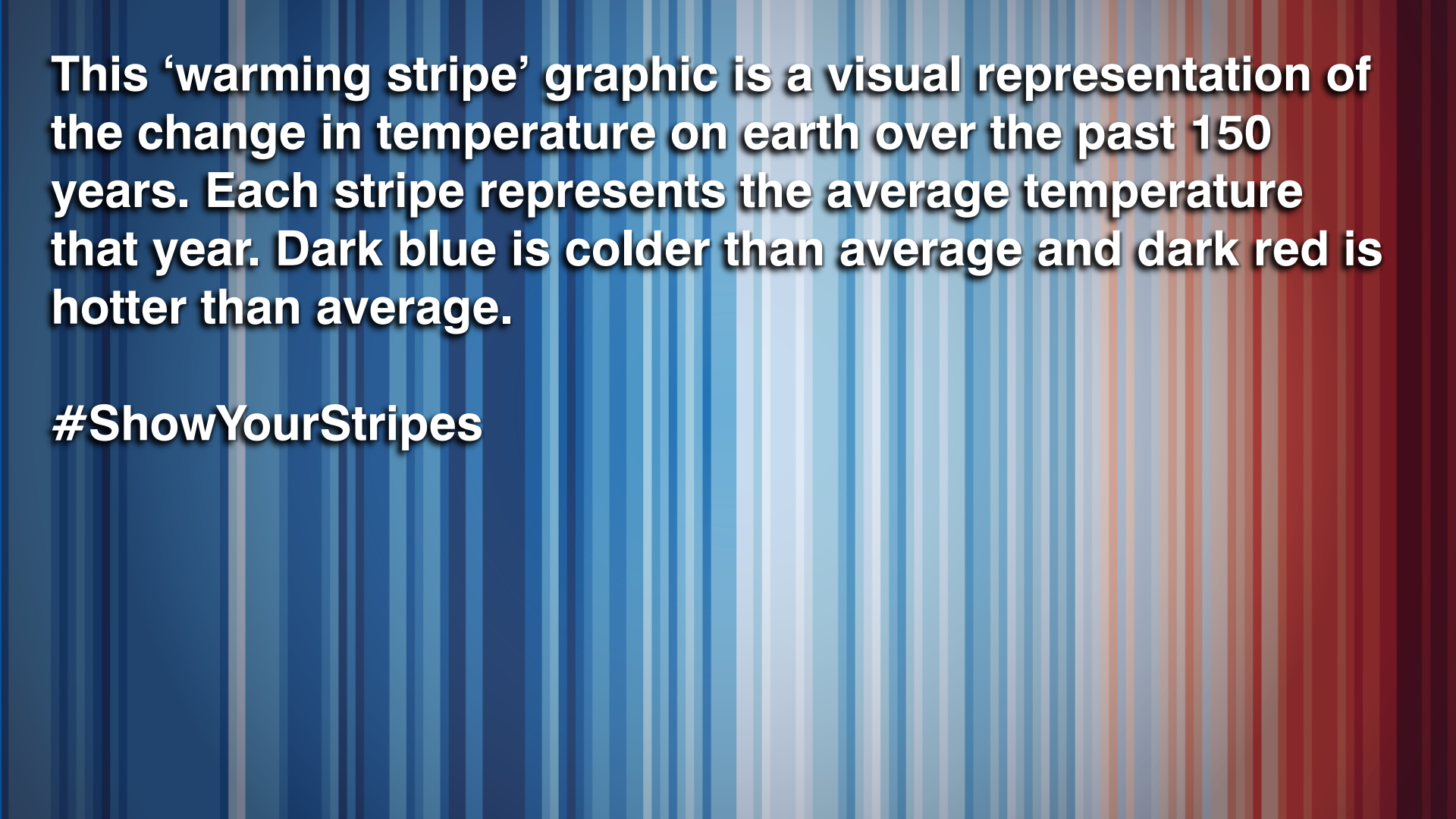
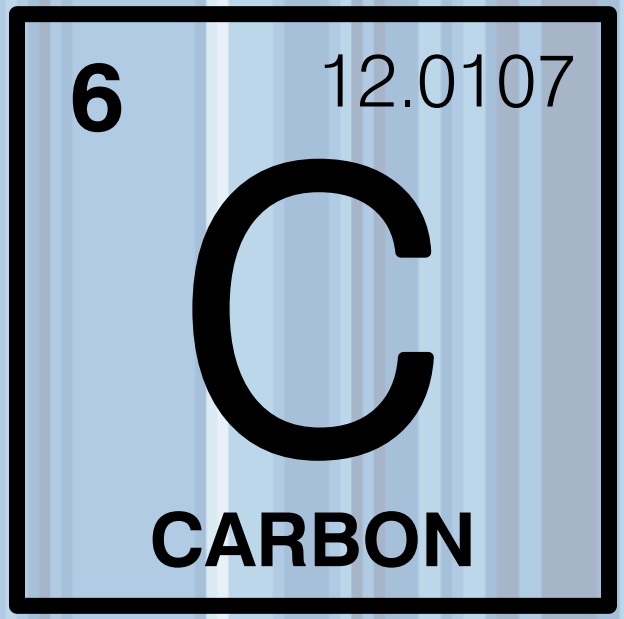

This ‘warming stripe’ graphic is a visual representation of the change in temperature on earth over the past 150 years. Each stripe represents the average temperature that year. Dark blue is colder than average and dark red is hotter than average.
#ShowYourStripes



PhiusCon 2023:

RE:CARBONIZATION

November 9, 2023

David Salamon, RA | CPHC

Architect + Sustainability Consultant

Salamon@ReVisionArch.com

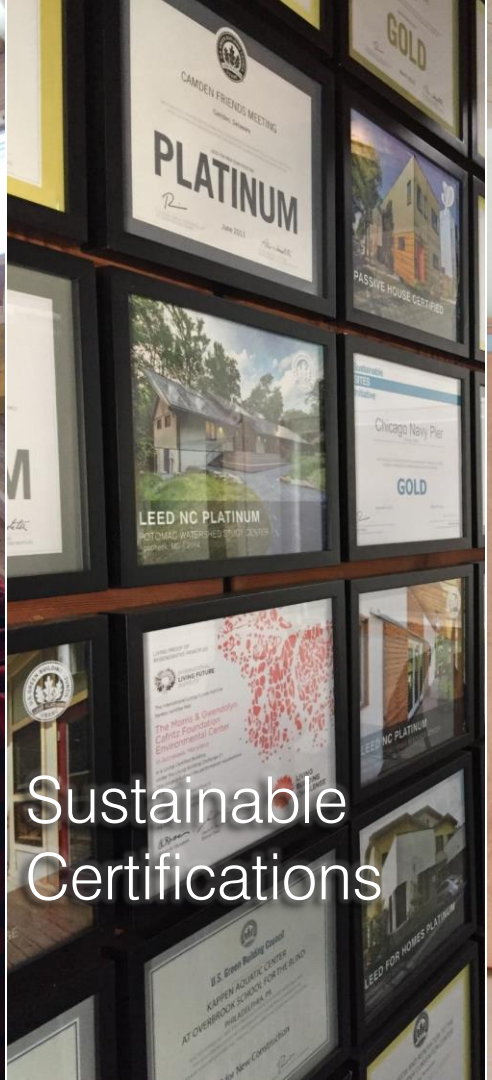
www.ReVisionArch.com

Re:Vision

Re:Vision

Green Architecture + Planning

Sustainability + Building Performance Services



Sustainable Certifications

Community Engagement

REMOVE BARRIERS

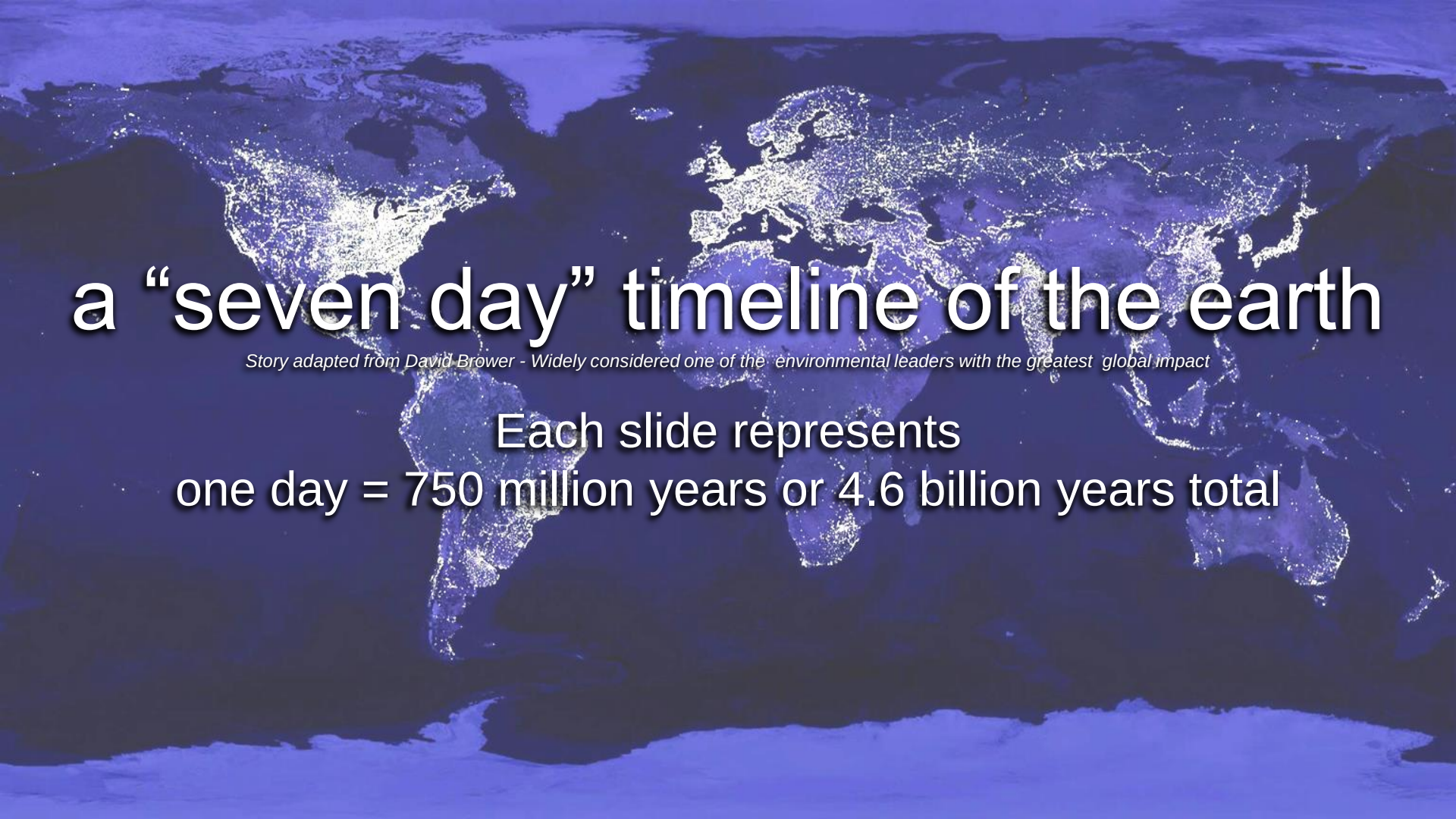
TO GREEN BUILDINGS AND SUSTAINABLE COMMUNITIES

“Dehydrate back into minerals,
A lifelong walk to the same exact spot.
Carbon's anniversary.

Someday, somehow, something will die,
and you will steal its carbon.
Someday you will die
and somehow something’s
gonna steal your carbon.”

Isaac Brock, lead singer for Modest Mouse,
“Parting of the Sensory”


the big picture of carbon



a “seven day” timeline of the earth

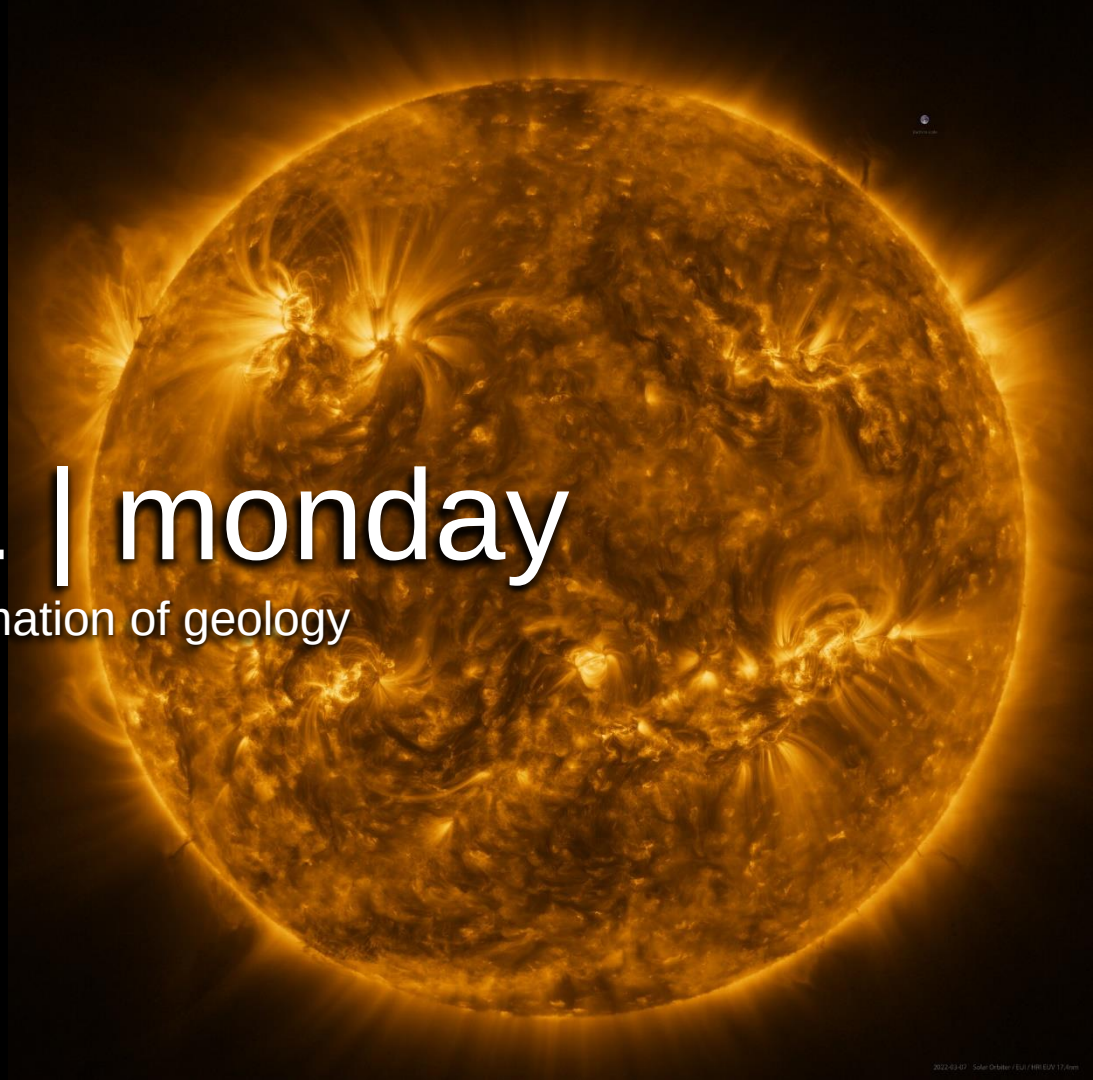
Story adapted from David Brower - Widely considered one of the environmental leaders with the greatest global impact

