

Carbon Drawdown Now!

Turning Buildings into Carbon Sinks

New Frameworks & Endeavour Sustainable Building School

NESEA BuildingEnergy Boston – March 14, 2019



New Frameworks

New Frameworks is committed to a kinder sort of building.. Our ecologically-minded building practices and comprehensive, full-service systems design make our buildings at home on earth while providing state-of-the-art comfort and efficiency for the people that rely on them.

More at: <https://newframeworks.com>



Endeavour Sustainable Building School

occupies a unique position in the green building world. We provide experiential education at the intersection of high-performance and natural building.

More at: <http://endeavourcentre.org>

Our Message

Our simple message:

Making carbon-storing buildings is the most impactful action the building community can undertake to address climate change.

Our “life cycle” message:

Truly addressing climate change requires us to **change our thinking**, and move beyond a narrow, mechanistic view of issues to an **interconnected style** of thinking.

Climate Change

Our simple message:

There is an overload of greenhouse gases in the atmosphere.
411 ppm and climbing.

Our “life cycle” message:

Lots of humans single-mindedly pursue a fossil-fuel economy to the exclusion of all other impacts: including human health, mass extinction, loss of biodiversity, climate change, racism, classism, sexism.

Buildings & Climate Change

Our simple message:

We must drastically reduce our building carbon emissions within a decade.

Our “life cycle” message:

Material substitutions in a business-as-usual scenario **isn't sufficient.**

We need to think outside our silos as building and design professionals and **connect our work** to that of other trades such as **sustainable forestry, eco-agriculture** and to movements for **social & climate justice.**

Climate Injustice

- Actions by the few affect the many
- With no accountability or recourse

Climate Justice

- Reconnect people across socially-reinforced divides for our common cause
- Create accountability
- Build political power to redirect resource control to the many

**We see carbon action
around buildings as
an opportunity to
decolonize our
industry.**



“**Organic matter in soils** on the plains **plummeted** by 50% in only one generation of **white settler colonialism**.... I realized that all our efforts to heal the soil entailed the **restoration of organic matter** and was, in effect, a decolonization of the soil. **We were inviting our non-human relations back onto the land and back into relationship with us.**”

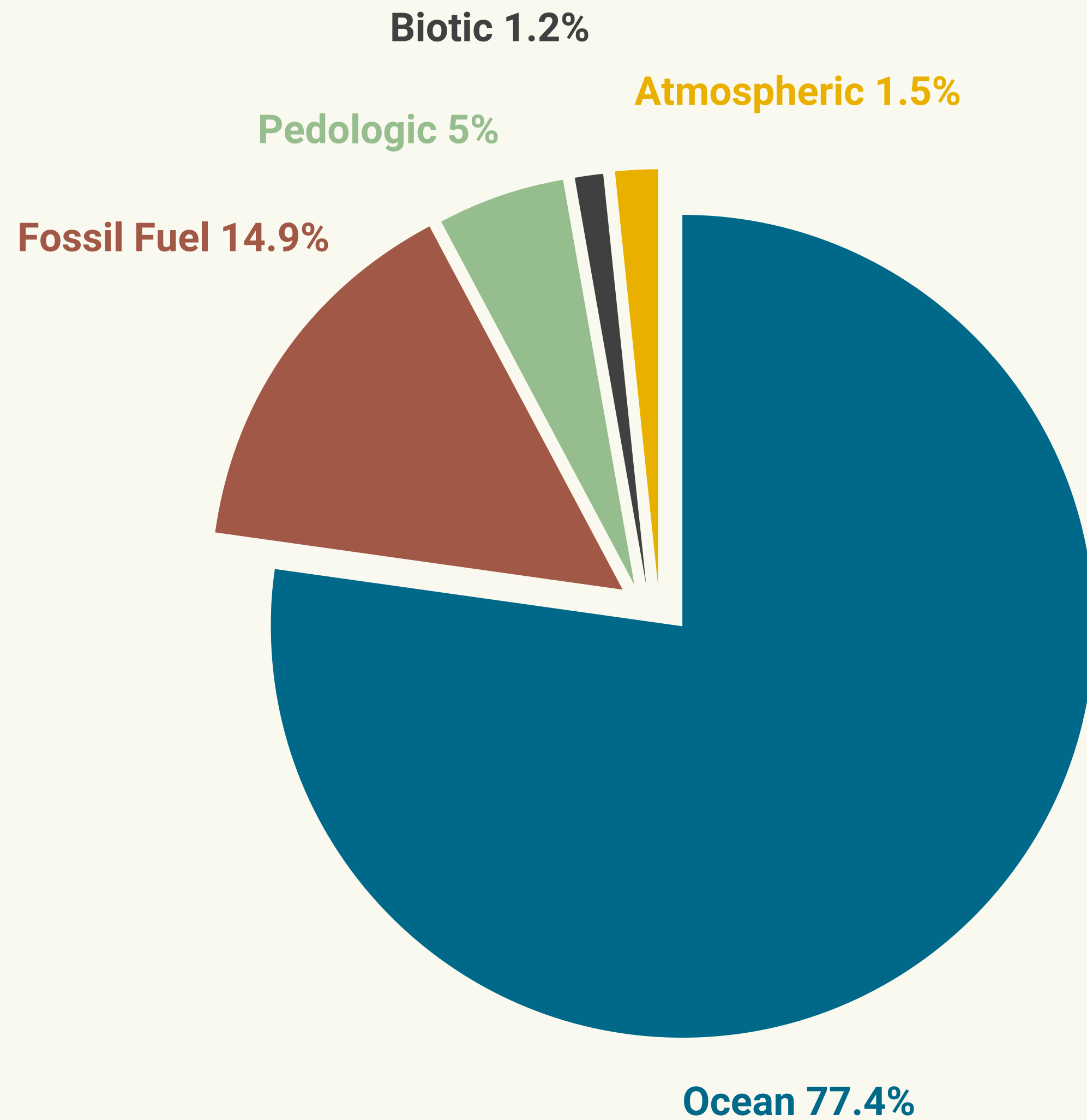
Leah Penniman,
Author of Farming While Black



