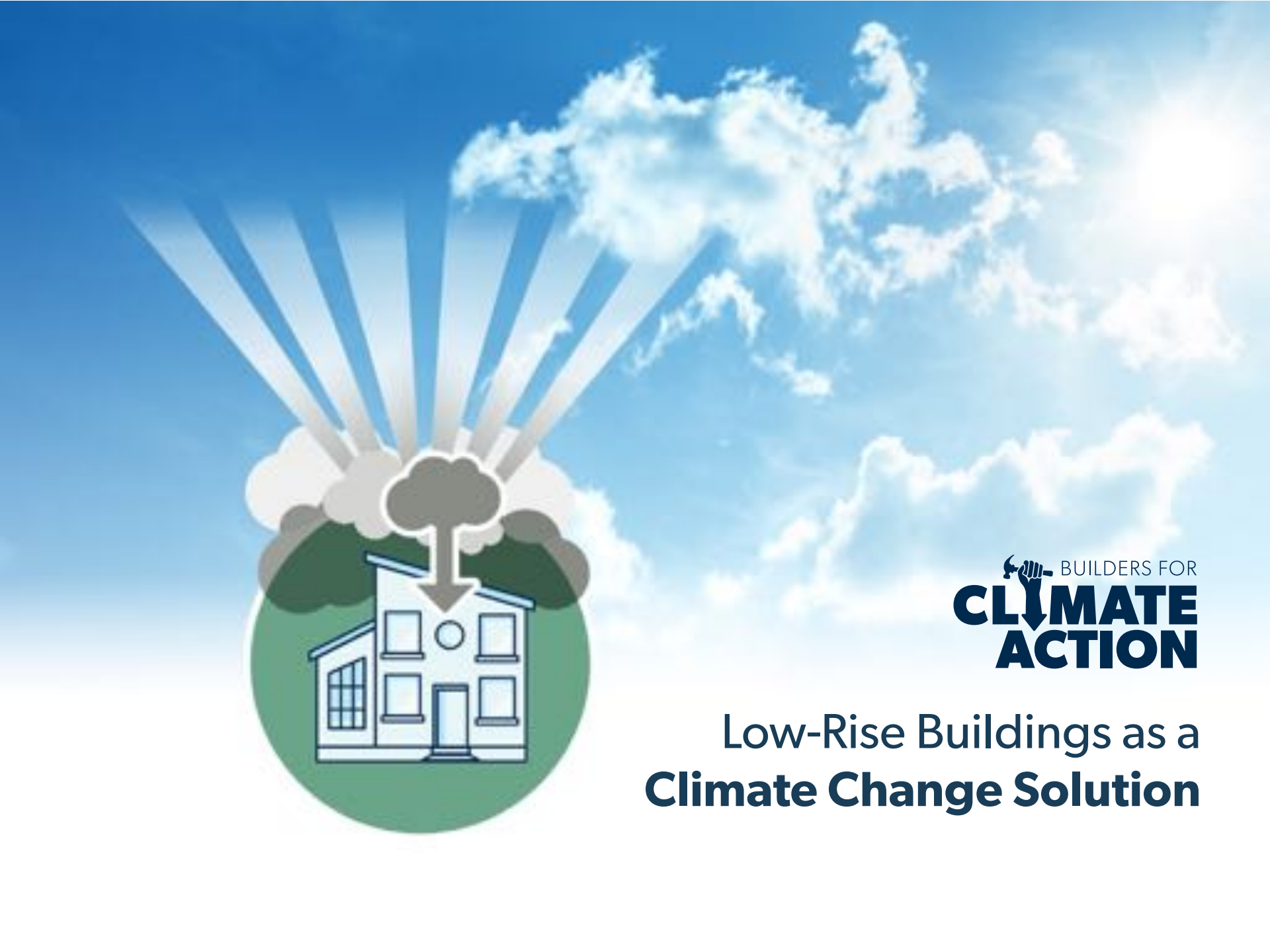


BUILDERS FOR CLIMATE ACTION

Low-Rise Buildings as a **Climate Change Solution**

Chris Magwood

Director, Endeavour Centre

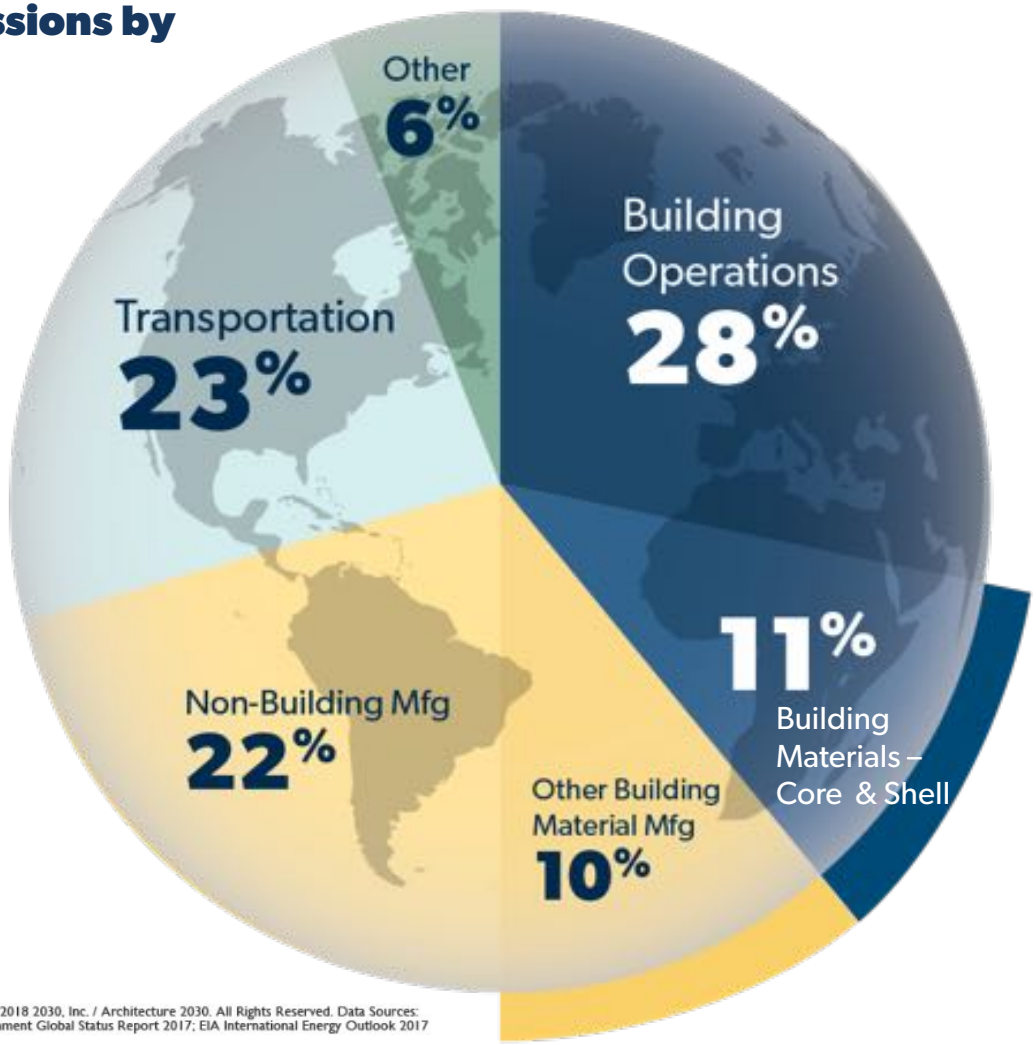
Director, Builders for Climate Action

Task Force Leader, Renewable Materials, Carbon Leadership Forum

MA, Trent University, Opportunities for CO_2 Storage in Building Materials

How much do buildings CONTRIBUTE TO CLIMATE CHANGE?