Each slide represents
one day = 750 million years or 4.6 billion years total

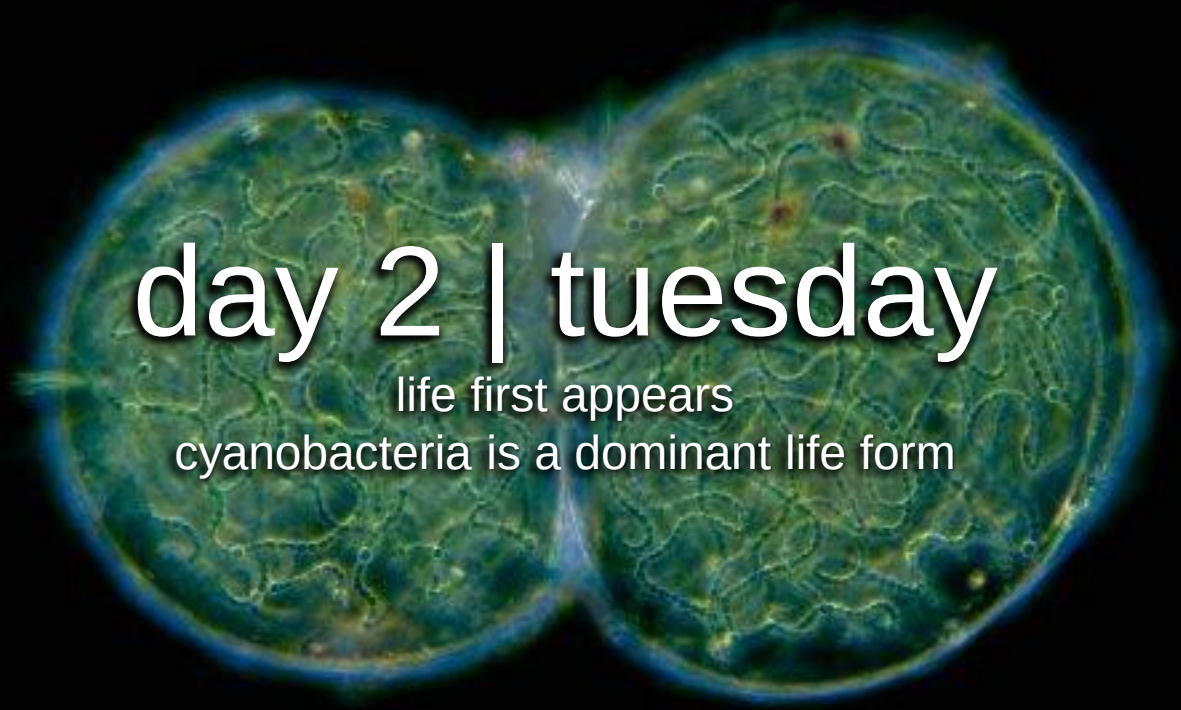
4.6 billion years ago

day 1 | monday

formation of geology



3.75 billion years ago



day 2 | tuesday

life first appears

cyanobacteria is a dominant life form

3 billion years ago

day 3 | wednesday

all life is restricted to the sea
biosphere gradually evolves
photosynthetic life forms increase
oxygen begins to be produced in large quantities as a metabolic byproduct


2.25 billion years ago
day 4 | thursday
half of earth's history is passed
plants form on earth's surface

1.5 billion years ago

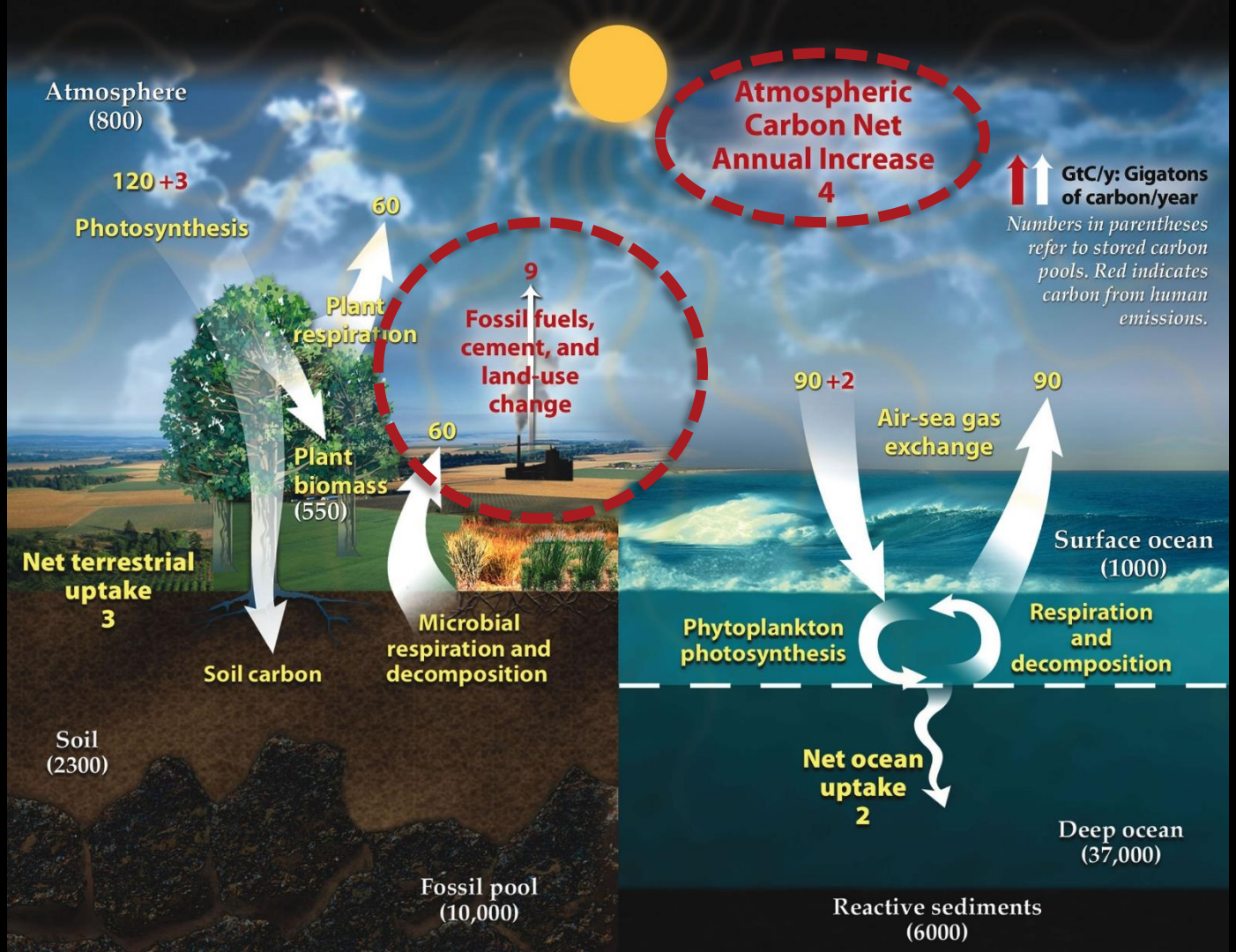
day 5 | friday

free oxygen molecules form ozone, blocking deadly UV light
paving the way for life forms to move from ocean to land

day 6 | saturday

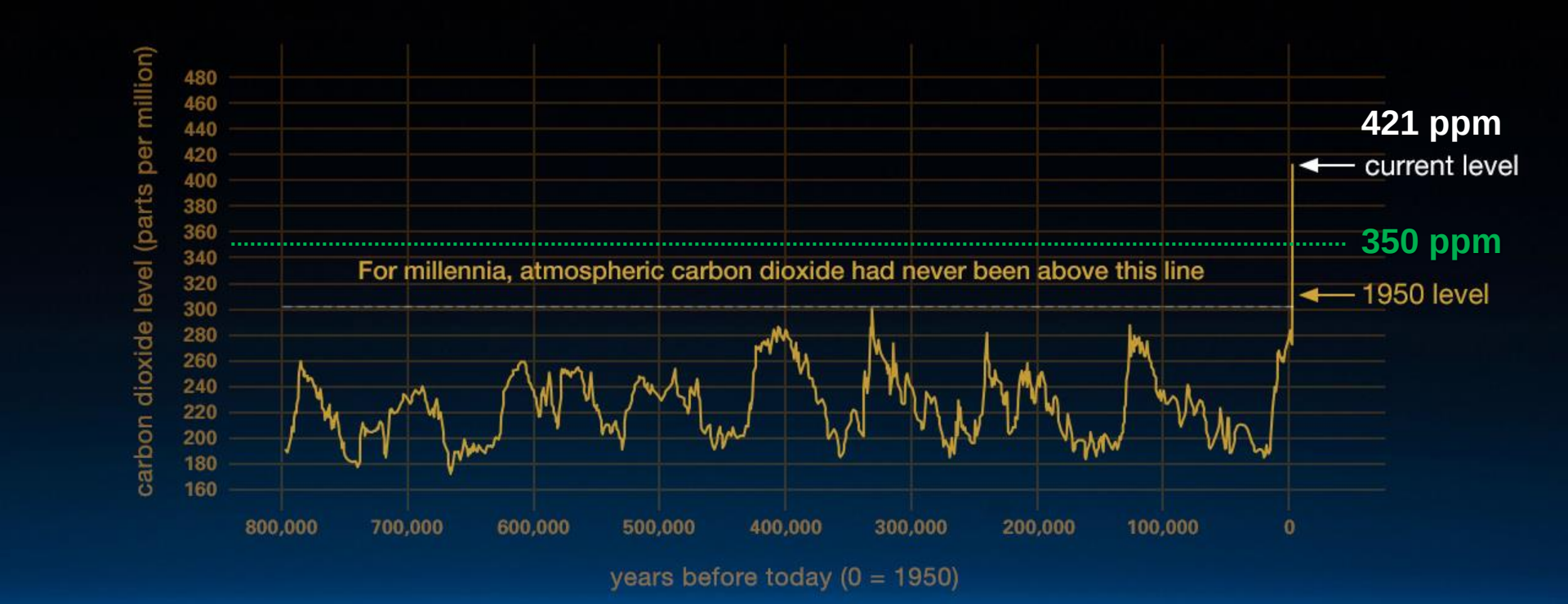
1:00 A.M. – Amphibians come onto land
4:00 P.M. – Giant reptiles appear and survive until 9:55 (6 hours)
10:00 P.M. – Primates appear
11:44 P.M. – Grand Canyon begins to form
11:59:54 P.M. – Homo sapiens arrive (6 seconds)


150 years ago
day 6 | late-night saturday
11:59:59.975 P.M - Humans begin to burn fossil fuel
(anyone ever done something stupid at 11:59pm on a Saturday?)


Atmosphere
(800)
120 +3
Photosynthesis
60
Plant respiration
9
Fossil fuels, cement, and land-use change
60
Plant biomass
(550)
Net terrestrial uptake
3
Soil carbon
Microbial respiration and decomposition
Soil
(2300)
Fossil pool
(10,000)
Atmospheric Carbon Net Annual Increase
4
GtC/y: Gigatons of carbon/year
Numbers in parentheses refer to stored carbon pools. Red indicates carbon from human emissions.
90 +2
90
Air-sea gas exchange
Surface ocean
(1000)
Phytoplankton photosynthesis
Respiration and decomposition
Net ocean uptake
2
Deep ocean
(37,000)
Reactive sediments
(6000)

day 7 | sunday

we have a lot of work to do!


carbon dioxide level (parts per million)
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
For millennia, atmospheric carbon dioxide had never been above this line
421 ppm
current level
350 ppm
1950 level
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
years before today (0 = 1950)

What is meant by “decarbonization”?

Energy decarbonization involves shifting the entire energy system in an attempt to stop carbon emissions from entering the atmosphere before they are ever released.

Carbon dioxide is the currency of photosynthesis, a source of Earth's capacity for regeneration. Soil carbon is the guarantor of healthy ecosystems and food and water security. **Carbon atoms are the building blocks of life.**

- William McDonough

“Carbon — the element — is not the enemy. Climate change is the result of breakdowns in the carbon cycle caused by us: **it is a design failure.**”

William McDonough, “Carbon Is Not The Enemy”

“Airborne carbon is a material in the wrong place, at the wrong dose and for the wrong duration. It is we who have made carbon, toxic. In the right place, carbon is a resource and a tool.”

William McDonough, “Carbon Is Not The Enemy”

recarbonization

Carbon isn't bad, it's just in the wrong place. Recarbonization is the mass re-balancing of the location of carbon in the Earth's biosphere.