Soil! The connector...

Connects agriculture, forestry, building materials. All industries & trades that interface with and harvest resources from soil are connected through soil.

It is **the meeting place**, the liminal space between organic and inorganic life. In ecology, all the action happens at the edges.



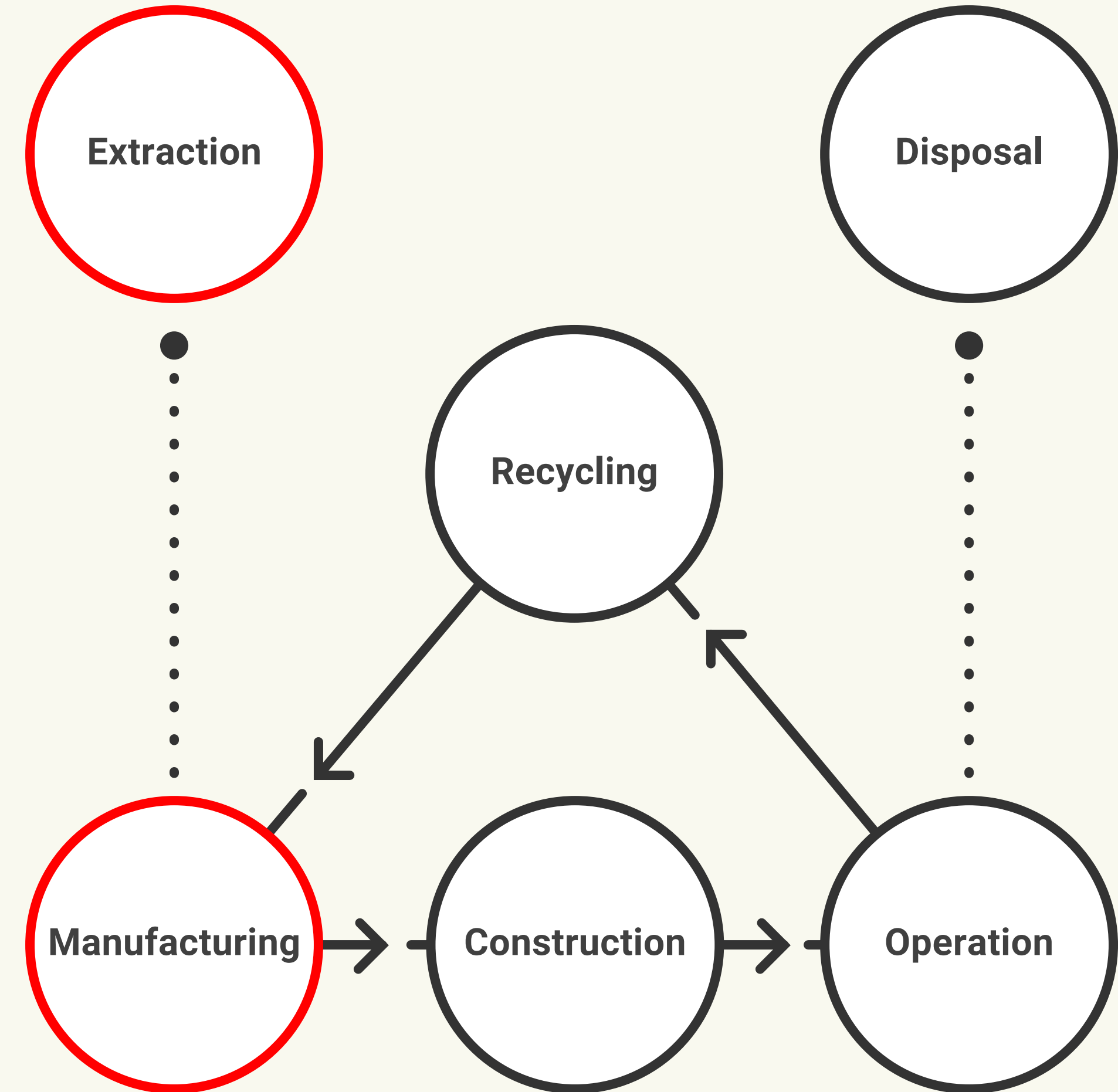
**Oh wow, you mean as a
builder or designer I need to
understand earth science?**

Yeah probably.