Total global emissions by sector, 2017



We can't meet global targets without addressing buildings

Material Embodied Carbon

Definition of Terms

EXTRACTION + TRANSPORTATION + MANUFACTURING

Expressed as $kgCO_2e/m^2$

Biogenic Materials + Carbon Sink/Carbon Storage

Definition of Terms

Carbon Drawdown

Removal of atmospheric CO_2 during growth

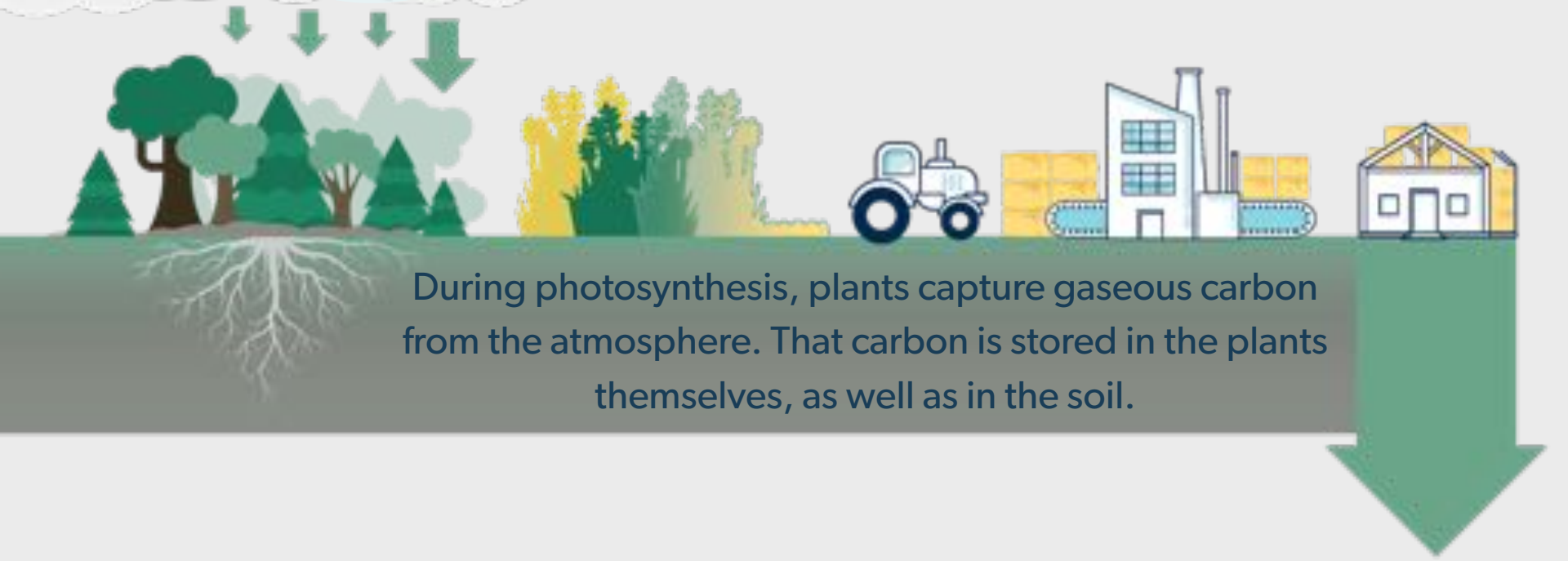
+

Carbon Emissions

Emissions from harvesting & manufacturing

=

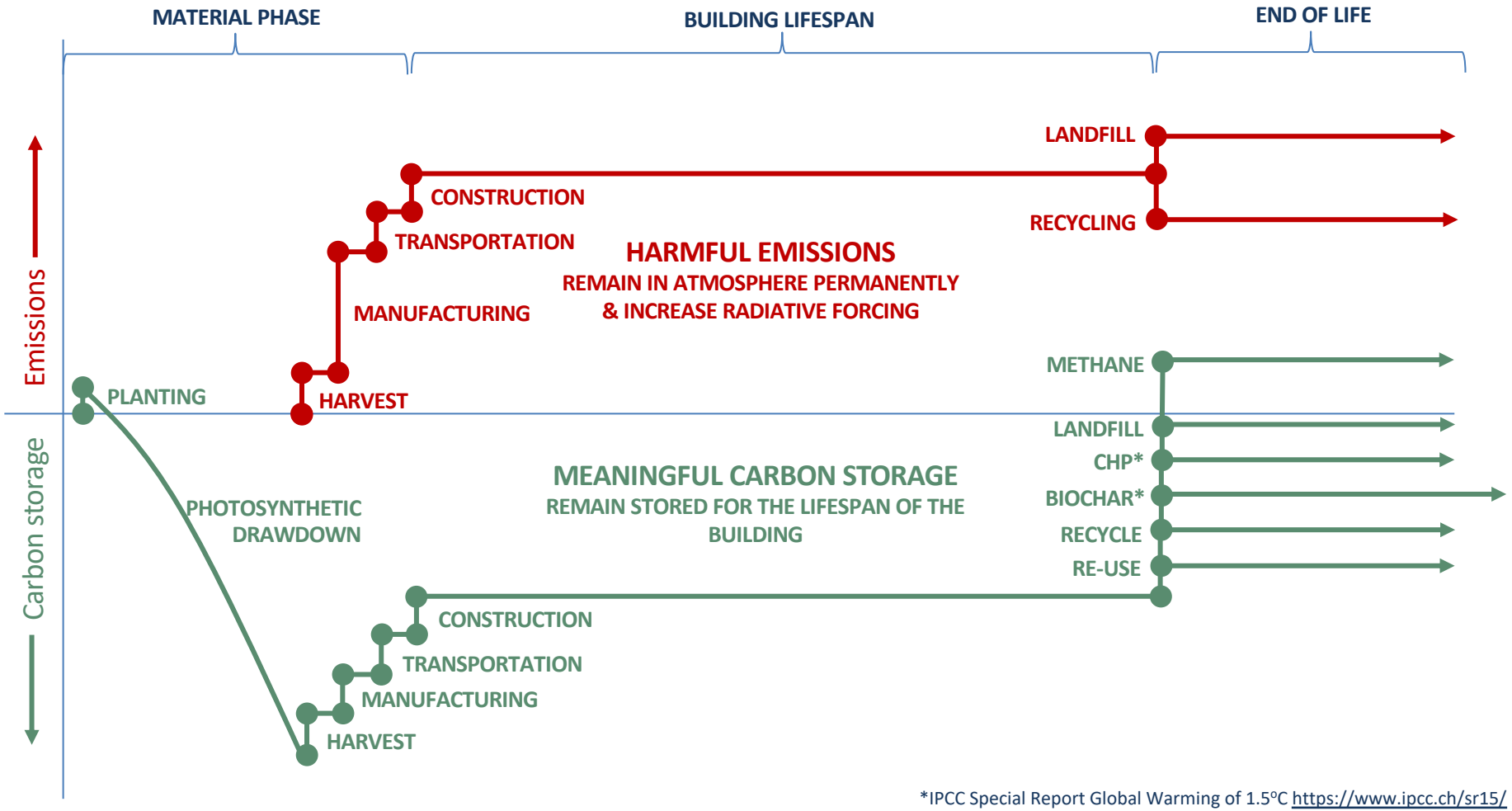
NET CARBON STORAGE



During photosynthesis, plants capture gaseous carbon from the atmosphere. That carbon is stored in the plants themselves, as well as in the soil.

Definition of Terms

The IPCC has established that “limiting warming to 1.5 degrees C will require **removing carbon from the atmosphere** in addition to reducing emissions.”*