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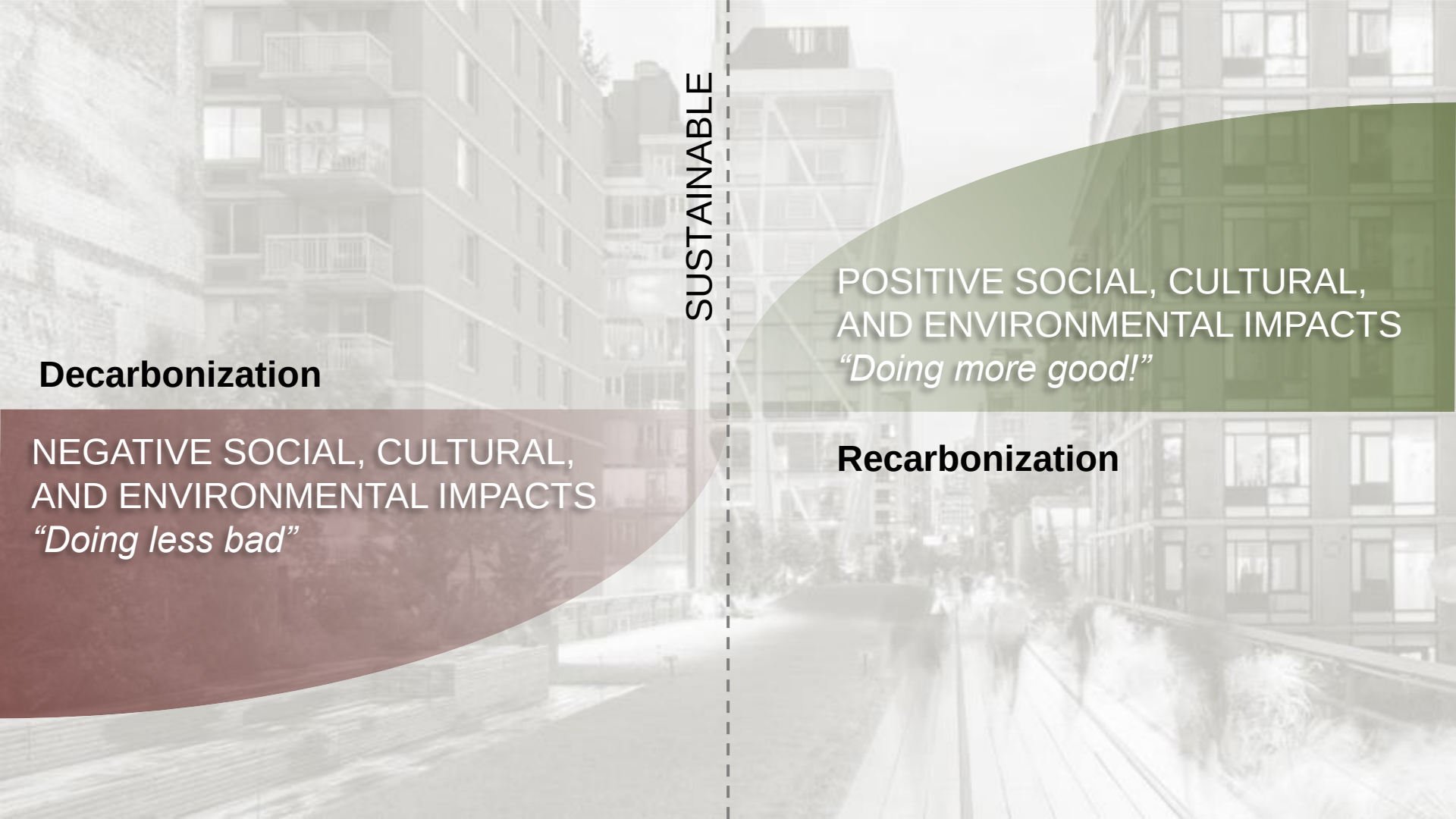
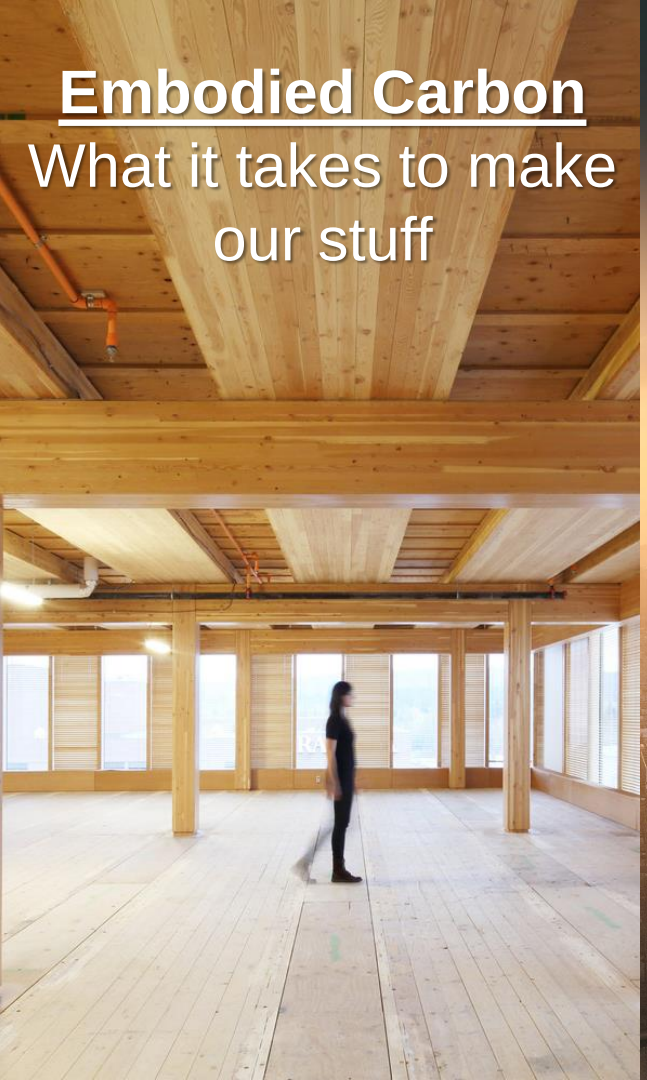
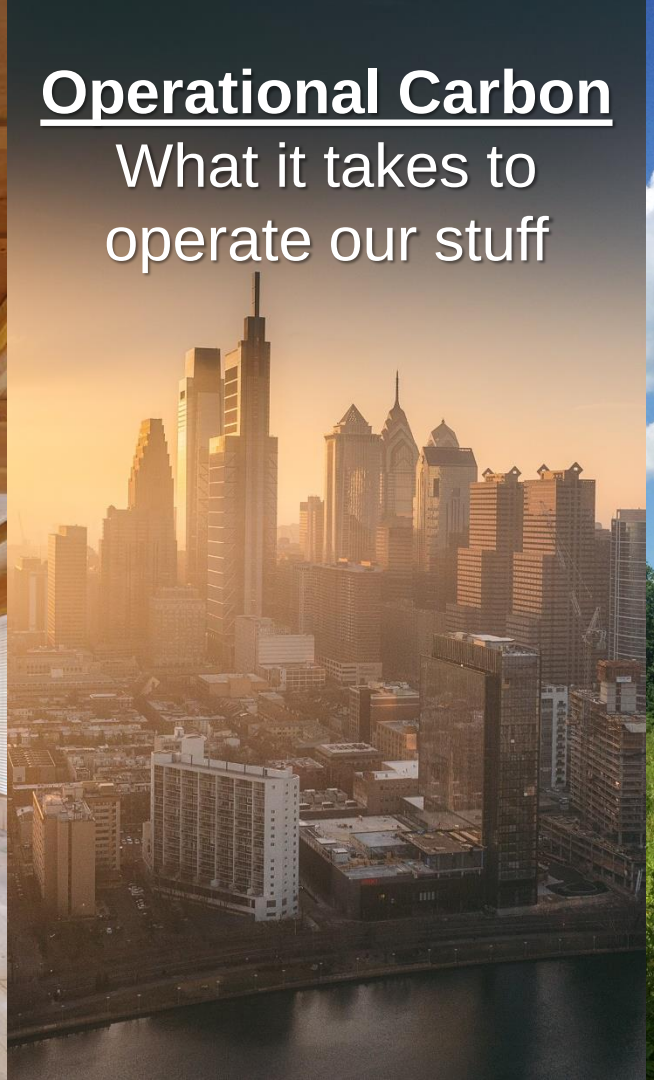

SUSTAINABLE
Decarbonization
NEGATIVE SOCIAL, CULTURAL, AND ENVIRONMENTAL IMPACTS
“Doing less bad”
POSITIVE SOCIAL, CULTURAL, AND ENVIRONMENTAL IMPACTS
“Doing more good!”
Recarbonization


Understanding carbon
Re:Vision



Embodied Carbon

What it takes to make our stuff



Operational Carbon

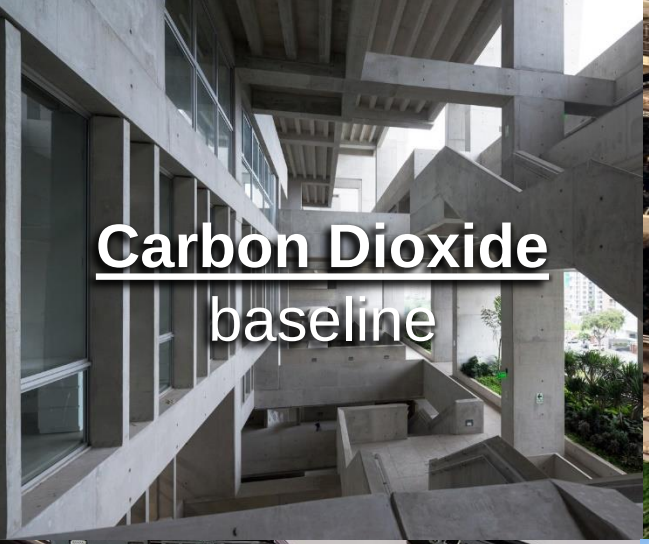
What it takes to operate our stuff

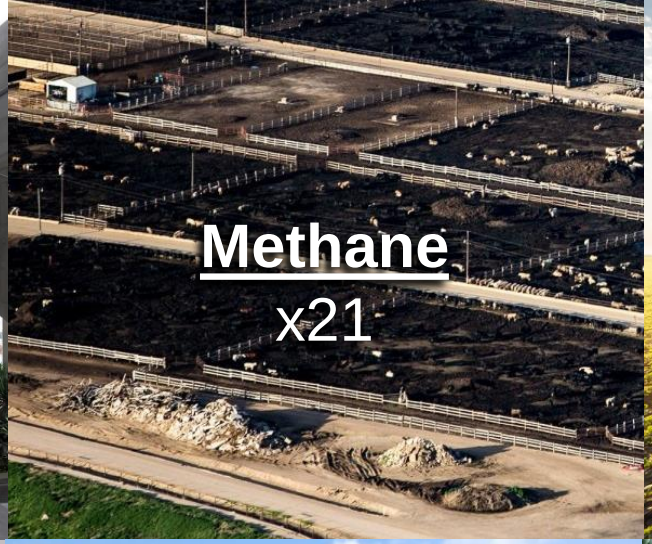
Sequestered Carbon

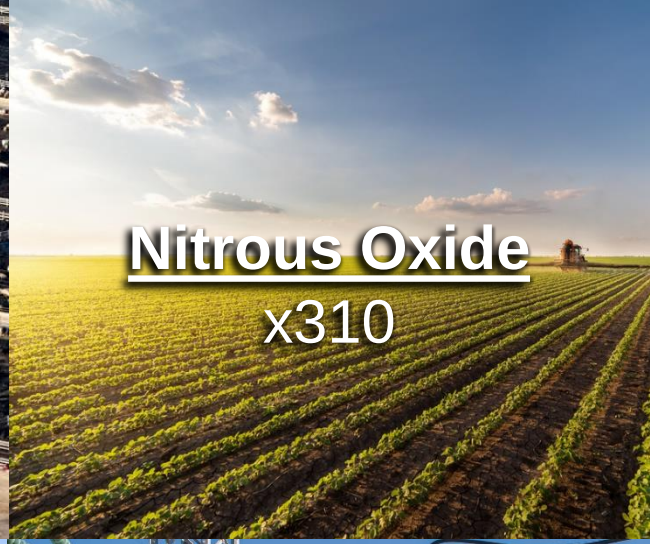
Carbon our stuff is storing or capturing

Re:Vision


When we say “carbon” or “CO_2e”
what we really mean is…


Carbon Dioxide
baseline

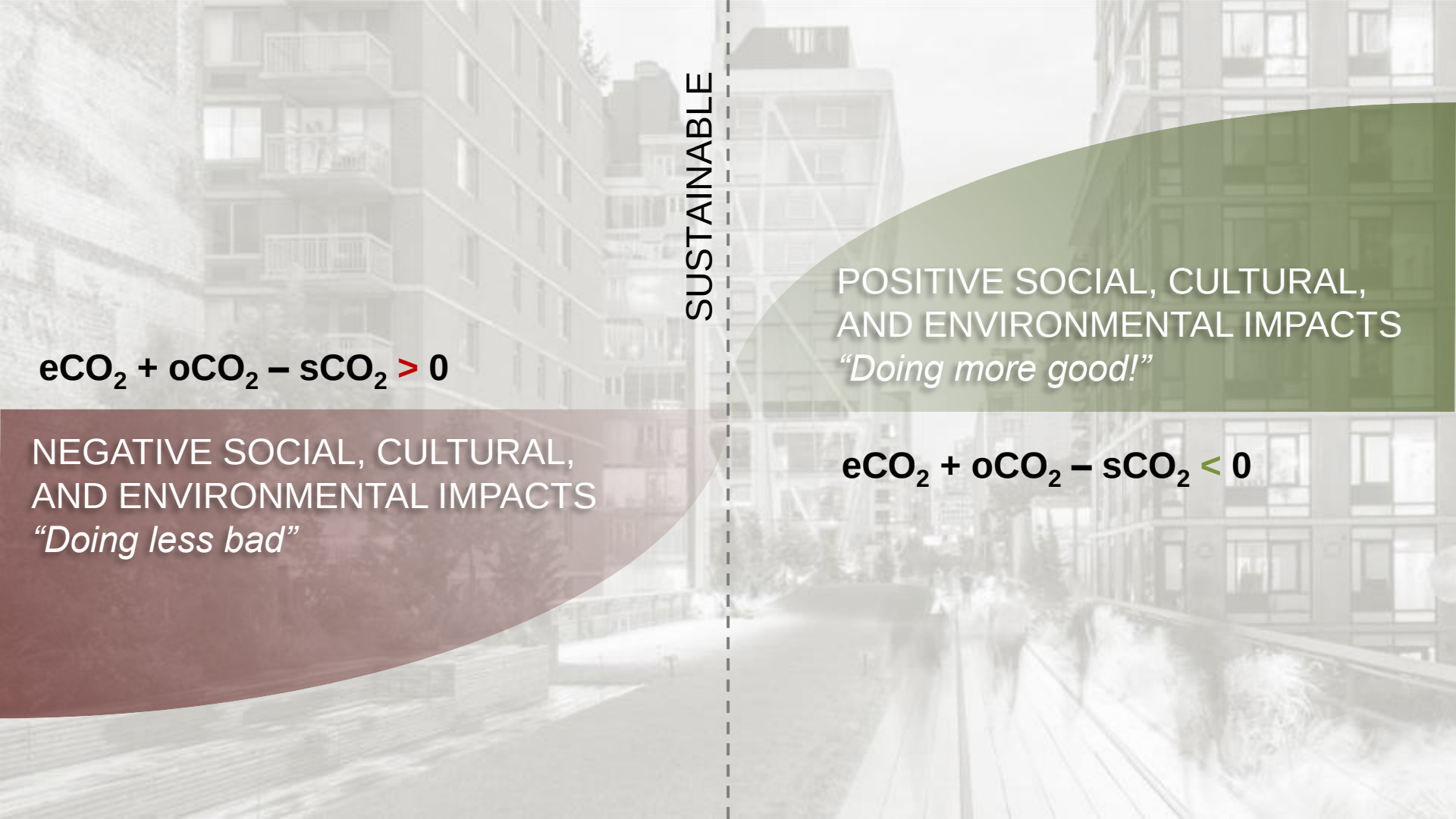

Methane
x21


Nitrous Oxide
x310


Petrofluorocarbons
X7,000

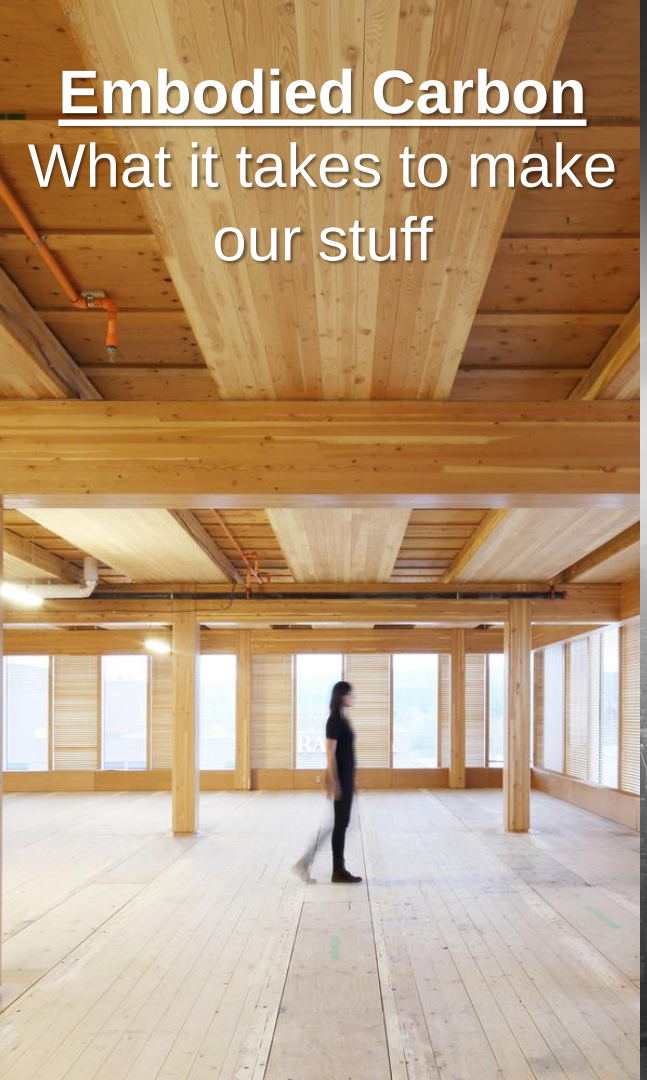

Hydrofluorocarbons
X11,700


Sulfur Hexafluoride
X23,900


SUSTAINABLE
$eCO_2 + oCO_2 - sCO_2 > 0$
NEGATIVE SOCIAL, CULTURAL, AND ENVIRONMENTAL IMPACTS
"Doing less bad"
POSITIVE SOCIAL, CULTURAL, AND ENVIRONMENTAL IMPACTS
"Doing more good!"
$eCO_2 + oCO_2 - sCO_2 < 0$