Embodied Carbon

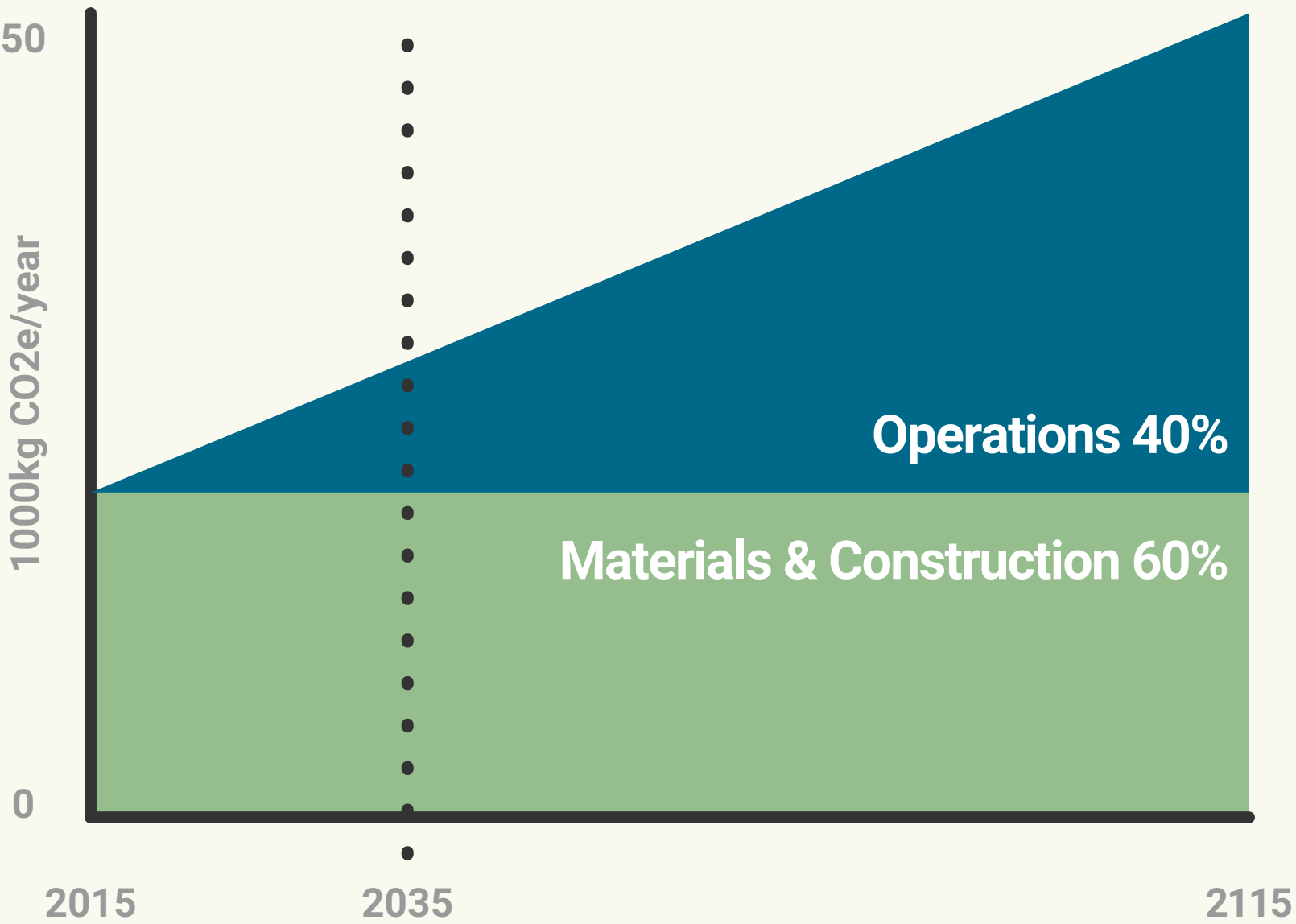
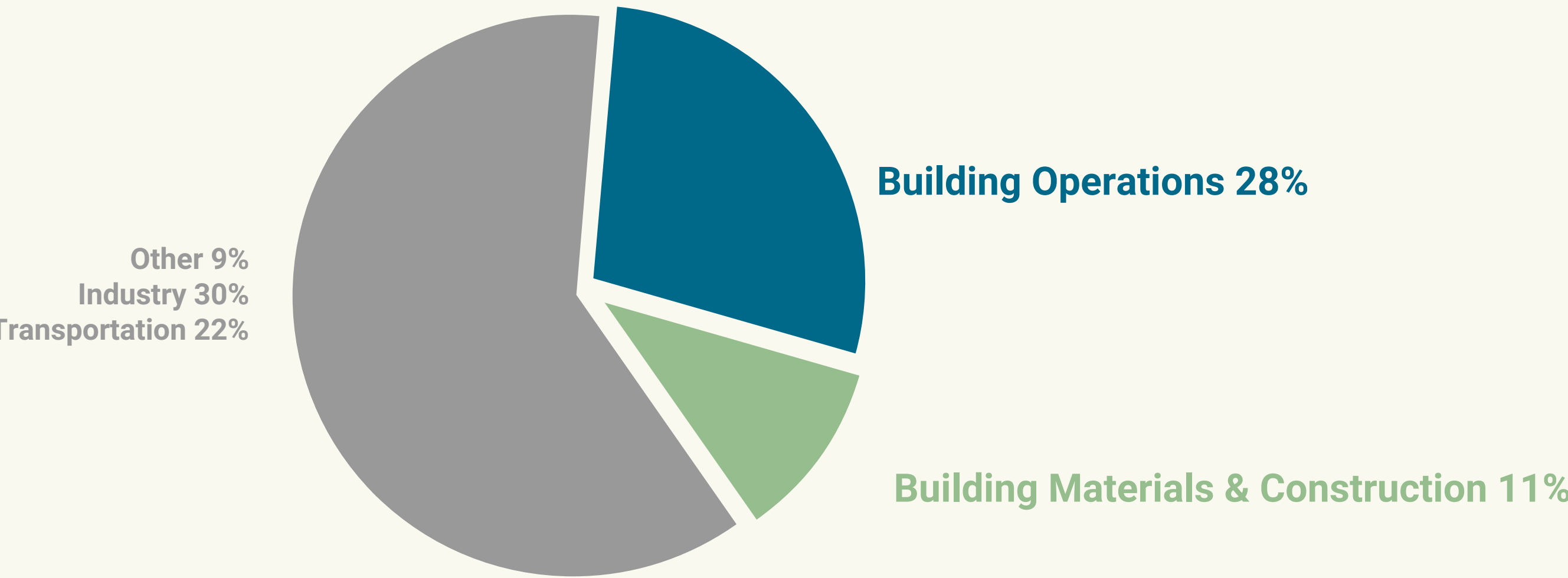
What is embodied carbon?