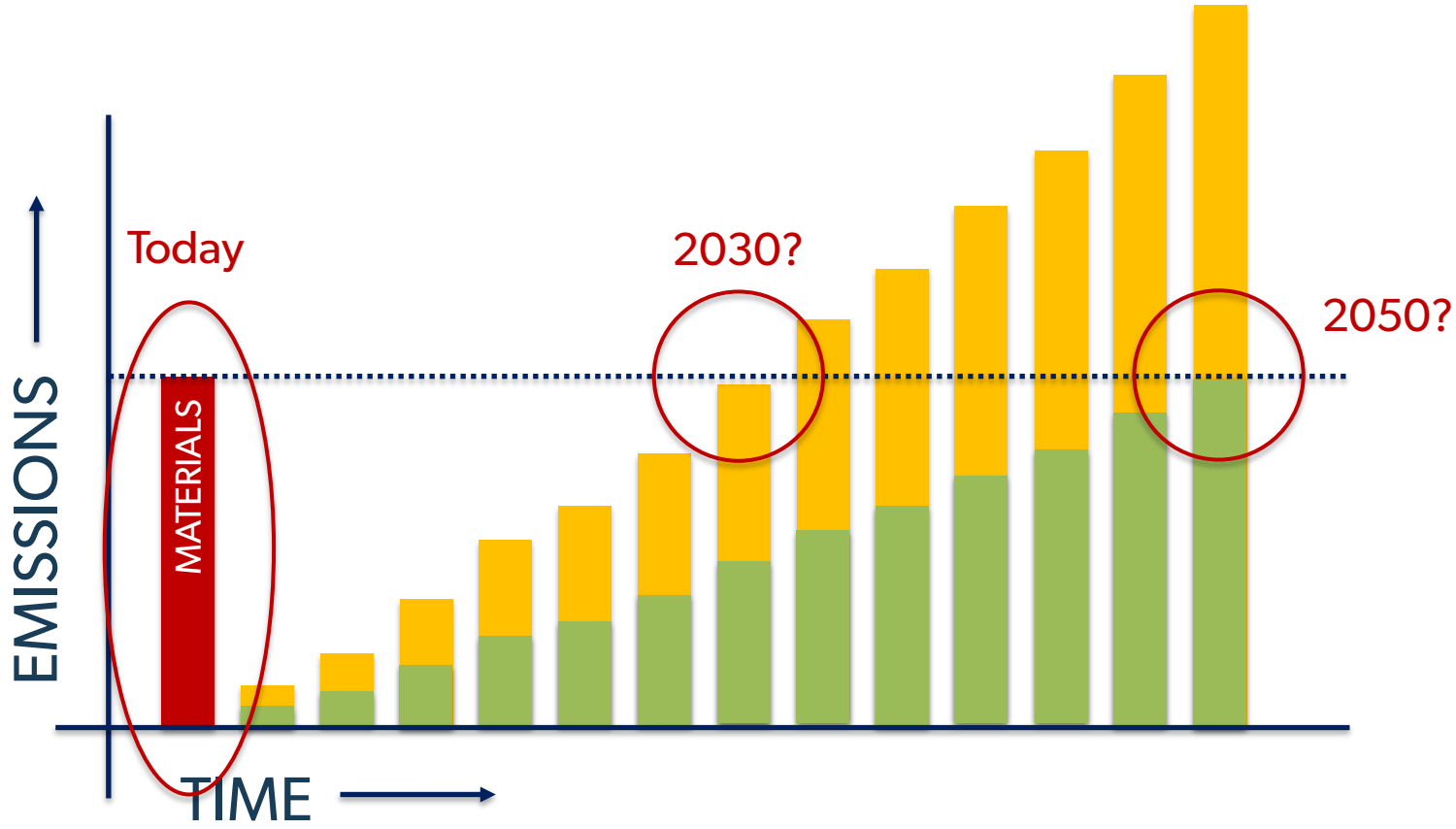


*IPCC Special Report Global Warming of 1.5ºC https://www.ipcc.ch/sr15/

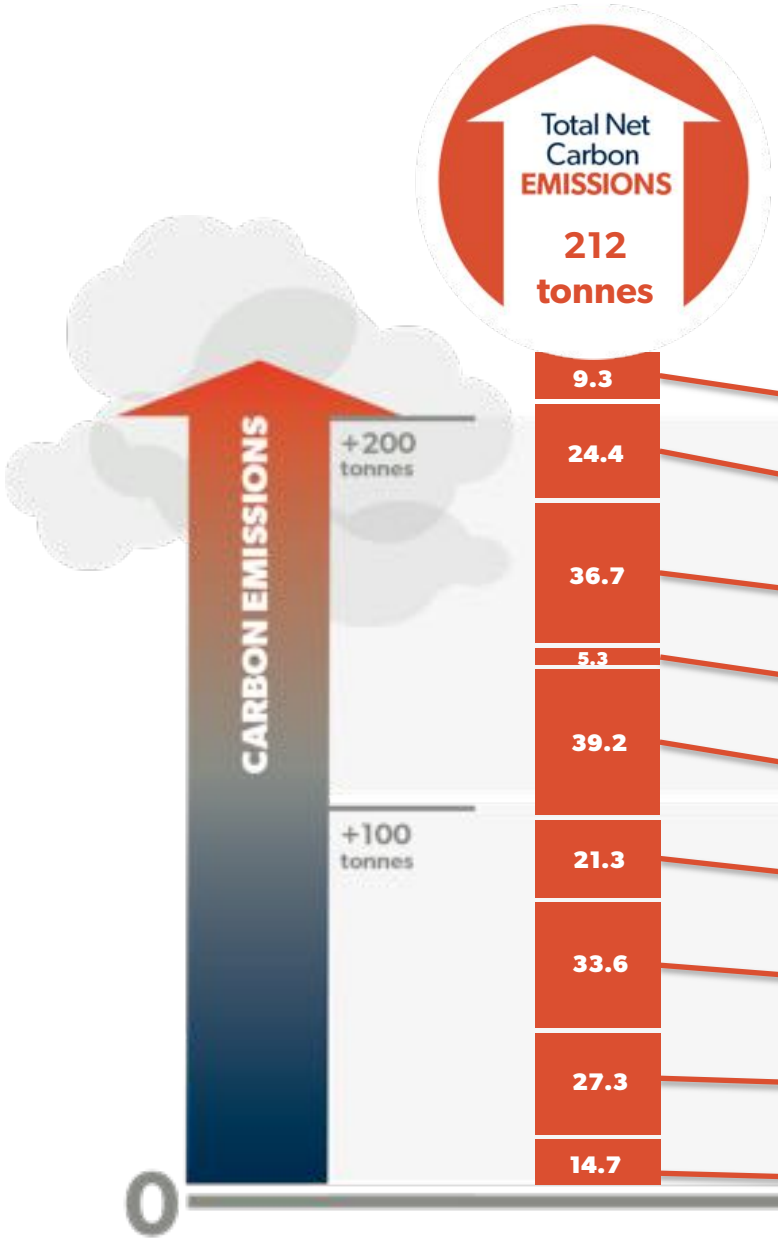
Time Value of Carbon

Definition of Terms

WE CAN'T "NET ZERO" OUR WAY OUT OF THIS !

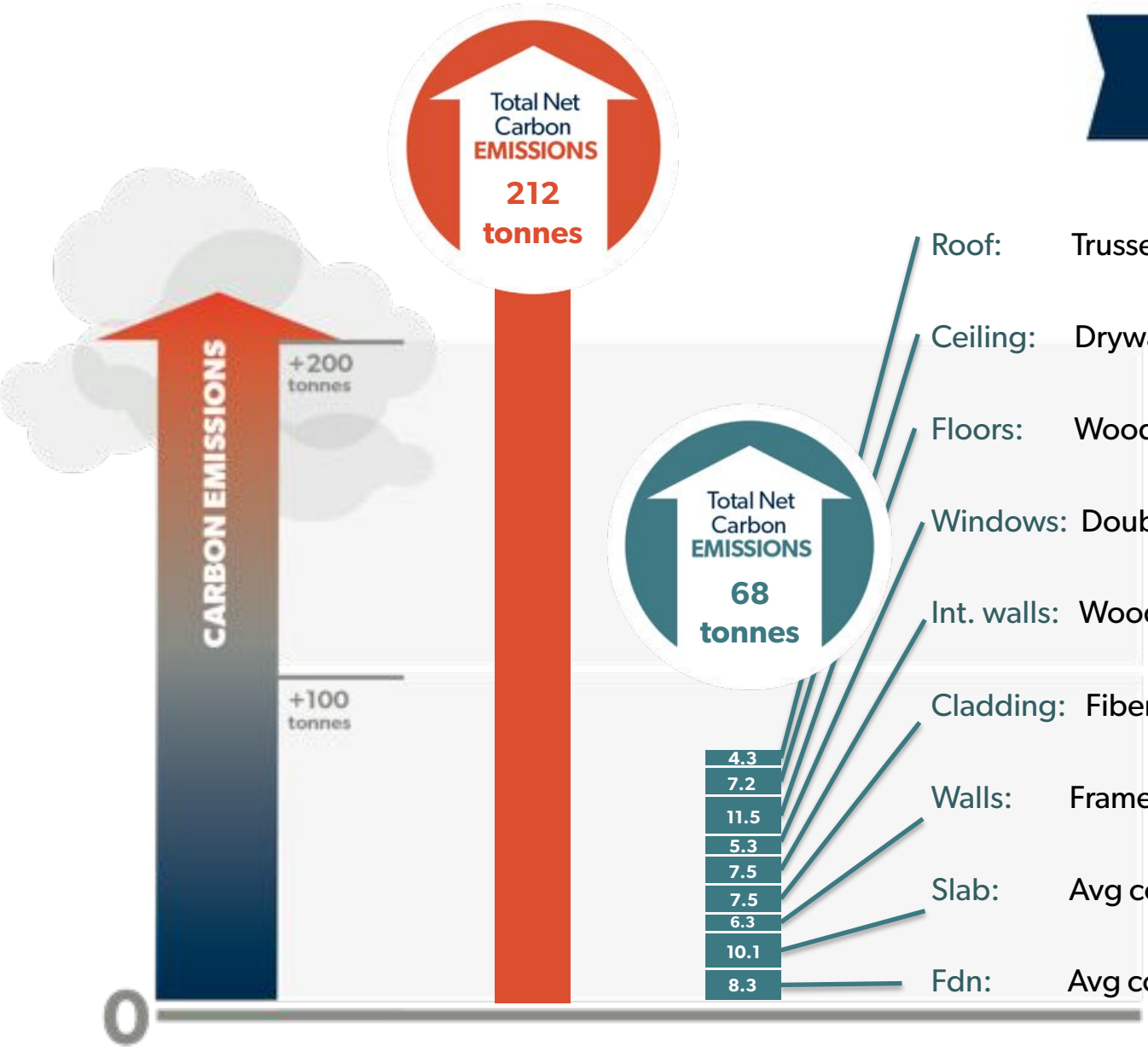


Upfront Embodied Carbon Comparison



Roof:	Trusses & OSB & clay tiles
Ceiling:	MgO board & ccSPF
Floors:	Steel joists & OSB & carpet & tile
Windows:	Double pane & vinyl frame
Int. walls:	Light steel framing & drywall
Cladding:	Cement brick
Walls:	Frame & OSB & ccSPF & XPS
Slab:	High EC concrete & XPS insulation
Fdn:	High EC concrete & XPS insulation