Embodied Carbon

What it takes to make our stuff



Re:Vision

Extraction

Transportation

Manufacturing

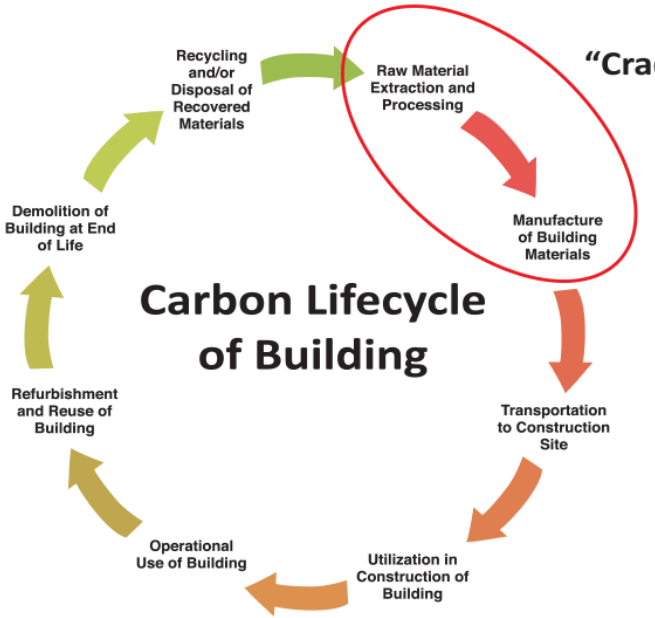
Transportation*

Installation*

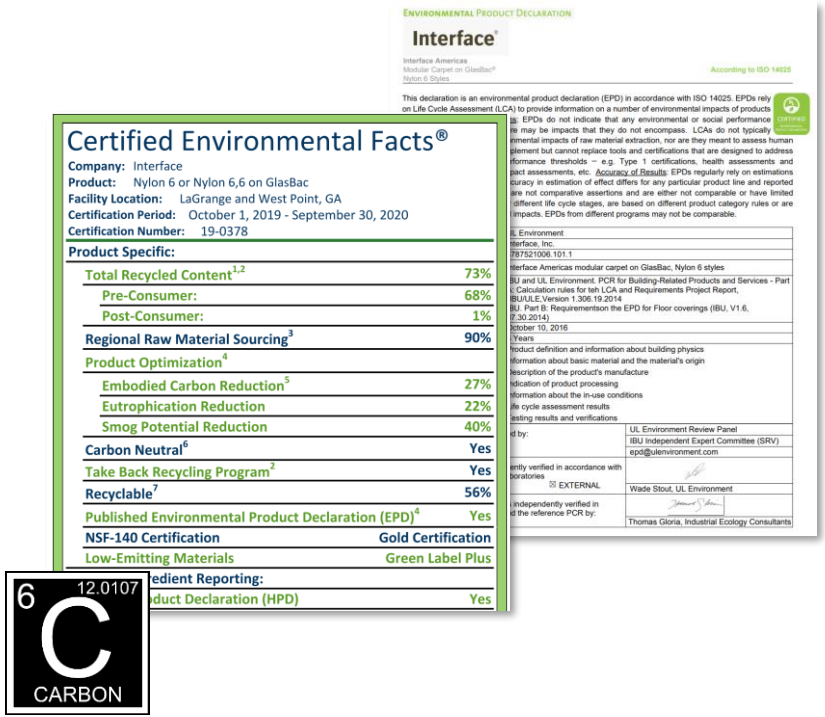
EMBODIED CARBON

Re:Vision

Carbon Tracking



"Cradle to gate"



TRUE OR FALSE:

The lowest embodied carbon building is wood timber construction.

TRUE OR FALSE:

The lowest embodied carbon building is wood timber construction.

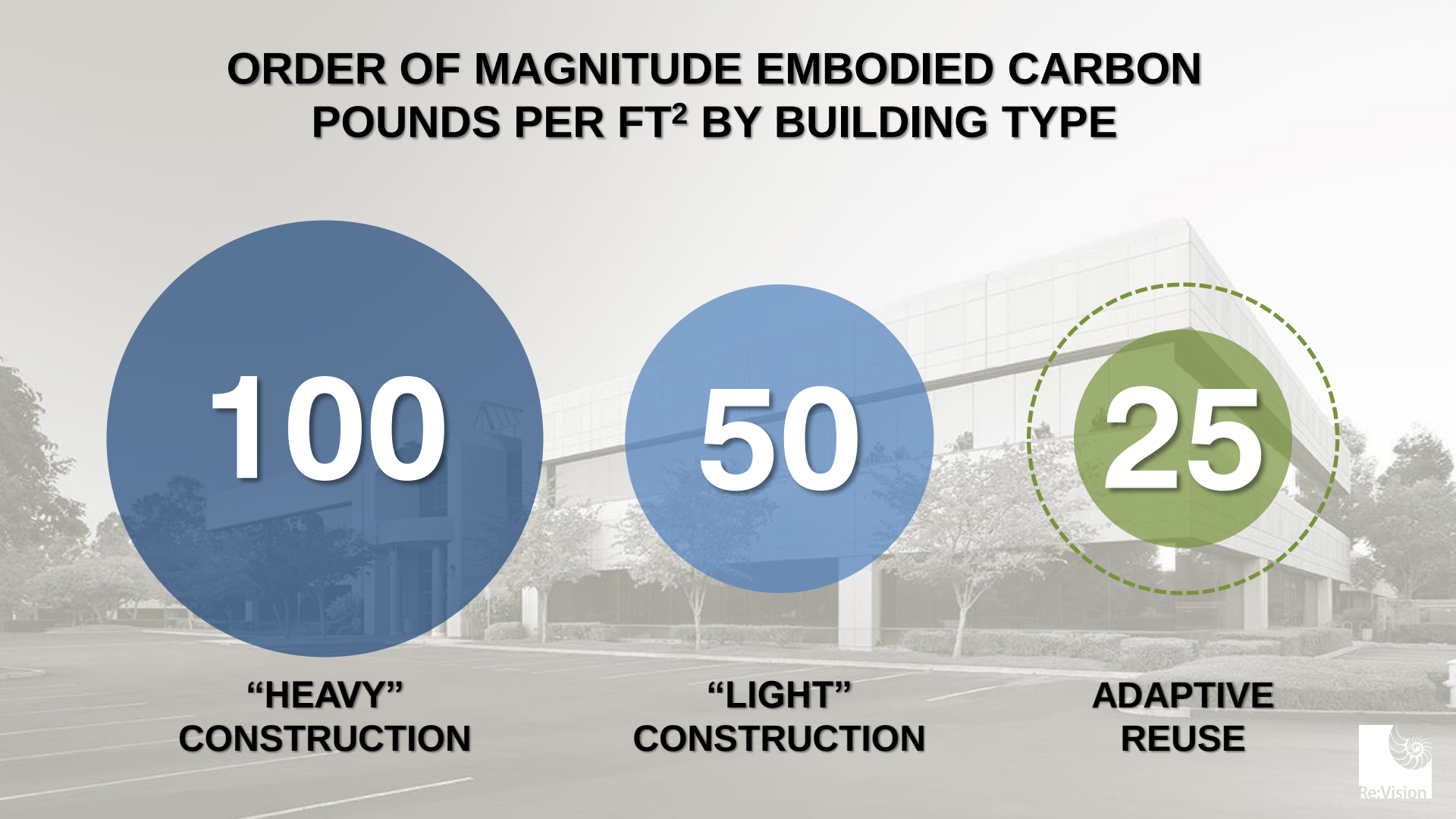
*The single most effective thing we can do to reduce embodied carbon in our buildings is….**adaptive re-use**!*

Embodied Carbon Case Study

NTT Sunnyvale

(This is a Re:Vision consulting project, we did not design this!)