The amount of CO₂ and other Greenhouse Gases (GHGs) released into the atmosphere as a result of the extraction and manufacturing of building materials.

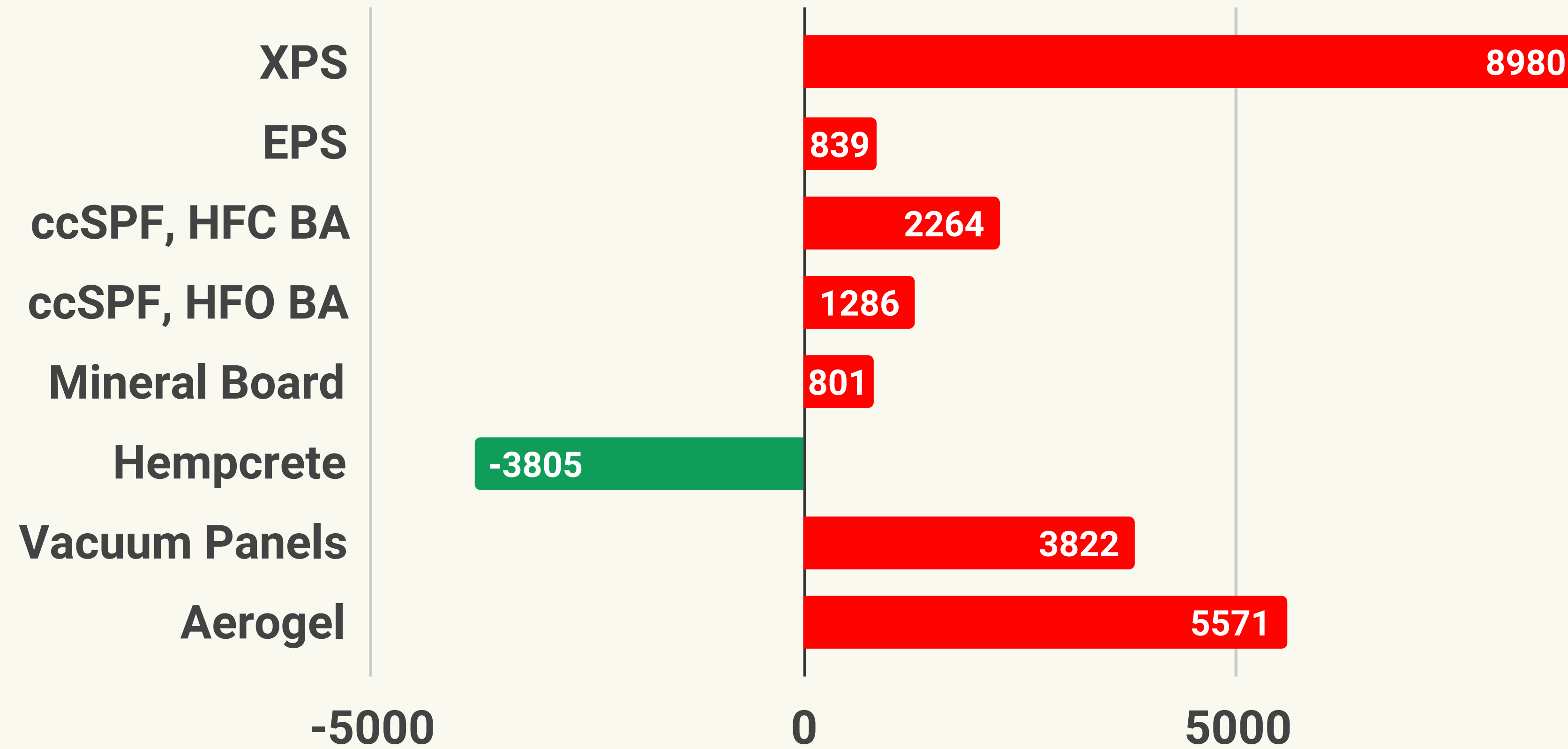


Global C02 Emission by Sector

Data Source: Architecture 2030



**We cannot “net zero energy”
our way out of the climate crisis.**



Embodied CO2e, kg