Upfront Embodied Carbon Comparison



Roof: Trusses & OSB & asphalt shingles

Ceiling: Drywall & mineral wool

Floors: Wood I-joists & eng. wood & vinyl

Windows: Double pane & vinyl frame

Int. walls: Wood frame & drywall

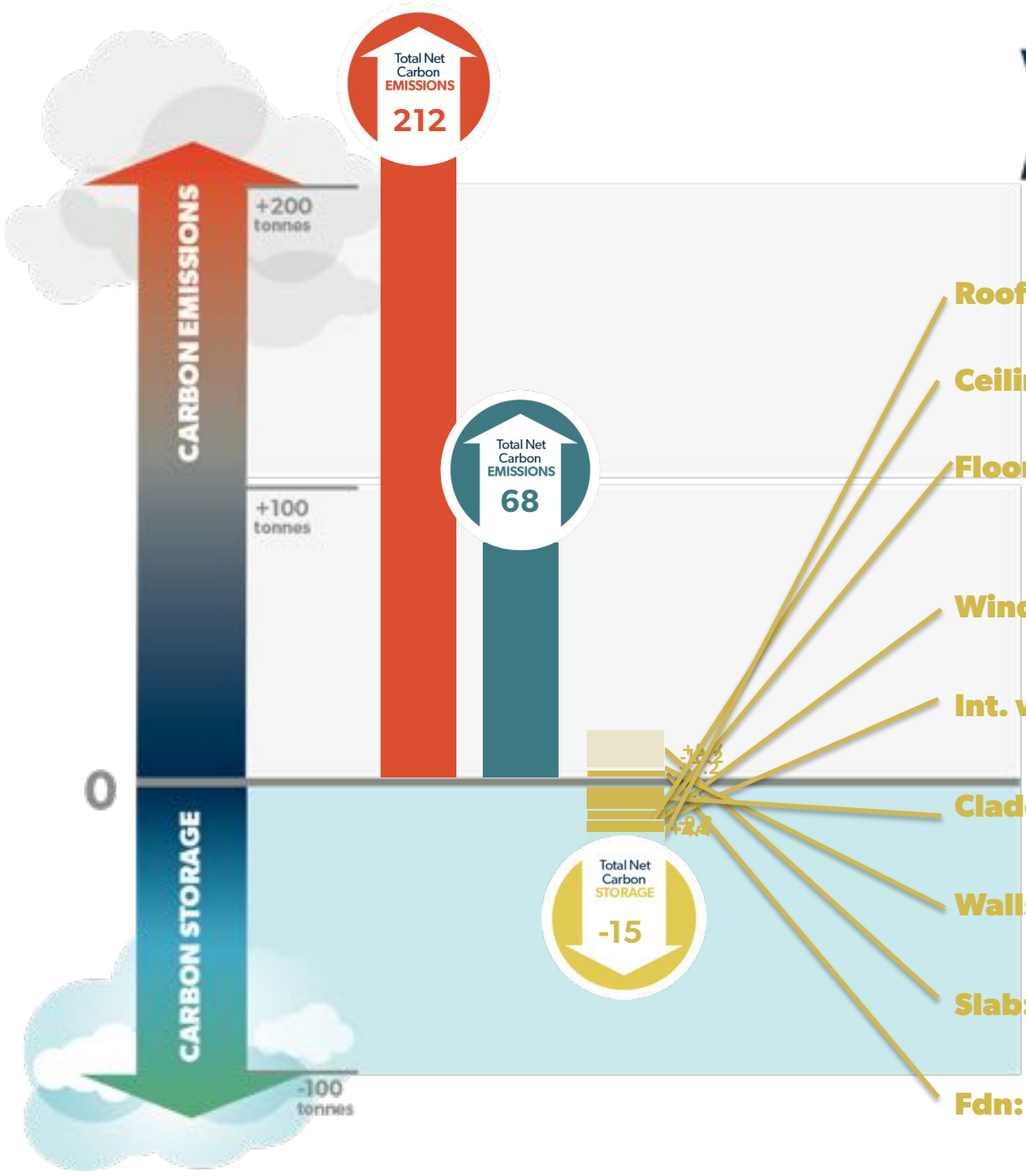
Cladding: Fiber cement

Walls: Frame & OSB & mineral wool

Slab: Avg concrete & mineral wool

Fdn: Avg concrete & mineral wool

Upfront Embodied Carbon Comparison



Roof: Trusses + plywood+ steel

Ceiling: Drywall + FSC wood + cellulose

Floors: 2x12 + plywood + FSC hardwood + engineered wood

Windows: Double pane + alum. clad wood

Int. walls: Framing + drywall + FSC wood

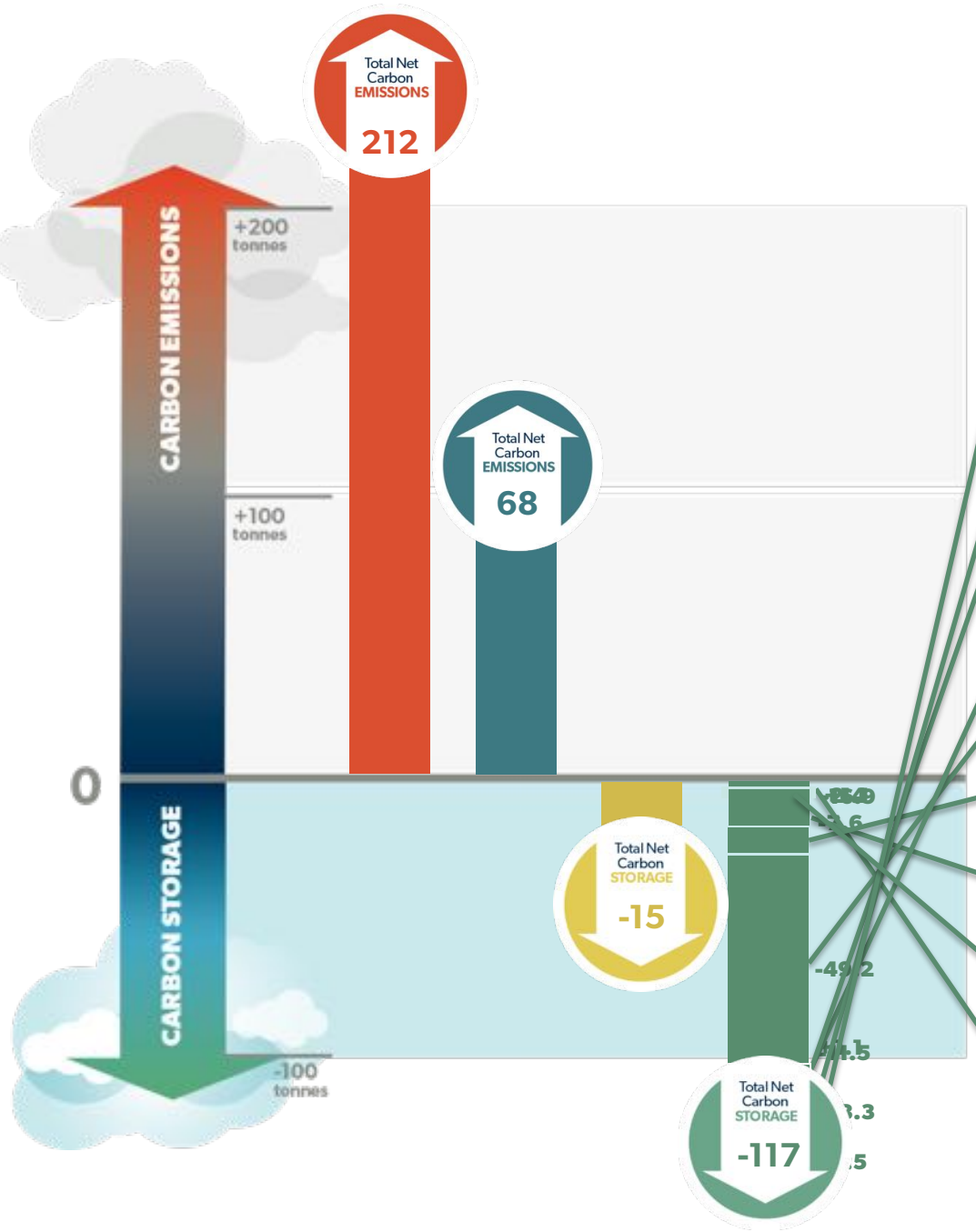
Cladding: FSC softwood

Walls: Frame + cellulose + wood fiberboard

Slab: High SCM concrete + EPS

Fdn: High SCM concrete + EPS

Upfront embodied carbon comparison



Roof: Trusses + FSC cedar shake

Ceiling: Straw insulation + ReWall

Floors: 2x12 + FSC plank + linoleum + FSC softwood

Windows: Double pane + wood frame

Int. walls: Compressed straw panels + ReWall

Cladding: FSC softwood

Walls: Double stud + straw + fiberboard

Slab: Adobe + expanded glass aggregate