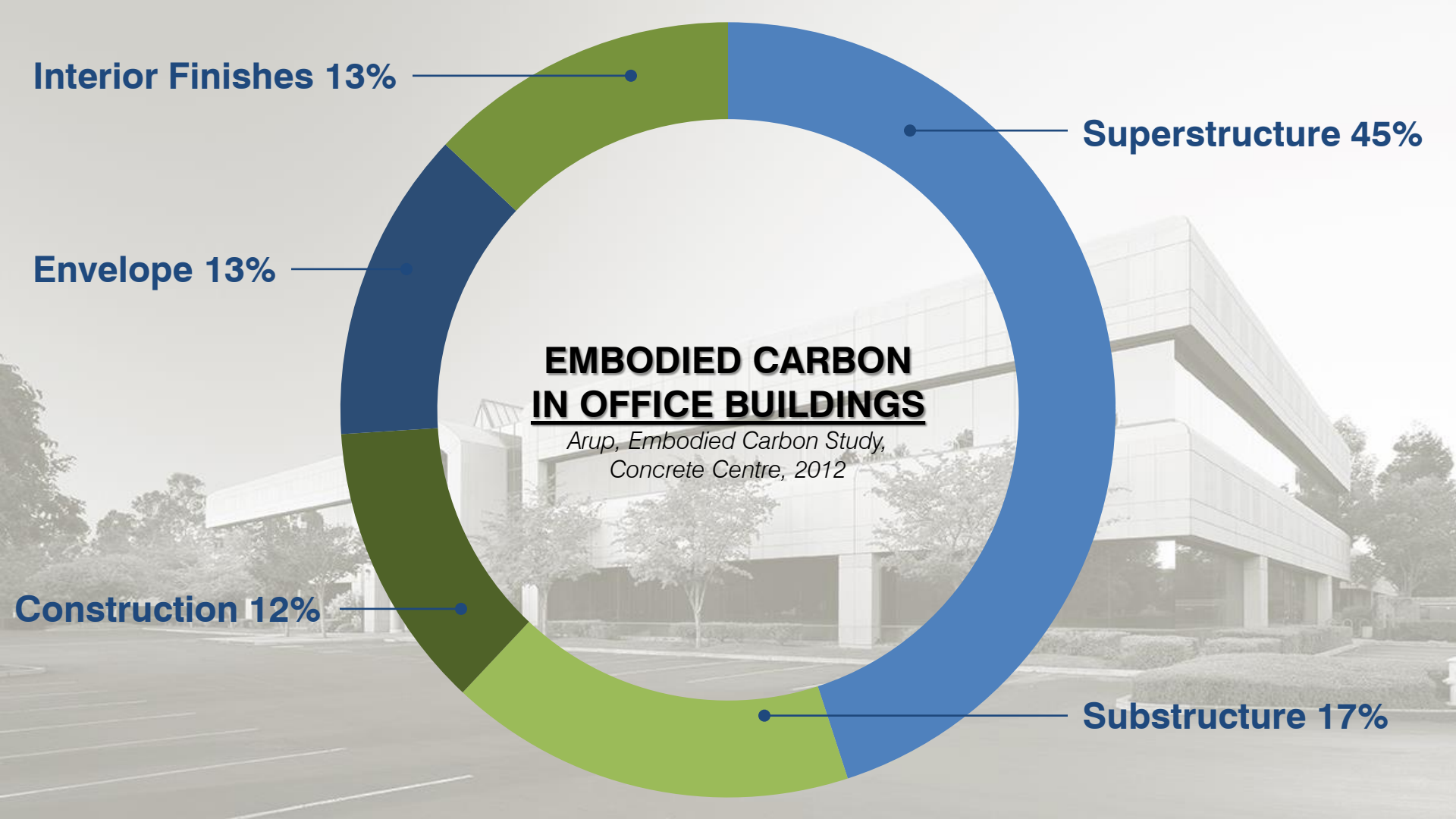
ORDER OF MAGNITUDE EMBODIED CARBON
POUNDS PER FT^2 BY BUILDING TYPE

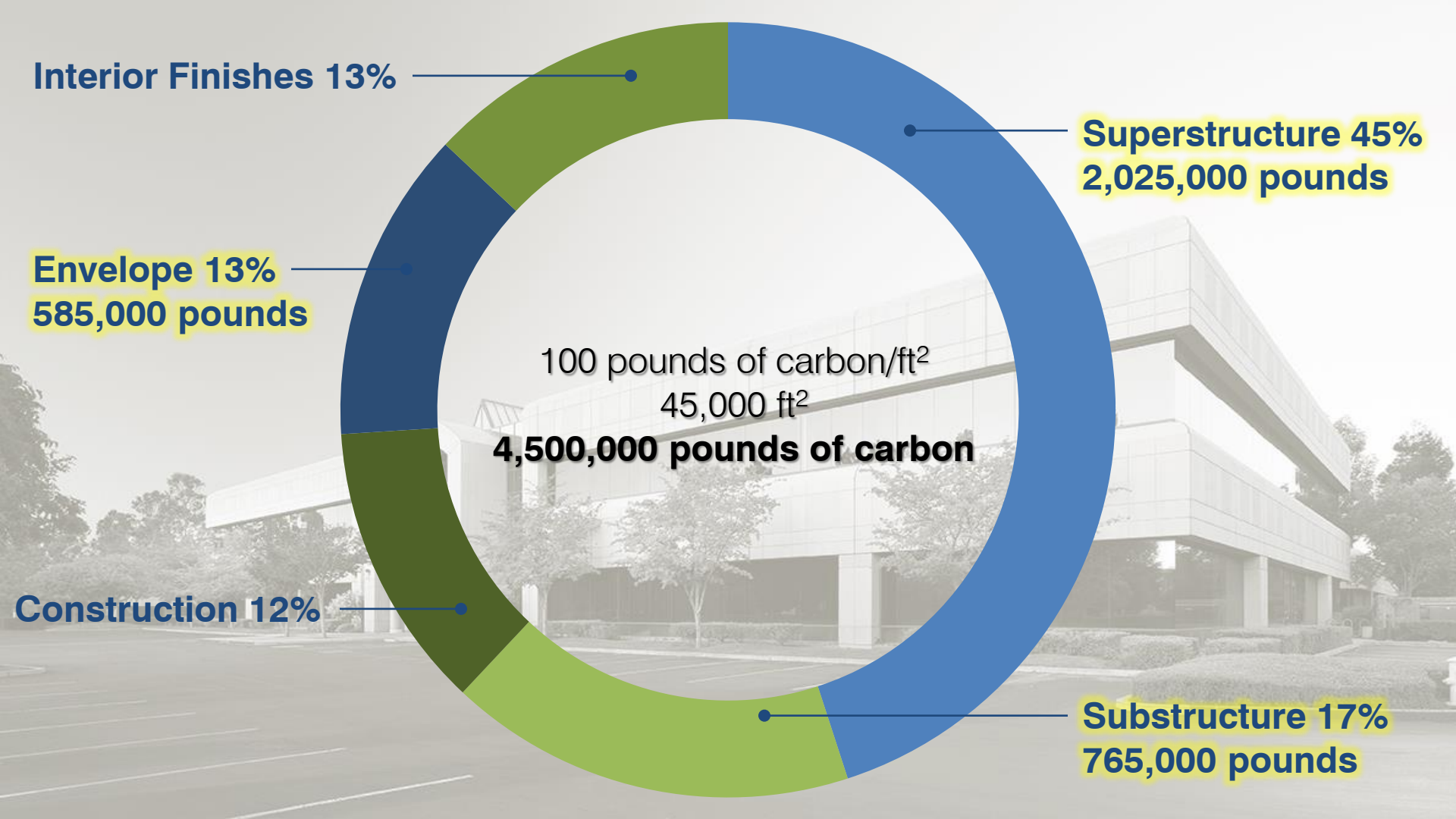


“HEAVY” CONSTRUCTION

“LIGHT” CONSTRUCTION

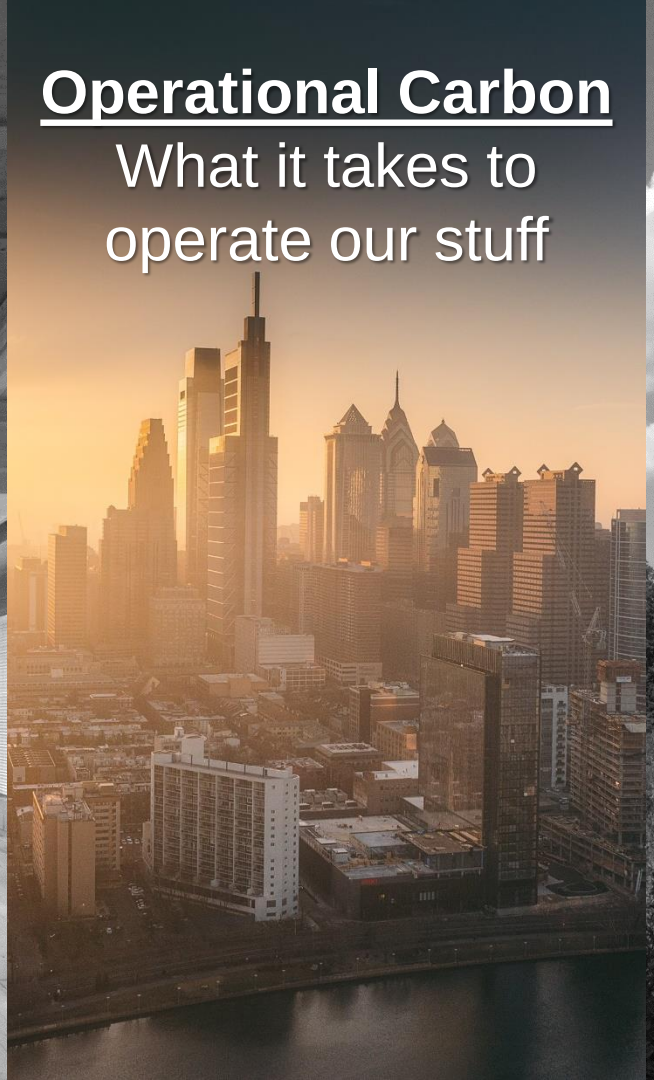
ADAPTIVE REUSE


Interior Finishes 13%
Superstructure 45%
Envelope 13%
EMBODIED CARBON
IN OFFICE BUILDINGS
Arup, Embodied Carbon Study,
Concrete Centre, 2012
Construction 12%
Substructure 17%

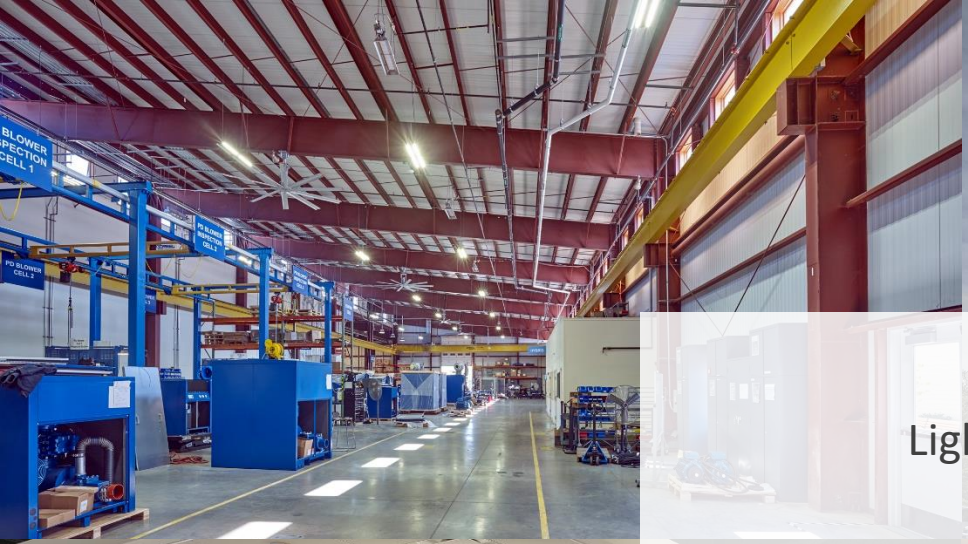

Interior Finishes 13%
Superstructure 45%
2,025,000 pounds
Envelope 13%
585,000 pounds
100 pounds of carbon/ft²
45,000 ft²
4,500,000 pounds of carbon
Construction 12%
Substructure 17%
765,000 pounds

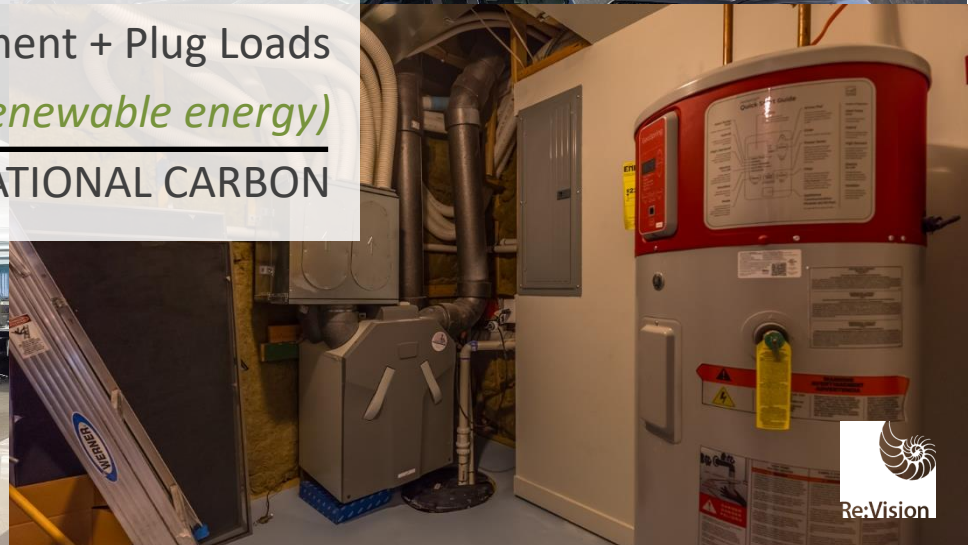
Operational Carbon

What it takes to operate our stuff



Re:Vision



HVAC

Lighting + Electrical

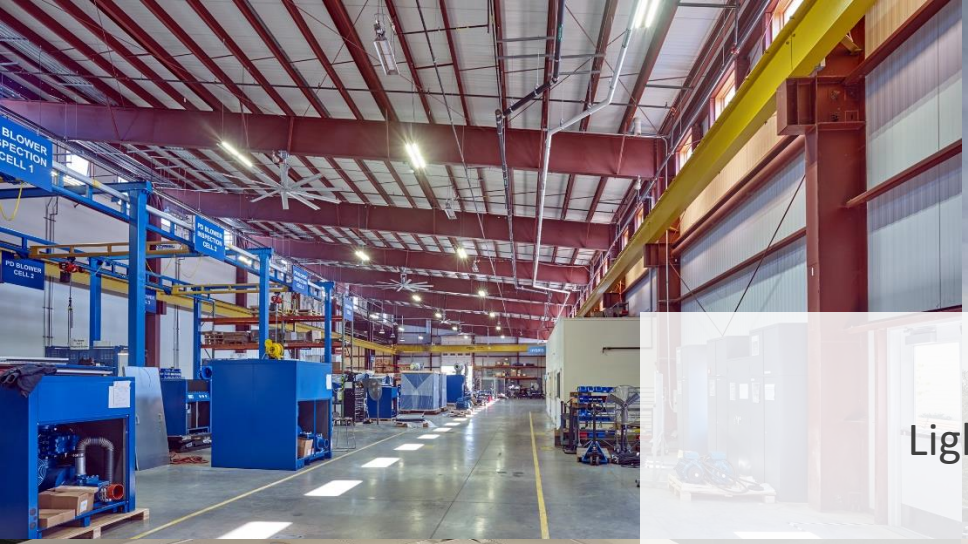
Plumbing

Equipment + Plug Loads

- (renewable energy)

OPERATIONAL CARBON

Re:Vision




HVAC

Lighting + Electrical

Plumbing

Equipment + Plug Loads

+ Transmission loss

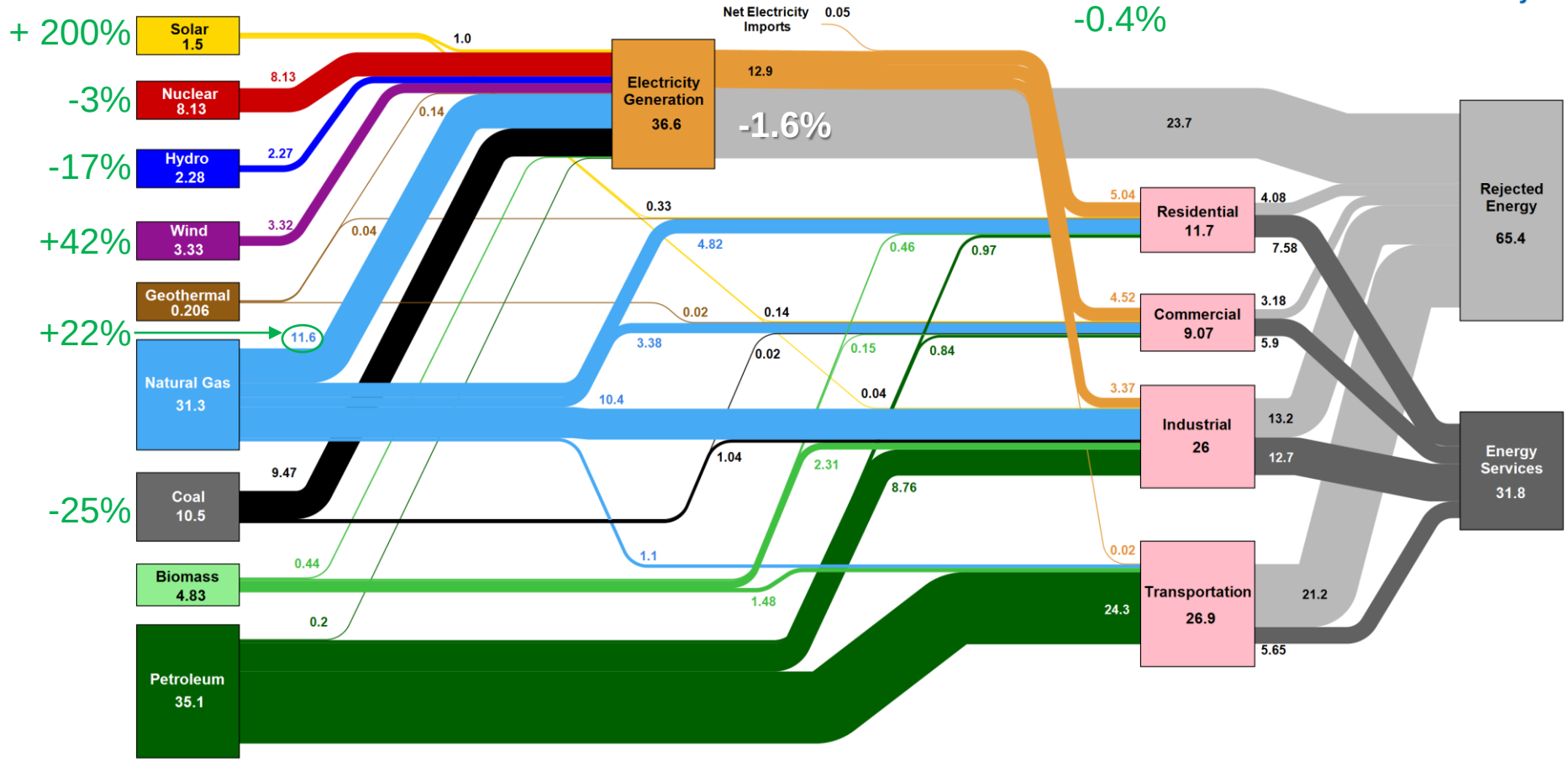
- (renewable energy)