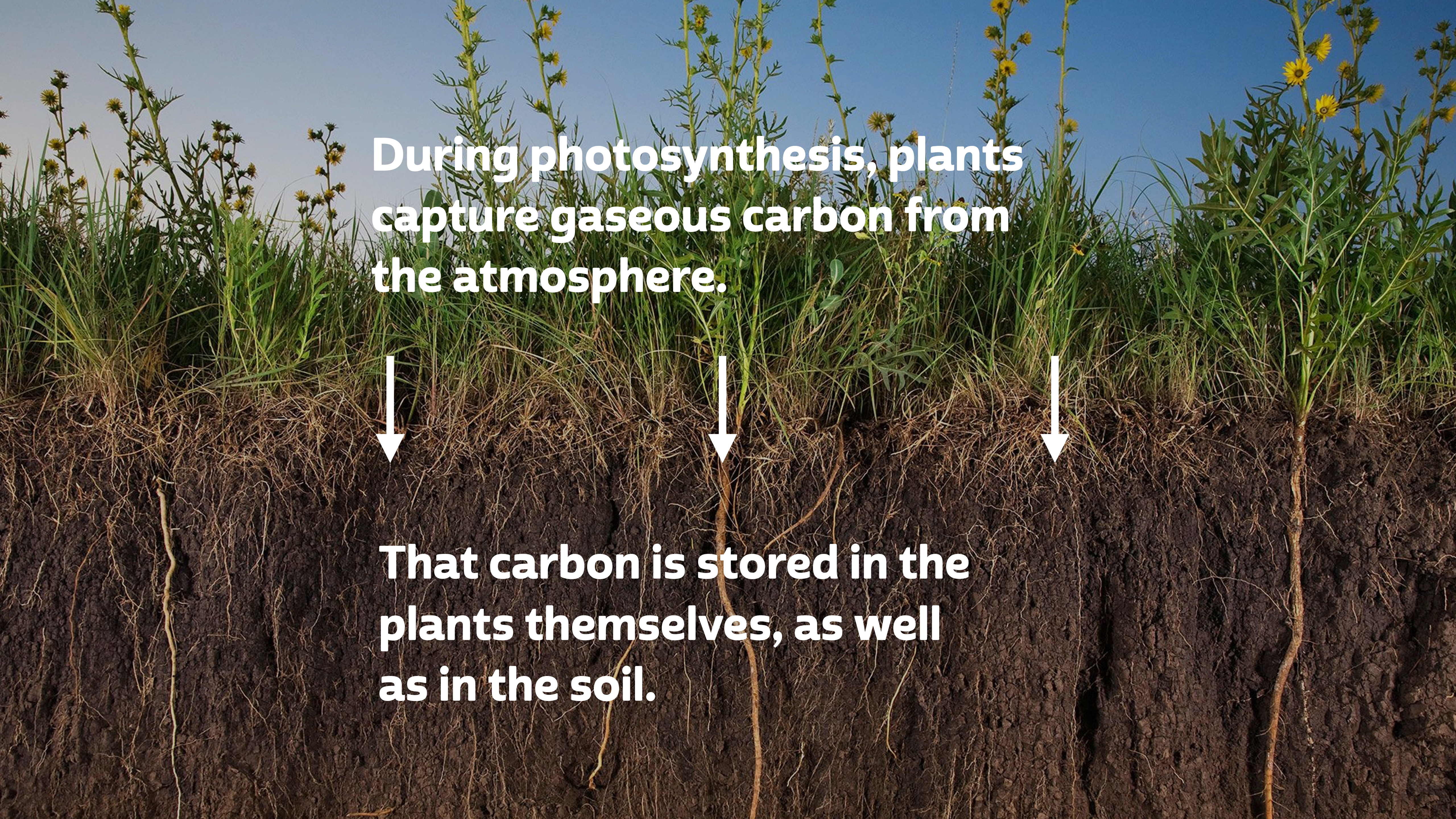
Embodied CO2e of Foundation Wall Insulation
R-20, 233 m2

Wait! What's this? A negative number?



Yes, a material that stores more atmospheric carbon than was emitted in harvesting & manufacturing! This opens up a whole new paradigm — **materials with carbon capture and storage potential!**