Fdn: Iso-span ICF with fiberboard

The same building can have very different up-front embodied carbon emissions (UEC)

Materials Matter

High UEC

Assembly includes:

- High carbon concrete
- XPS & closed cell spray foam
- Brick cladding
- Steel interior framing
- Drywall
- Vinyl windows
- Tile & carpet flooring
- Clay tile roofing

Typical UEC

Assembly includes:

- Average carbon concrete
- Mineral wool insulation
- Fiber cement cladding
- Wood & TJI interior framing
- Drywall
- Vinyl windows
- Engineered wood & vinyl flooring
- Asphalt shingle roofing

Best Conventional UEC

Assembly includes:

- High SCM concrete
- Cellulose & wood fiberboard insulation
- Wood cladding
- Wood interior framing
- Drywall & wood walls
- Aluminum clad wood windows
- Engineered wood & FSC hardwood flooring

Best UEC

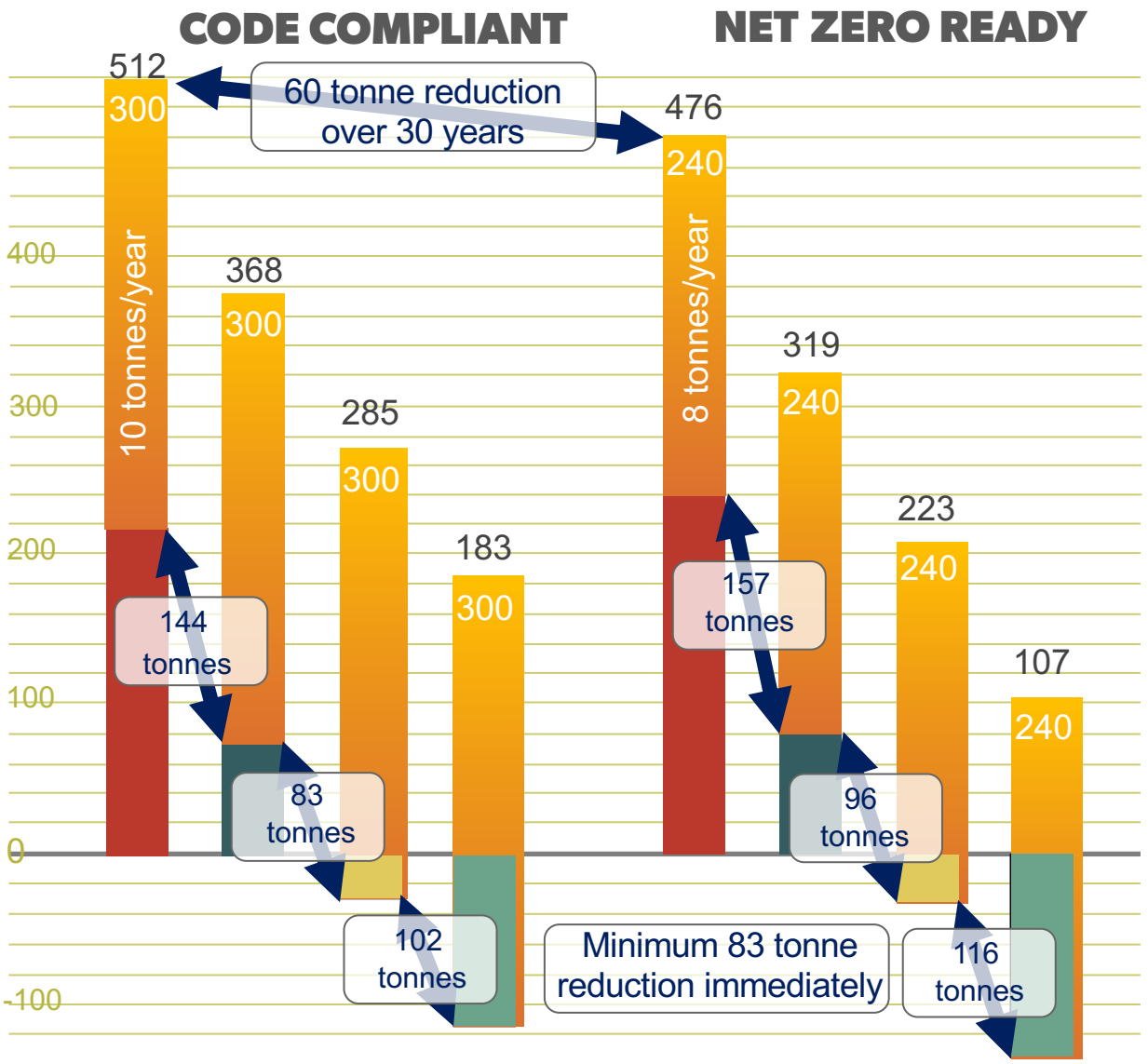
Assembly includes:

- Iso-Span ICF with high SCM concrete
- Expanded glass sub-grade insulation
- Straw & wood fiberboard insulation
- Wood cladding
- Compressed straw panel interior walls
- ReWall interior cladding
- Wood windows
- Linoleum & FSC softwood flooring
- Cedar shake roofing