OPERATIONAL CARBON

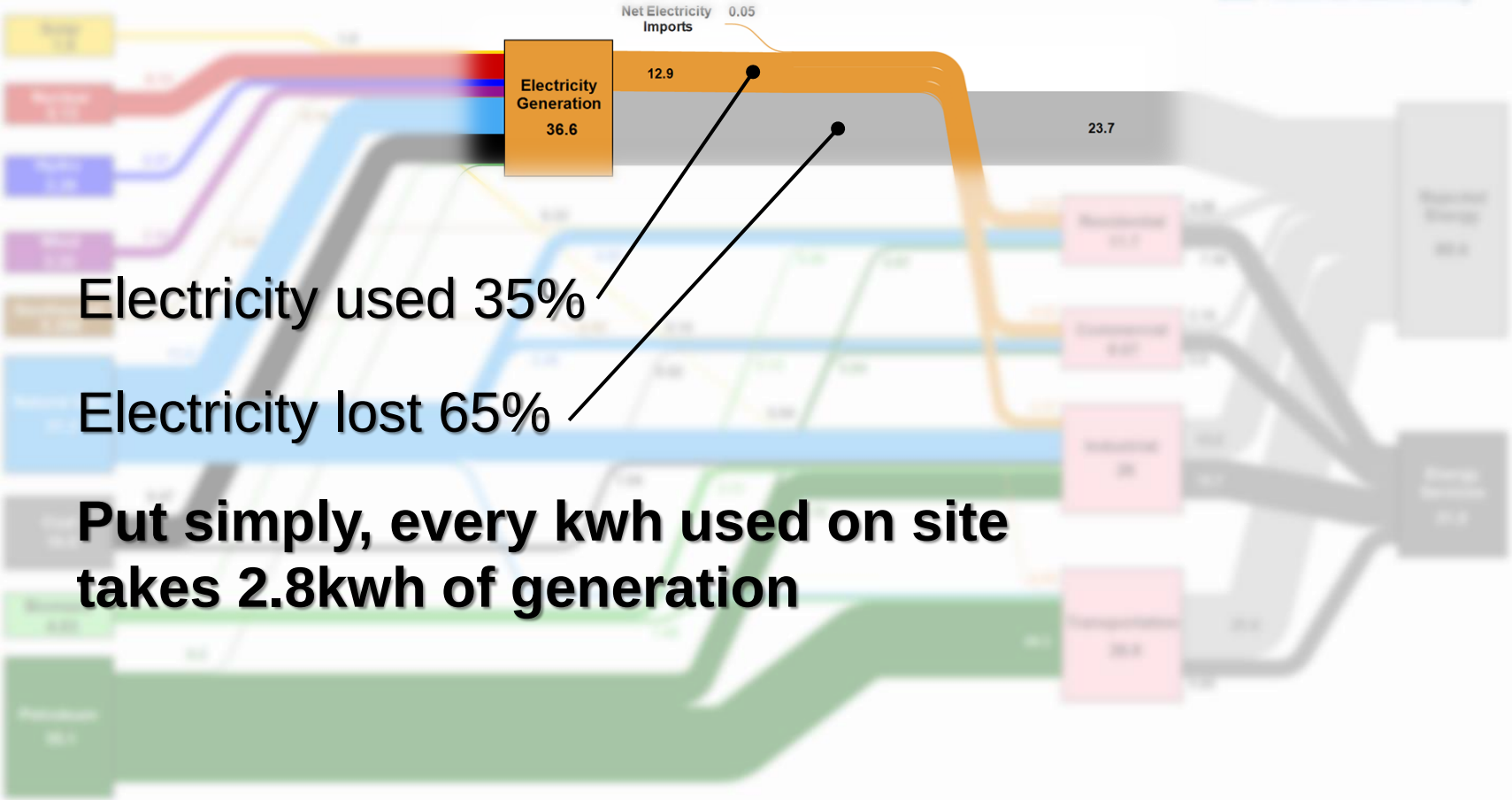
Re:Vision

Estimated U.S. Energy Consumption in 2021: 97.3 Quads

Lawrence Livermore National Laboratory

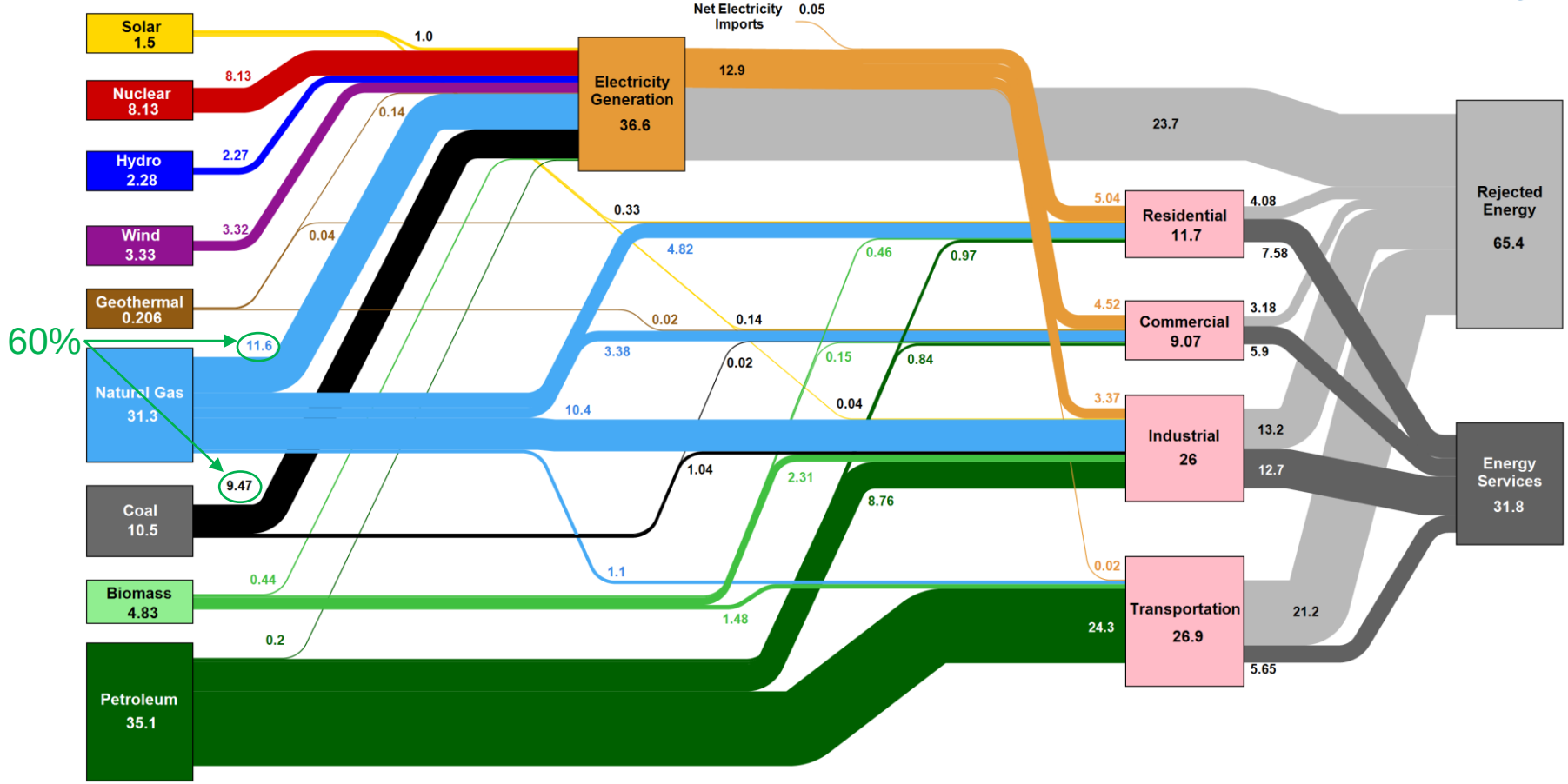


Source: LLNL March, 2022. Data is based on DOE/EIA MER (2021). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

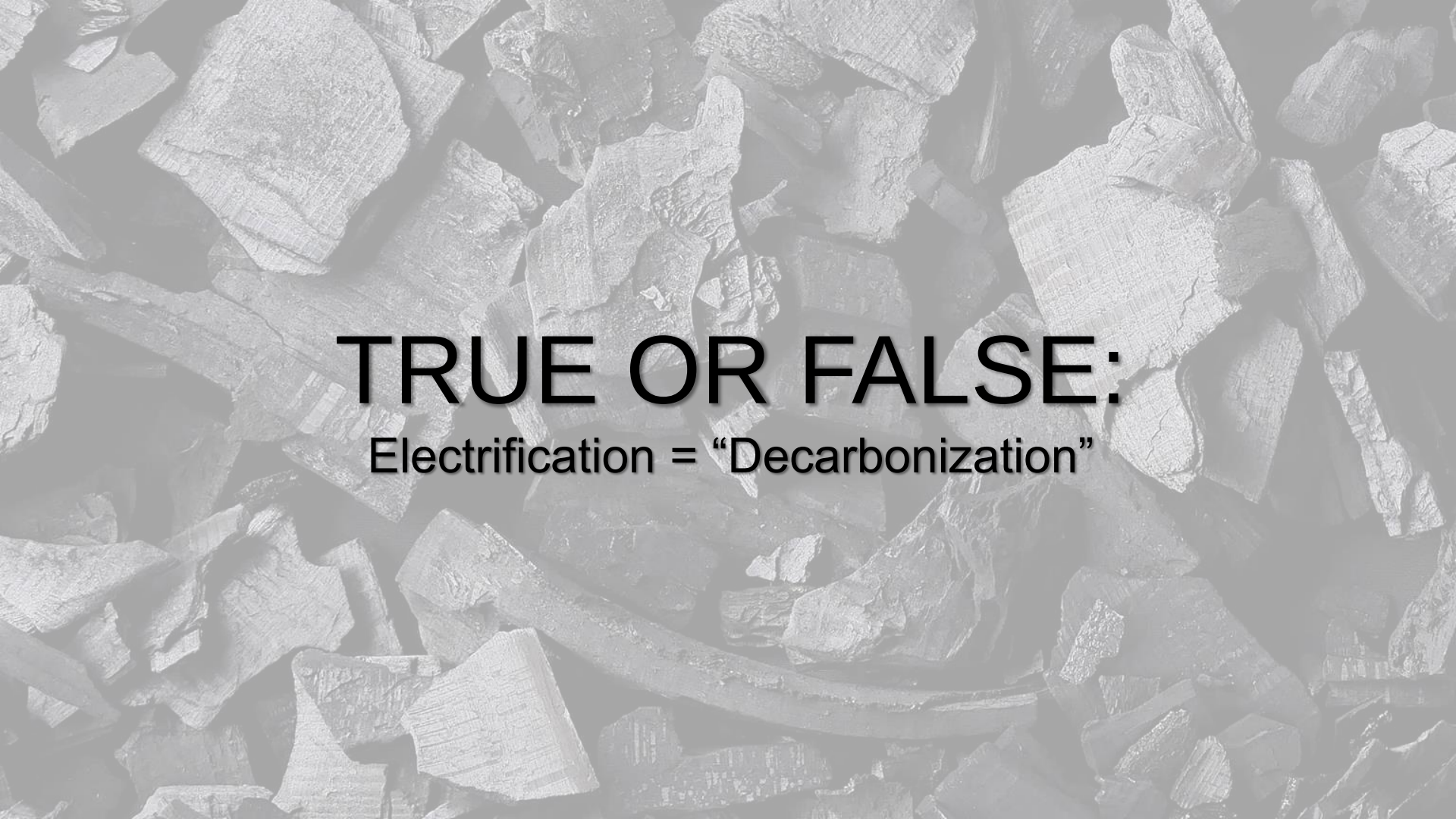

Net Electricity Imports
0.05
Electricity Generation
36.6
12.9
23.7
Electricity used 35%
Electricity lost 65%
Put simply, every kwh used on site takes 2.8kwh of generation

Estimated U.S. Energy Consumption in 2021: 97.3 Quads

Lawrence Livermore National Laboratory



Source: LLNL March, 2022. Data is based on DOE/EIA MER (2021). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector and 49% for the industrial sector, which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527


TRUE OR FALSE:
Electrification = “Decarbonization”

TRUE OR FALSE:

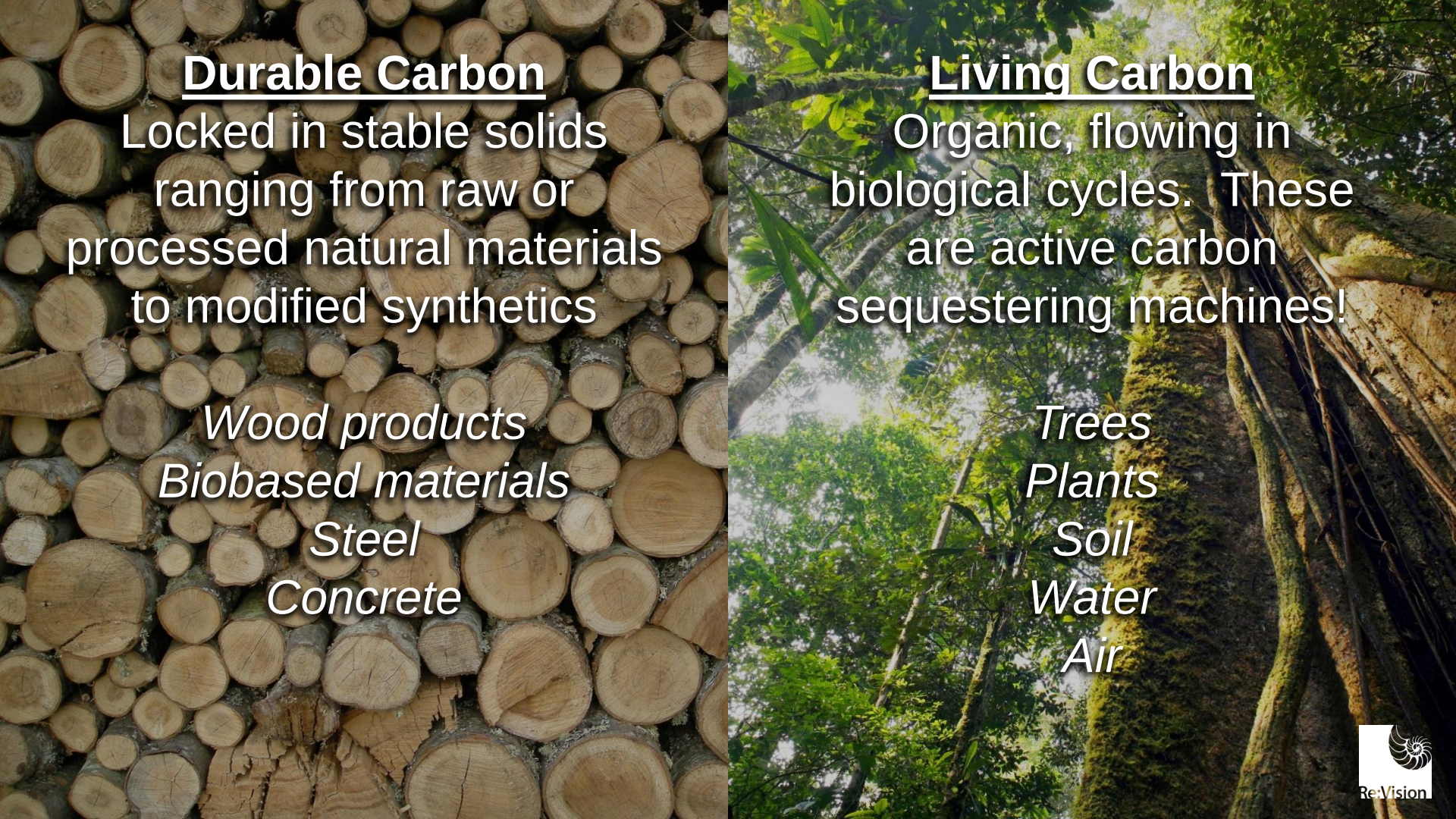
Electrification = “Decarbonization”

*Electrification, the elimination of fossil fuels from our buildings, is a critical step to both **de-** and **re-carbonizing** the built environment, but unless we address the site and source operational carbon it is not enough.*

Sequestered Carbon

Carbon our stuff is storing or capturing

Re:Vision



Durable Carbon

Locked in stable solids ranging from raw or processed natural materials to modified synthetics

Wood products
Biobased materials
Steel
Concrete

Living Carbon

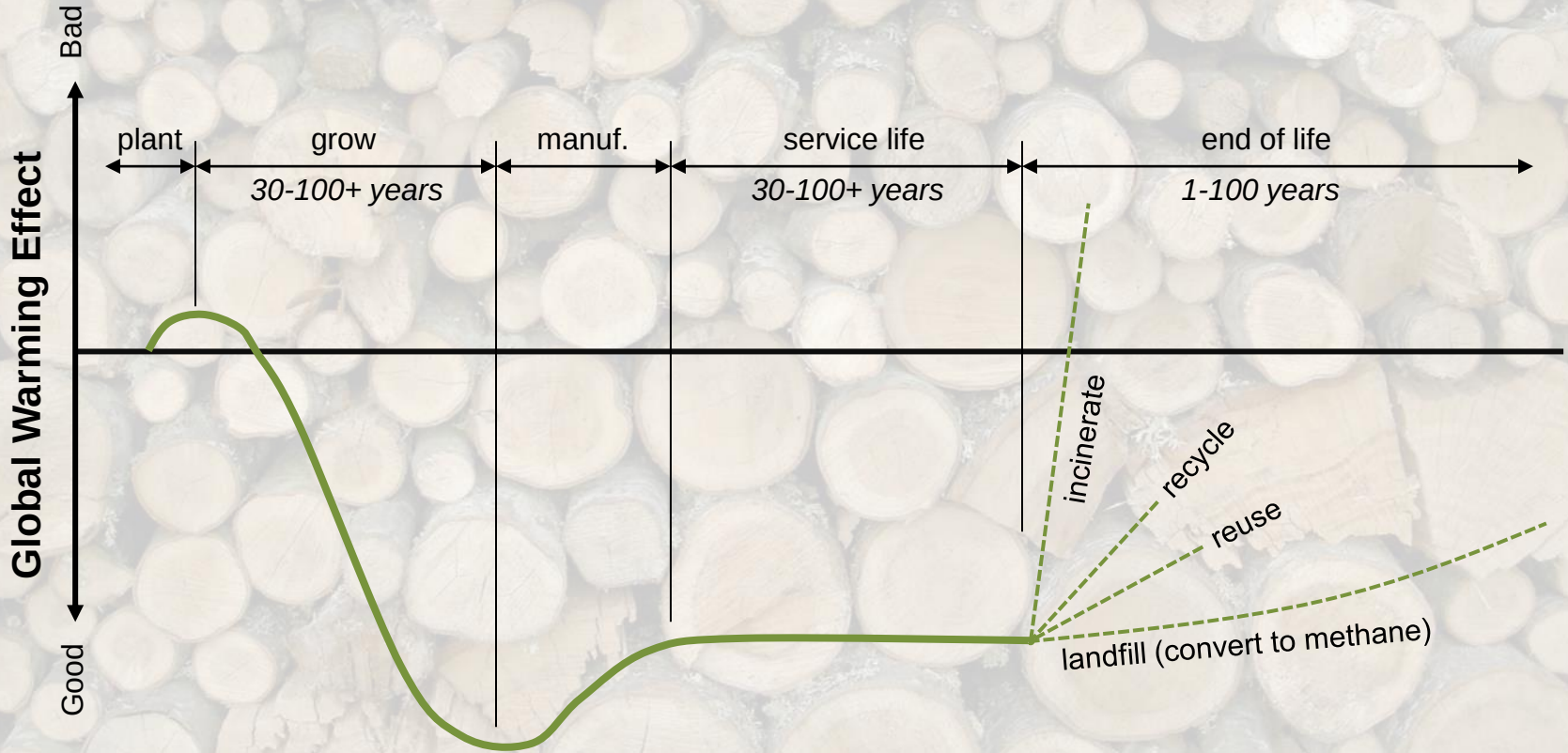
Organic, flowing in biological cycles. These are active carbon sequestering machines!