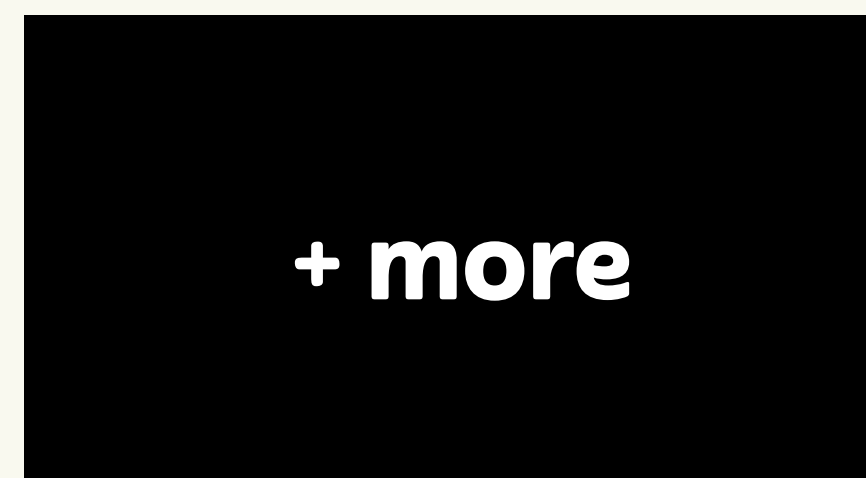
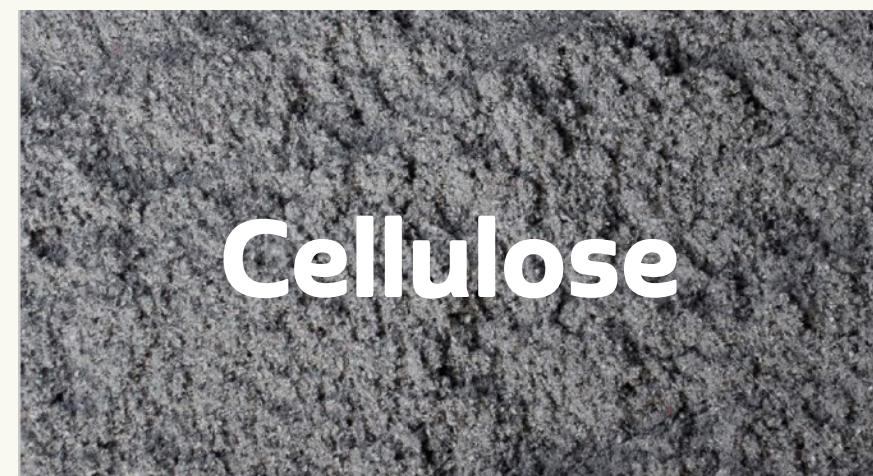
How does this work?



**During photosynthesis, plants
capture gaseous carbon from
the atmosphere.**

**That carbon is stored in the
plants themselves, as well
as in the soil.**

There are lots of **plant-based, carbon-storing building materials**

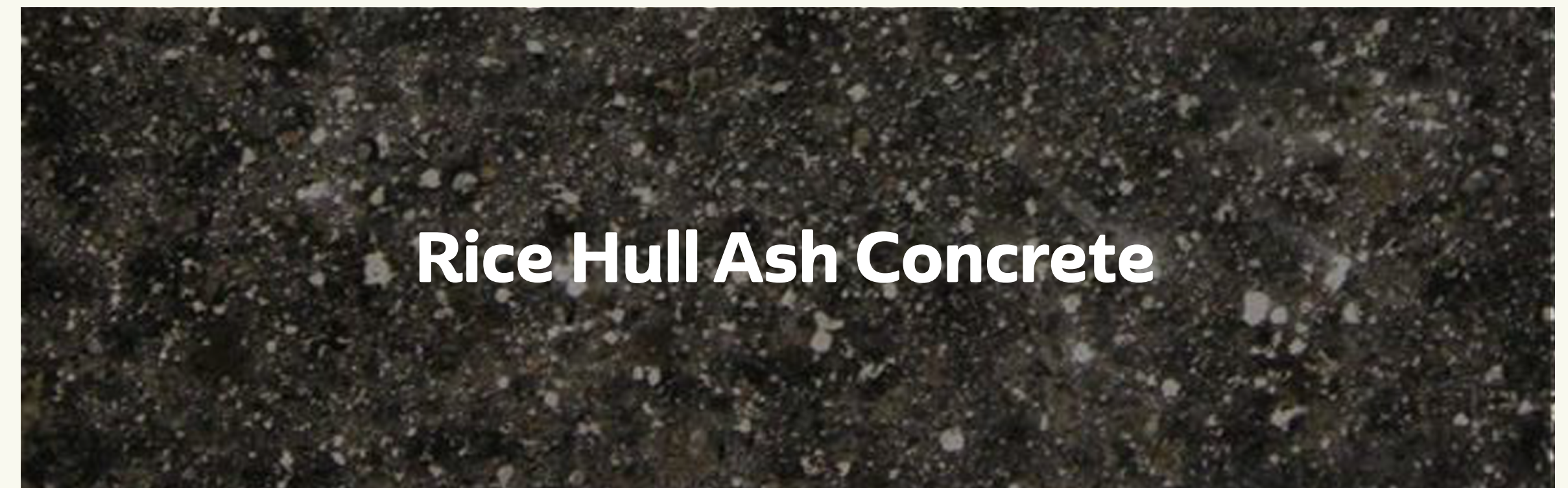


and no red list chemicals!