Natural gas heating,

Toronto, 2020-2050

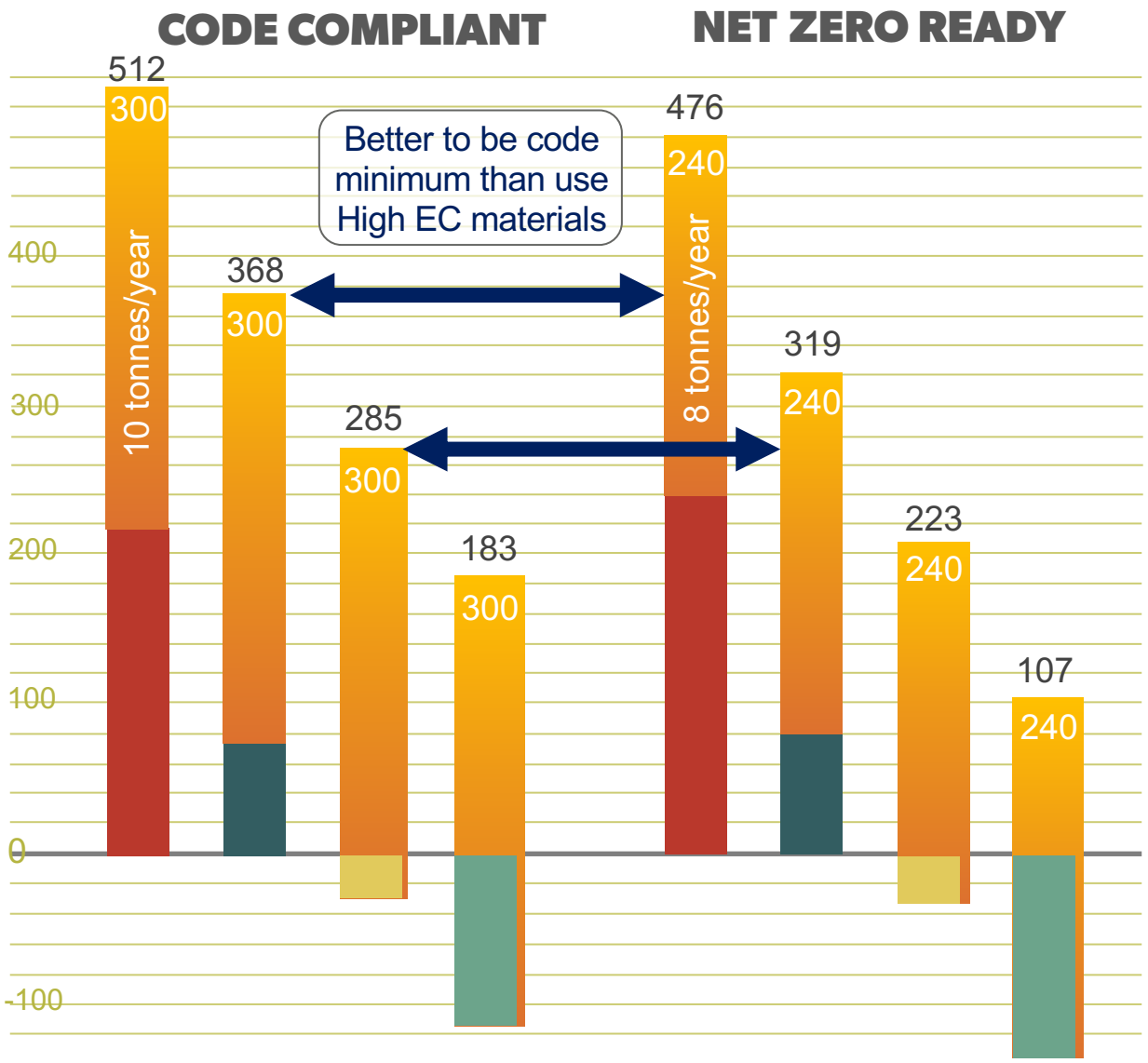
Operational carbon comparison



Natural gas heating,

Toronto, 2020-2050

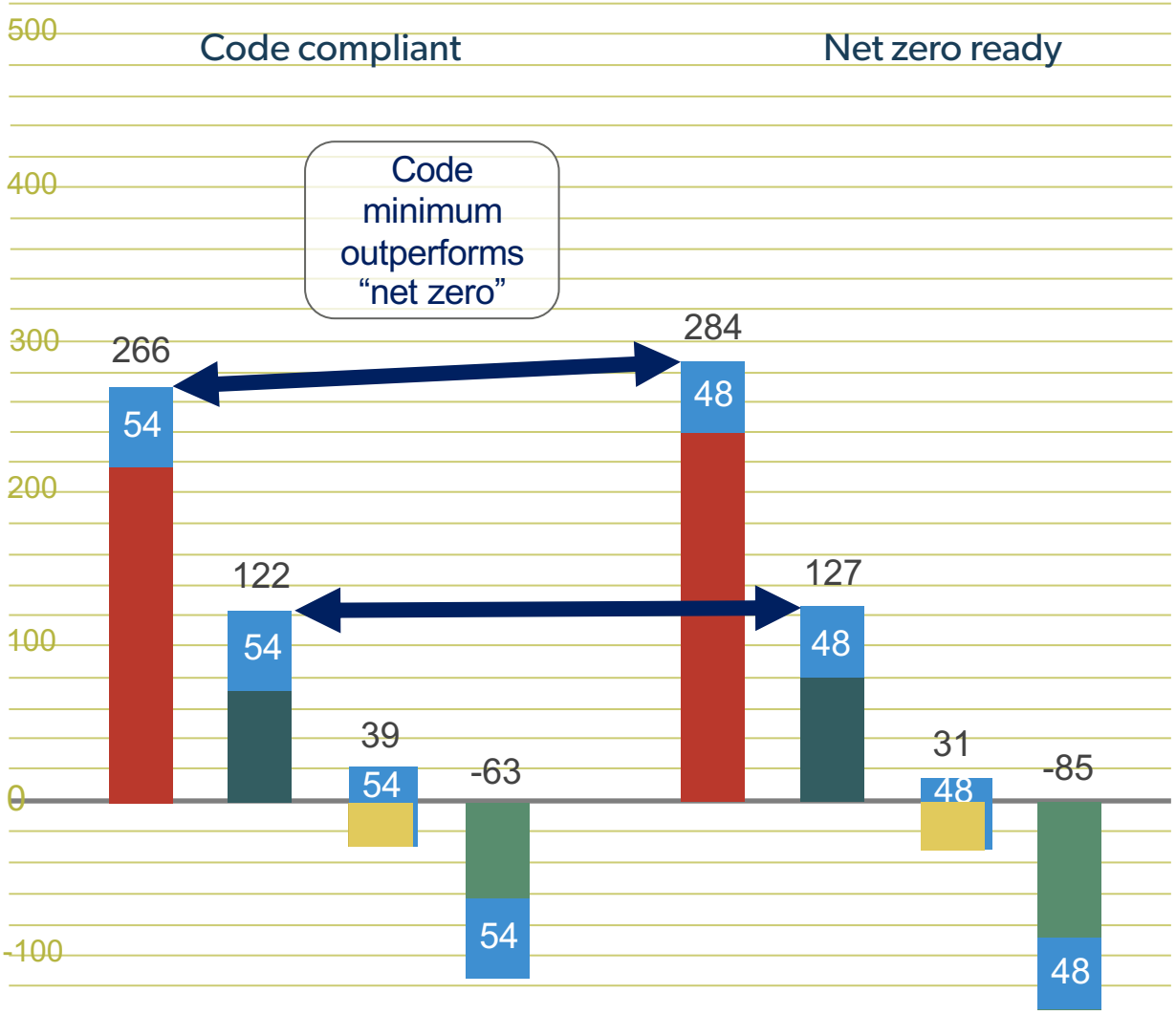
Operational carbon comparison



Air source heat pump,

Toronto, 2020-2050

Operational carbon comparison

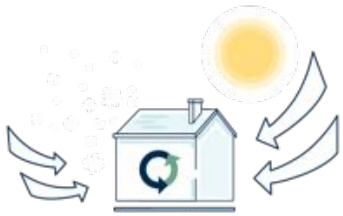


New way to DEFINE
BUILDING PERFORMANCE

Up-Front Embodied Carbon Emissions

+

Operational Carbon Emissions



ENERGY
USE INTENSITY

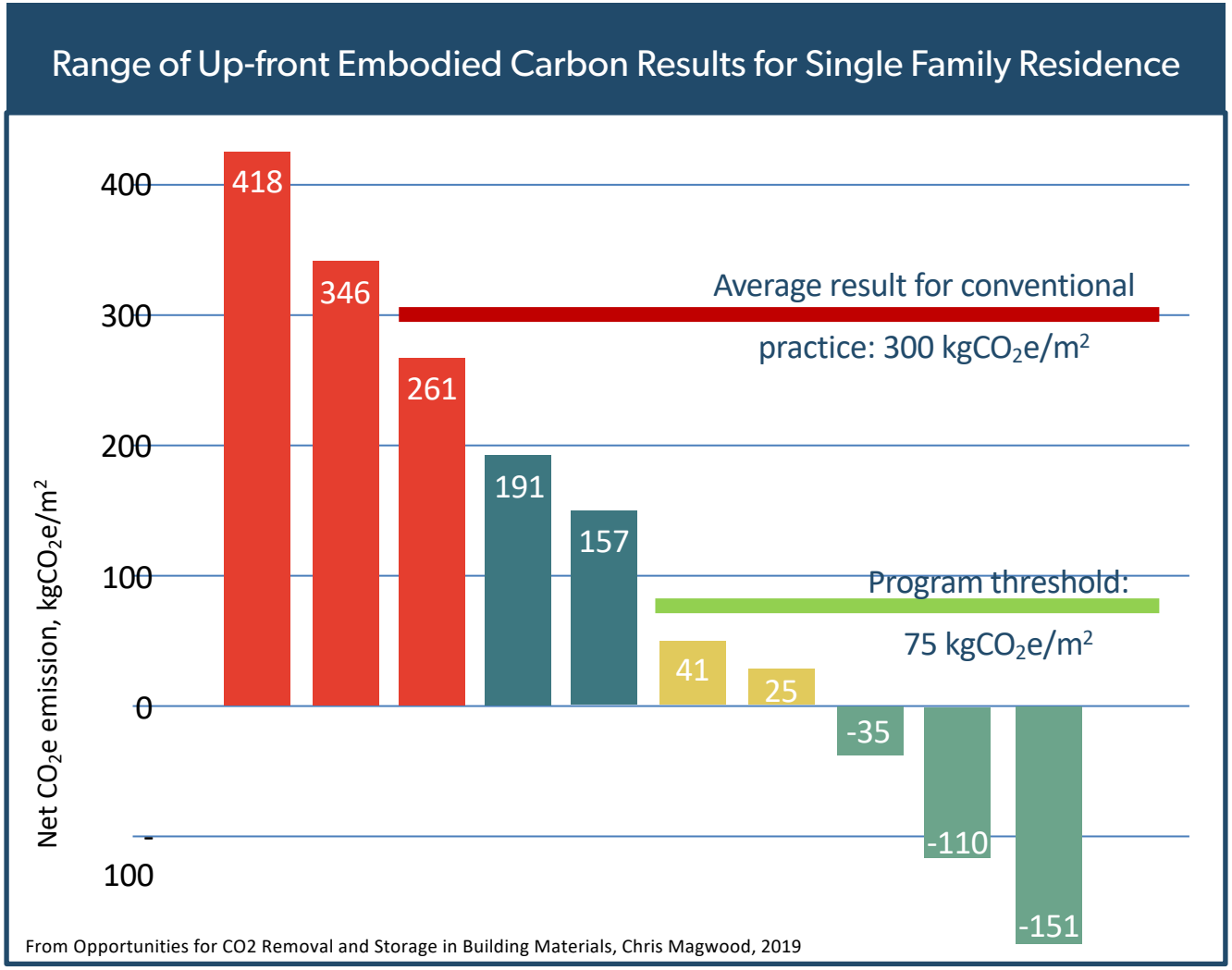
✖

ENERGY SOURCE
EMISSIONS

=

CARBON USE INTENSITY

Builders for Climate Action and Douro-Dummer Township incentive program.



Rebate to reduce 225kg/m^2 or ~50 tonnes per 2,000 square foot house!

Stacked benefits of biogenic materials

Occupant health & safety

No RED LIST chemicals
No toxic manufacturing

Local sourcing

Agricultural by-products
Forestry residues
Municipal recycling resources

Regional manufacturing

Small-medium sized facilities
Local jobs

Reduced waste

No RED LIST chemicals
Biodegradable

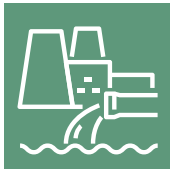
Global warming potential

Ozone depletion

Eutrophication

Acidification

Photochemical ozone creation



Depletion of abiotic resources

Depletion of fossil fuels

Zero House - Prefab modular home, net zero design

Design: Ryerson University & Endeavour Centre
100m² single unit two-bedroom
Designed to be one unit in a 16-unit development

25 tonnes net carbon storage in a single unit
400 tonnes storage potential in 16-unit development

Key carbon storing materials: Prefab straw bale walls, prefab cellulose wall, roof & floor panels, MSL Fibreboard exterior insulation board, ReWall interior sheathing, Mycofoam insulation, cork sheathing panels, FSC wood floor and plywood interior wall cladding.

Offices & Meeting Hall - Urban infill, net-positive design

Design: Endeavour Centre
225m² three offices, large meeting room, staff room

CASE STUDIES

81 tonnes net carbon storage

Key carbon storing materials: Straw bale and cellulose wall insulation, cellulose floor and roof insulation, Nexcem ICF foundation, FSC wood siding and flooring, clay plaster, sustainably harvested timber frame.

Energy: 105% on site generation
of solar electricity
0.6 ACH/50 air tightness

BUILDERS FOR CLIMATE ACTION

www.buildersforclimateaction.org

ENDEAVOUR
THE SUSTAINABLE BUILDING SCHOOL

www.endeavourcentre.org