Trees
Plants
Soil
Water
Air

Re:Vision

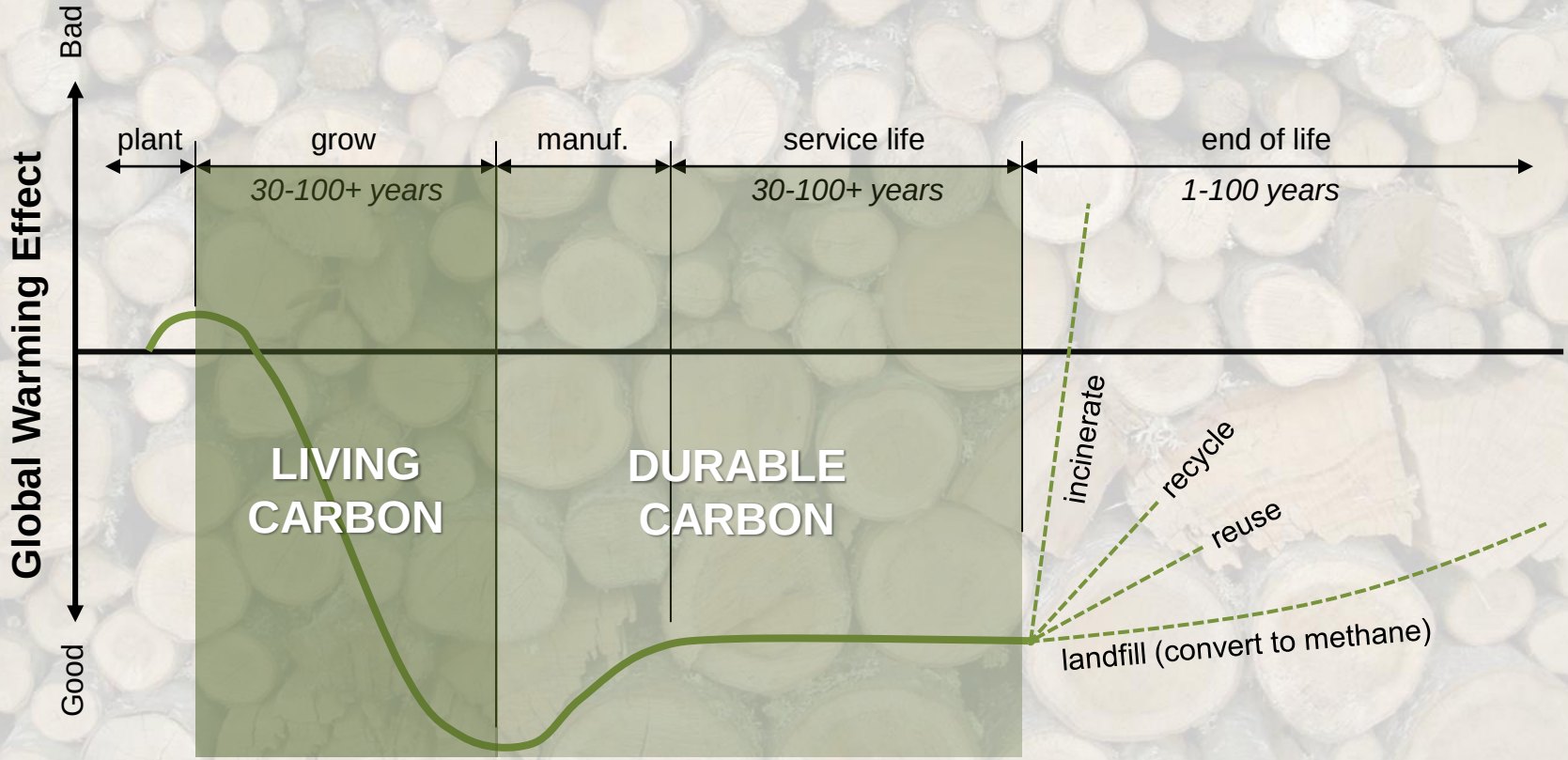
Wood Product Lifetime Carbon Emissions

The New Carbon Architecture, Bruce King



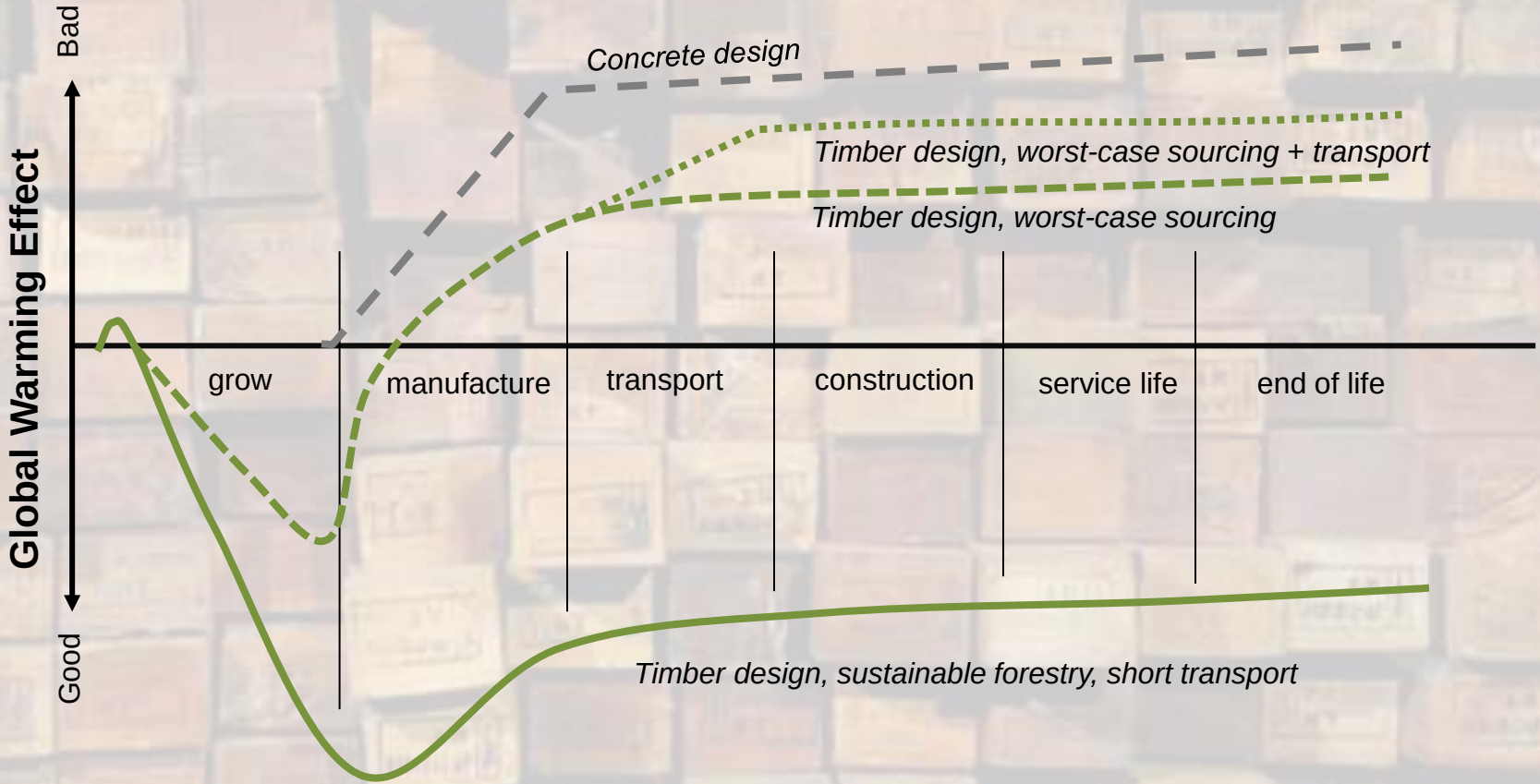
Wood Product Lifetime Carbon Emissions

The New Carbon Architecture, Bruce King



Wood vs. Concrete Design Lifetime Carbon Emissions

The New Carbon Architecture, Bruce King



TRUE OR FALSE:

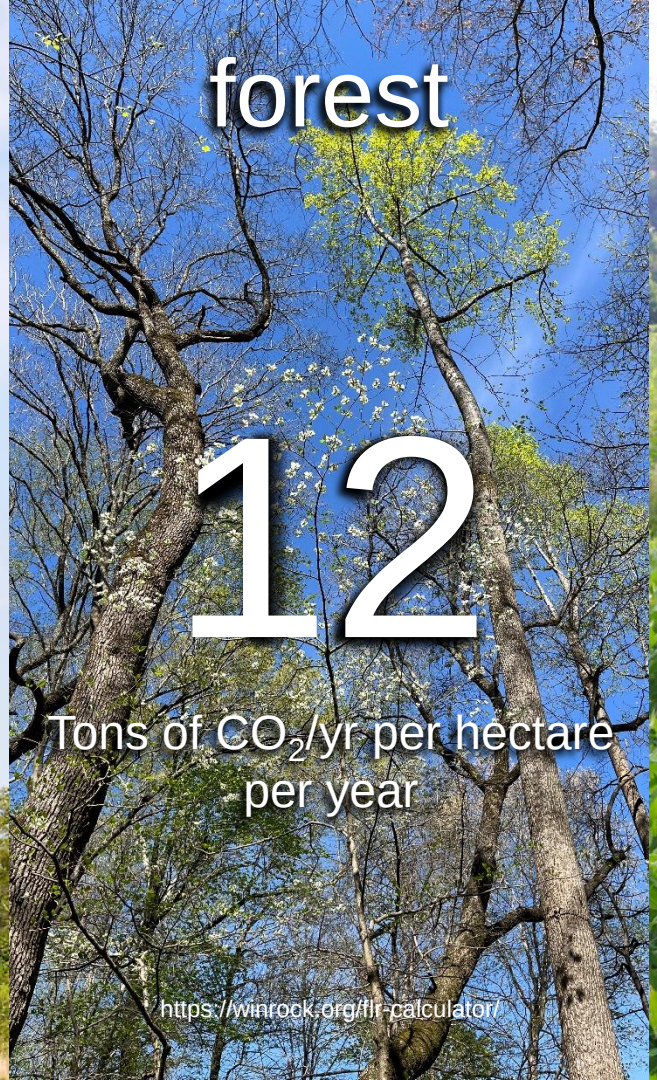
Meadows sequester more carbon than forests.

TRUE OR FALSE:

Meadows sequester more carbon than forests.

Emerging data shows that healthy meadows can sequester more carbon than forests. Doing so builds deep resilient soil which holds carbon and nurtures ecosystems.


tree
22
Pounds of CO_2/yr
first 20 years
https://onetreeplanted.org


forest
12
Tons of CO_2/yr per hectare
per year
https://winrock.org/flr-calculator/


meadow
21
Tons of CO_2/yr per hectare
per year
Tahoe Regional Planning Agency

Sequestered Carbon Case Study

Aerzen USA Office + Manufacturing Facility

DURABLE CARBON SEQUESTRATION

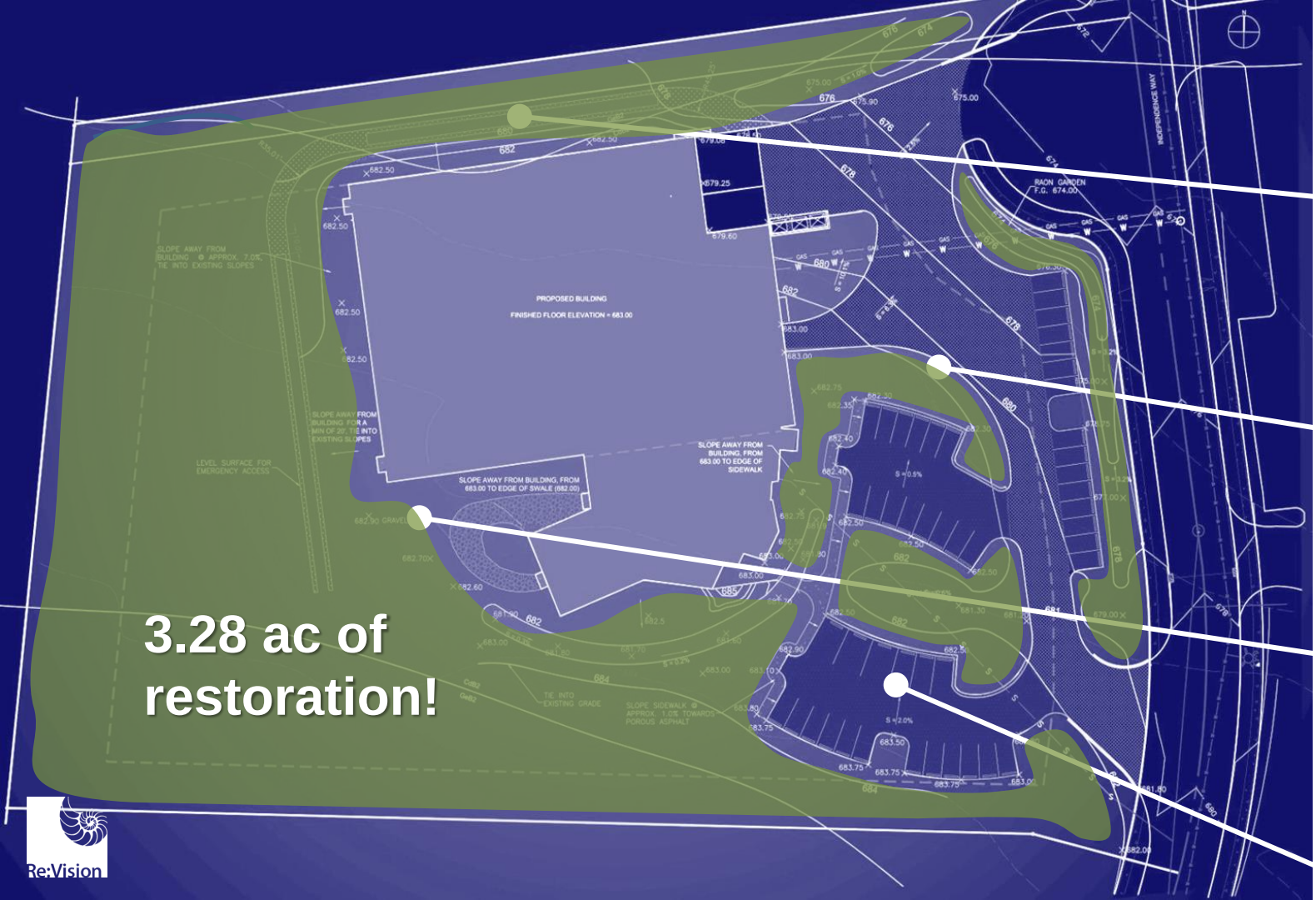
Straw Bale Walls

Paralam Structural Frame

FSC Certified Wood

Bio-based Flooring

Re:Vision


PROPOSED BUILDING
FINISHED FLOOR ELEVATION = 683.00
SLOPE AWAY FROM BUILDING, FROM 683.00 TO EDGE OF SWALE (682.00)
SLOPE AWAY FROM BUILDING, FROM 683.00 TO EDGE OF SIDEWALK
LEVEL SURFACE FOR EMERGENCY ACCESS
INDEPENDENCE WAY
RAON GARDEN
F.G. 674.00
3.28 ac of restoration!