...some that are **mineral-based**



...and some **interesting hybrids.**



Greenhouse Gas (GHG) Evaluation Study

Single Unit Residential

2,000 square feet

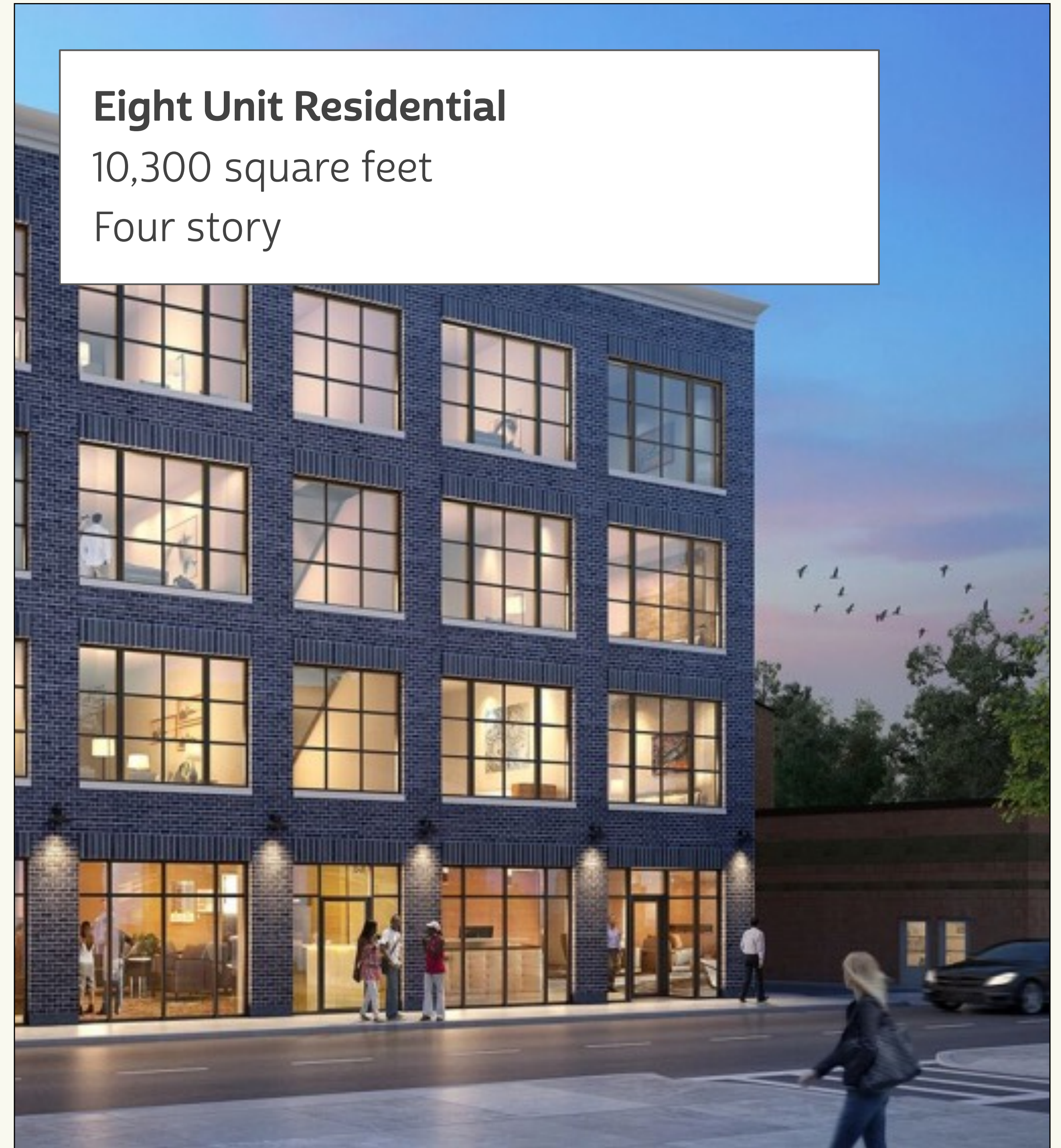
Bungalow with full basement



Eight Unit Residential

10,300 square feet

Four story

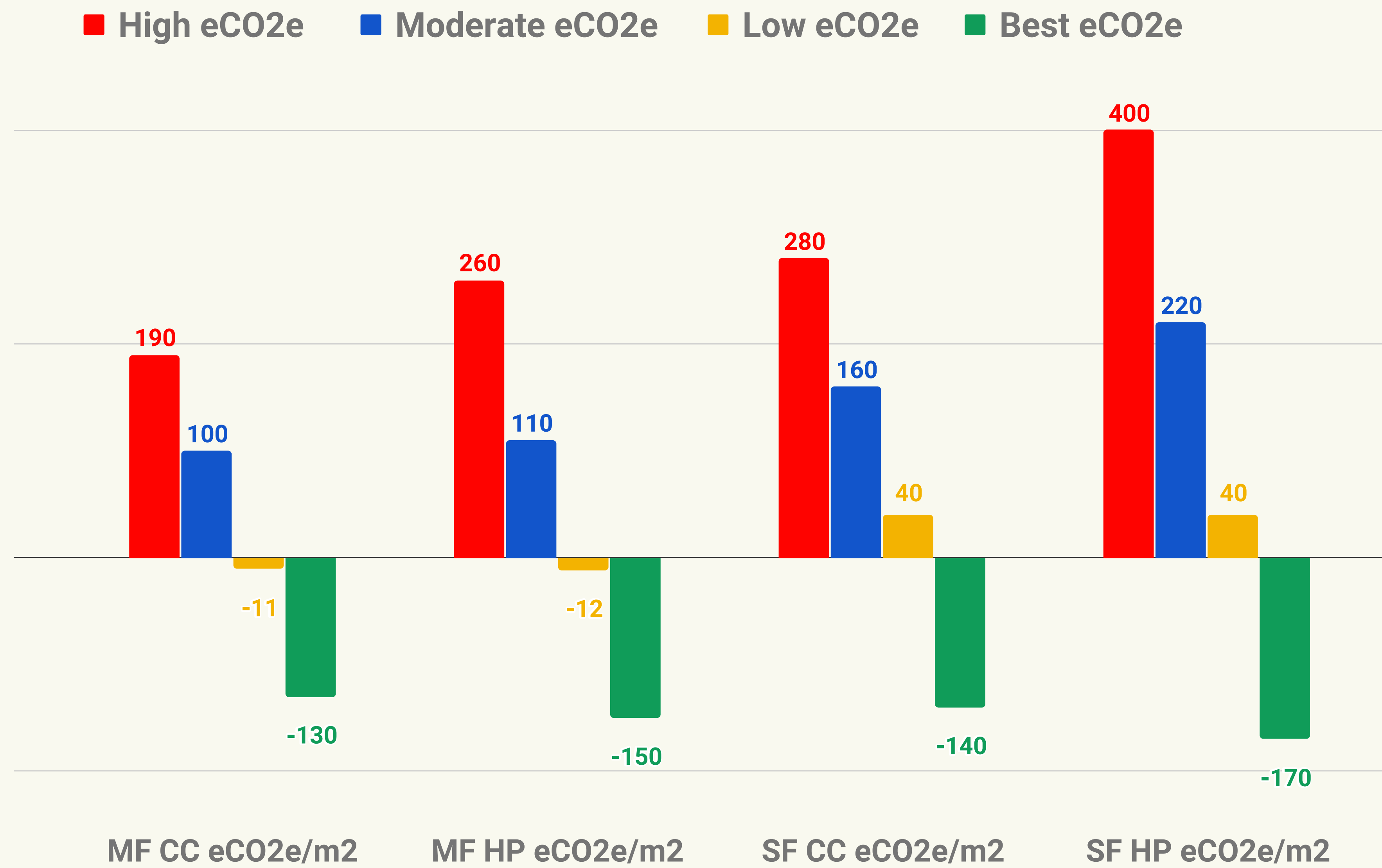


Embodied GHG Emissions



Our sources of data:

- Industry average EPD for North America
- Product specific EPD for North America
- Industry average EPD for Europe
- Product specific EPD for Europe
- LCA data from peer reviewed sources
- ICE database



Eight Unit Residential Embodied CO ₂ e emissions, kg per square meter	Single Unit Residential Embodied CO ₂ e emissions, kg per square meter