Planted Fire Lane


Rain Gardens


Restored Meadows


Porous Pavement

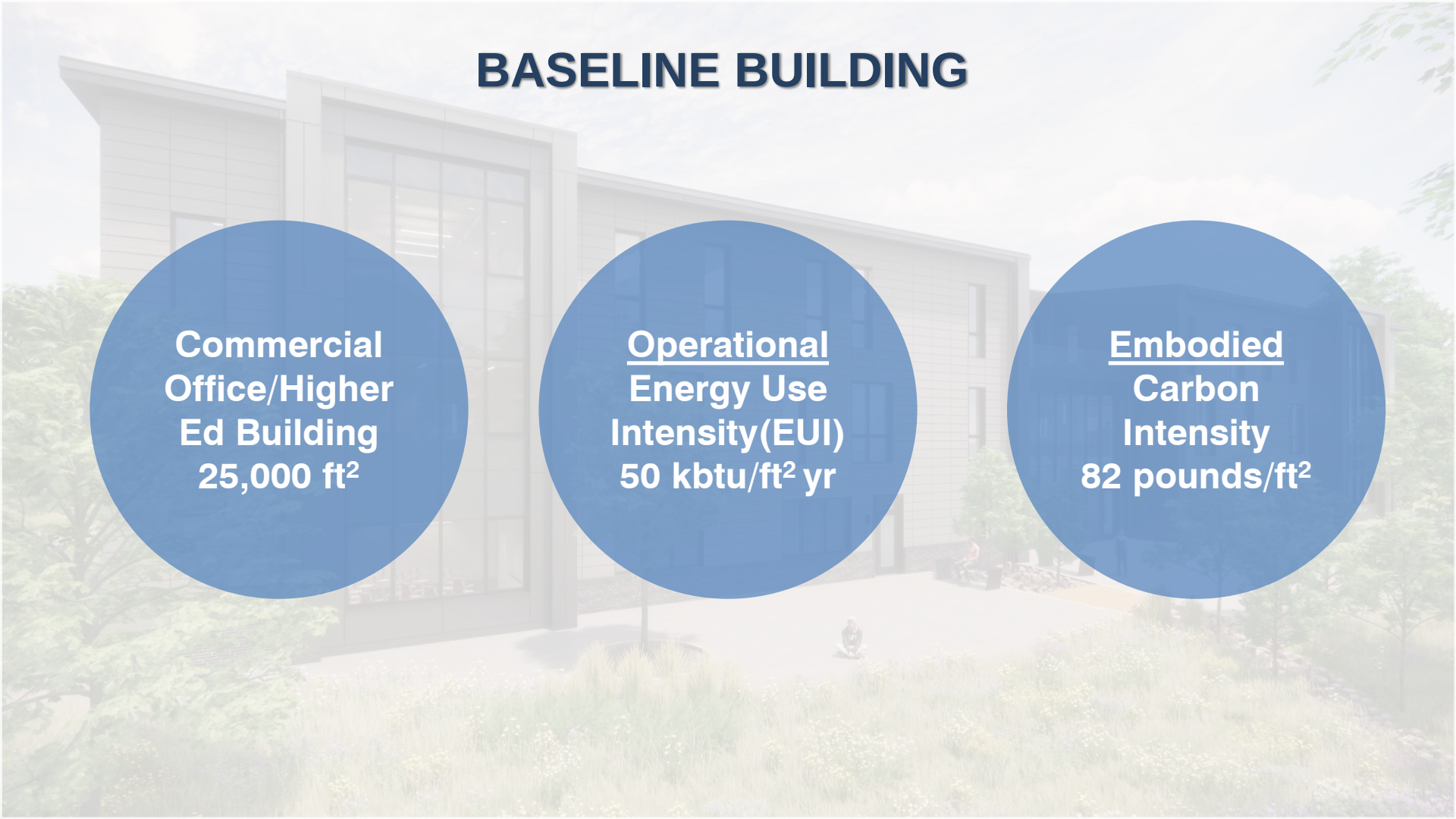
3.28 acres of thriving meadow sequesters 55,860 pounds of carbon per year!

1 acre sequesters 16,800 lbs CO_2/yr


recarbonization
Now, let's put this all together!
Re:Vision


METROPOLIS
PLANET POSITIVE
AWARDS
2023 WINNER
Fahy Commons, Muhlenberg College
Construction Complete Late 2022
LBC Core + LEED Platinum
Re:Vision

BASELINE BUILDING



Commercial Office/Higher Ed Building
25,000 ft^2

<u>Operational</u>
Energy Use Intensity(EUI)
50 $kbtu/ft^2$ yr

<u>Embodied</u>
Carbon Intensity
82 $pounds/ft^2$

BASELINE BUILDING

Commercial Office/Higher Ed Building
25,000 ft^2

30 years

Operational
Annual Carbon Intensity
15 pounds/ft^2

11,250,000 Pounds CO_2e

Embodied
Carbon Intensity
82 pounds/ft^2

2,050,000 Pounds CO_2e

STEP 1: BUILD LESS

Commercial Office/Higher Ed Building
20,000 ft^2

30 years
80% of baseline

<u>Operational</u>
Annual Carbon Intensity
15 pounds/ft^2

9,000,000
Pounds CO_2e

<u>Embodied</u>
Carbon Intensity
82 pounds/ft^2

1,640,000
Pounds CO_2e

STEP 2: DEEP ENERGY EFFICIENCY

(reduce EUI to 20!)

Commercial Office/Higher Ed Building
20,000 ft²

30 years
40% of baseline

Operational
Annual Carbon Intensity
6 pounds/ft²

3,600,000
Pounds CO_2e

Embodied
Carbon Intensity
82 pounds/ft²

1,640,000
Pounds CO_2e

STEP 3: REDUCE EMBODIED CARBON OF STRUCTURE AND ENCLOSURE

Commercial Office/Higher Ed Building
20,000 ft²

30 years
37% of baseline

Operational
Annual Carbon Intensity
6 pounds/ft²

3,600,000
Pounds CO_2e

Embodied
Carbon Intensity
64 pounds/ft²

1,280,000
Pounds CO_2e

STEP 4: REDUCE EMBODIED CARBON OF INTERIORS

Commercial Office/Higher Ed Building 20,000 ft^2

30 years

34% of baseline

Operational Annual Carbon Intensity 6 pounds/ft^2

3,600,000 Pounds CO_2e

Embodied Carbon Intensity 48 pounds/ft^2

960,000 Pounds CO_2e

STEP 5: RENEWABLE ENERGY (PV – 70%)

Commercial Office/Higher Ed Building 20,000 ft^2

30 years

15% of baseline

Operational
Annual Carbon Intensity
1.8 pounds/ft^2

1,080,000
Pounds CO_2e

Embodied
Carbon Intensity
48 pounds/ft^2

960,000
Pounds CO_2e

STEP 6: ADD BACK TRANSMISSION LOSS ☹

Commercial Office/Higher Ed Building 20,000 ft^2

30 years

37% of baseline

Operational Annual Carbon Intensity 5 pounds/ft^2

3,024,000 Pounds CO_2e

Embodied Carbon Intensity 48 pounds/ft^2

960,000 Pounds CO_2e


Let’s put the site to work…

Half hectare meadow restoration!

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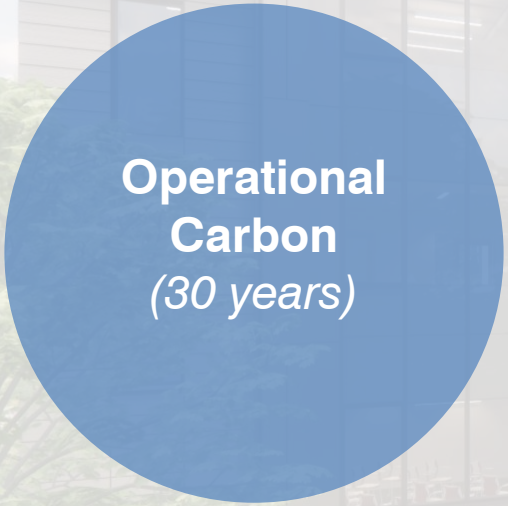
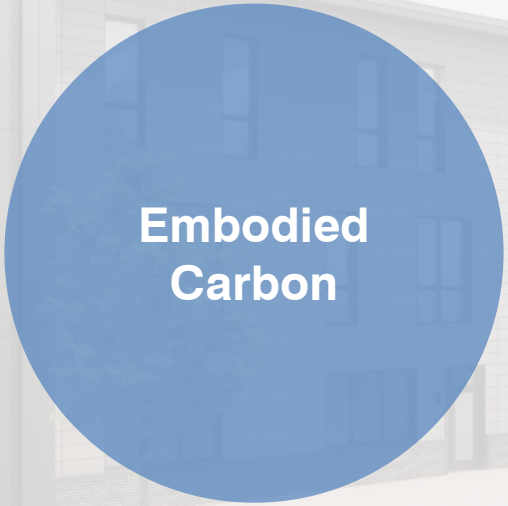
STEP 7: PUT THE SITE TO WORK



3,024,000
Pounds CO_2e



960,000
Pounds CO_2e

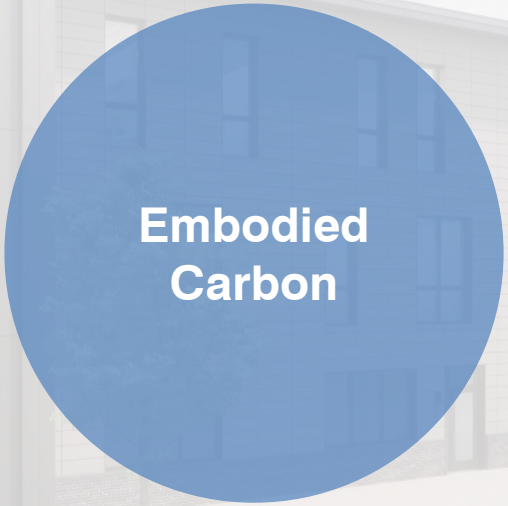
330,000
Pounds CO2e


So, all of that hard work and we’re still not “restorative”?

ANSWER – Go for Net-zero energy!

(PV system sized at 110%)

330,000
Pounds CO2e



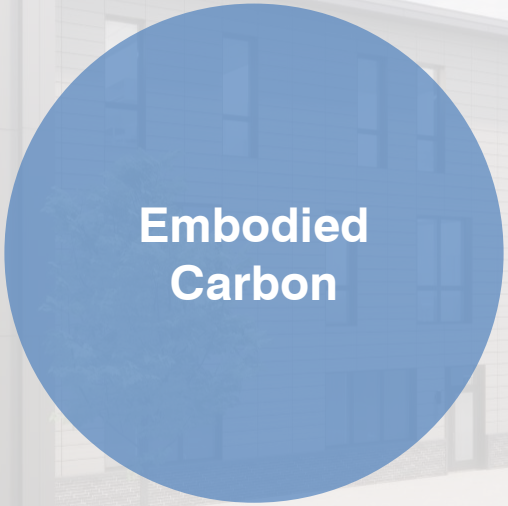
960,000
Pounds CO_2e

-630,000
Pounds CO2e

EVEN BETTER – NZE + Double Meadow!

(we are working with Muhlenberg on this)

-360,000
Pounds CO2e



960,000
Pounds CO_2e

-1,260,000
Pounds CO2e

OUR OWN LESSONS LEARNED FROM THIS

30 years is too long to pay off our carbon debt

Operational Carbon

Net-positive energy is critical

Embodied Carbon

Adaptive-reuse would speed up the payback

Sequestered Carbon

More meadow would speed up the payback

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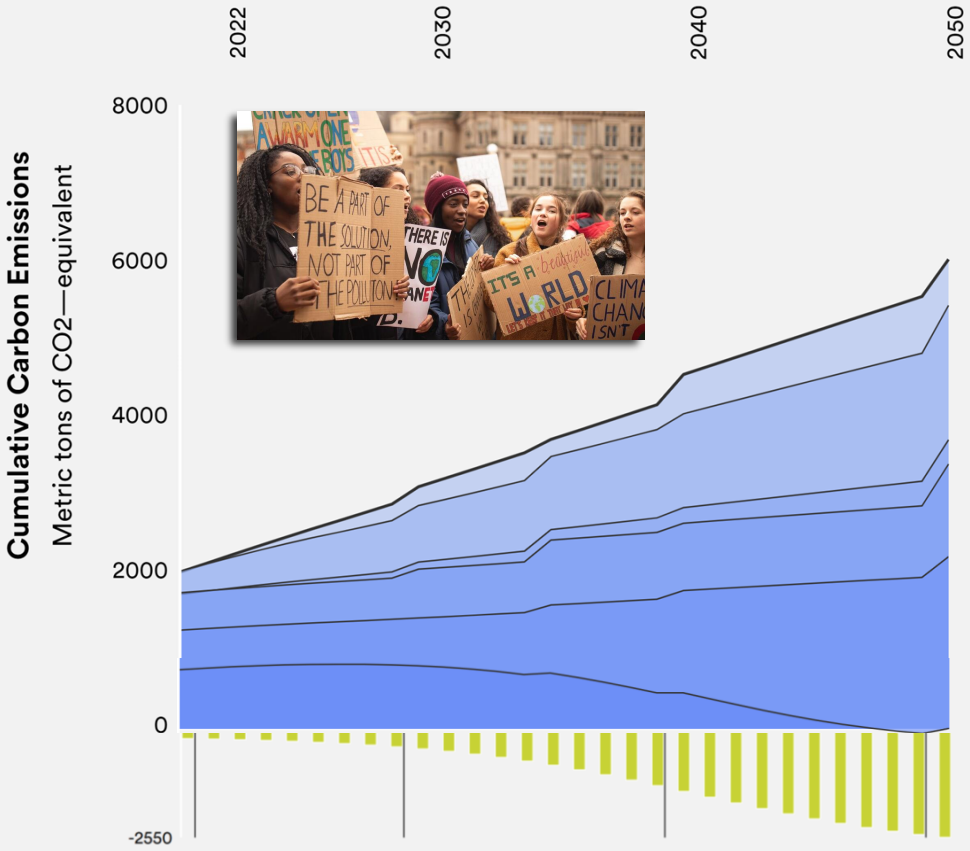
day 7 | sunday

we have a lot of work to do!

Recarbonization action plan

Marching orders for your work in the built environment:



1. Develop a Recarbonization Plan at the start of your projects!
2. 100% Electric - No more fossil fuels.
3. Reduce EUI
4. Add renewable energy
5. Reuse existing carbon and / or
6. New material to be low-carbon and/or carbon sequestering.
7. Put your site to work to actively sequester carbon.

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thank you!

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