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What can this mean...

Worst Case Scenario
at +345.9 kg/m²

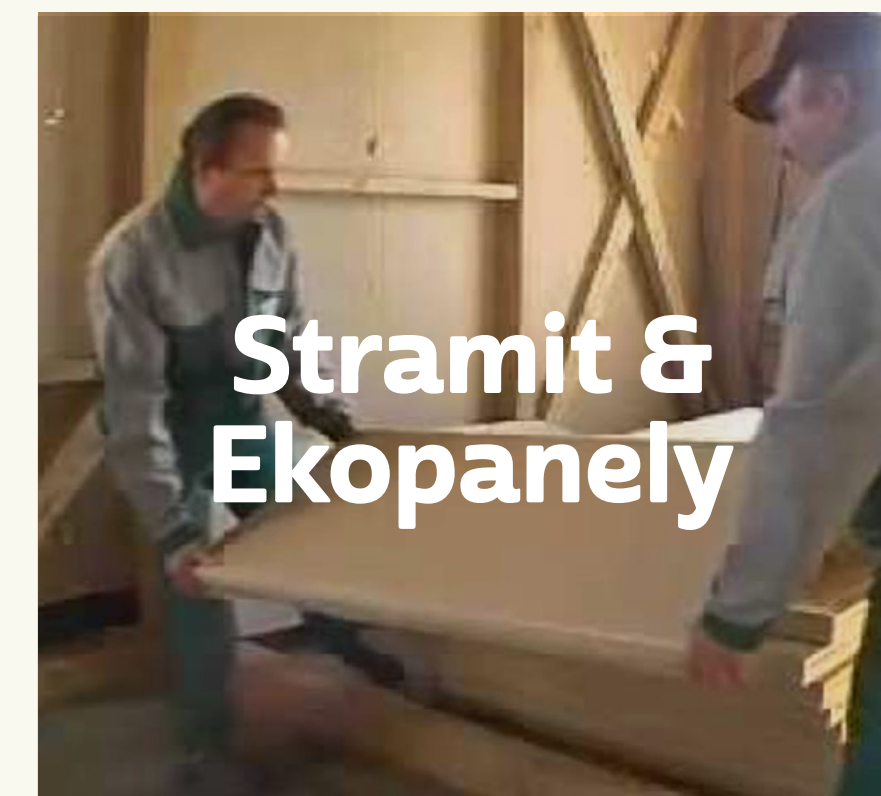
= **+83.4 million tonnes** of CO₂e
= Adding emissions of **23 coal plants***

Best Case Scenario
at -150.7 kg/m²

= **-36.3 million tonnes** of CO₂e
= Removing emissions of **10 coal plants***

*500 MW Plant with 3.5 million tons of CO₂e Emissions Annually
241.1 million square meters new low-rise residential construction in US, 2017
U.S. Census Bureau/U.S. HUD, CB19-21

2.16 billion tons of grain straw
were grown globally in 2016. That's
enough carbon storage to **offset**
all current transportation GHG
emissions and more than **replace**
all current insulation materials.



Operational GHG Emissions

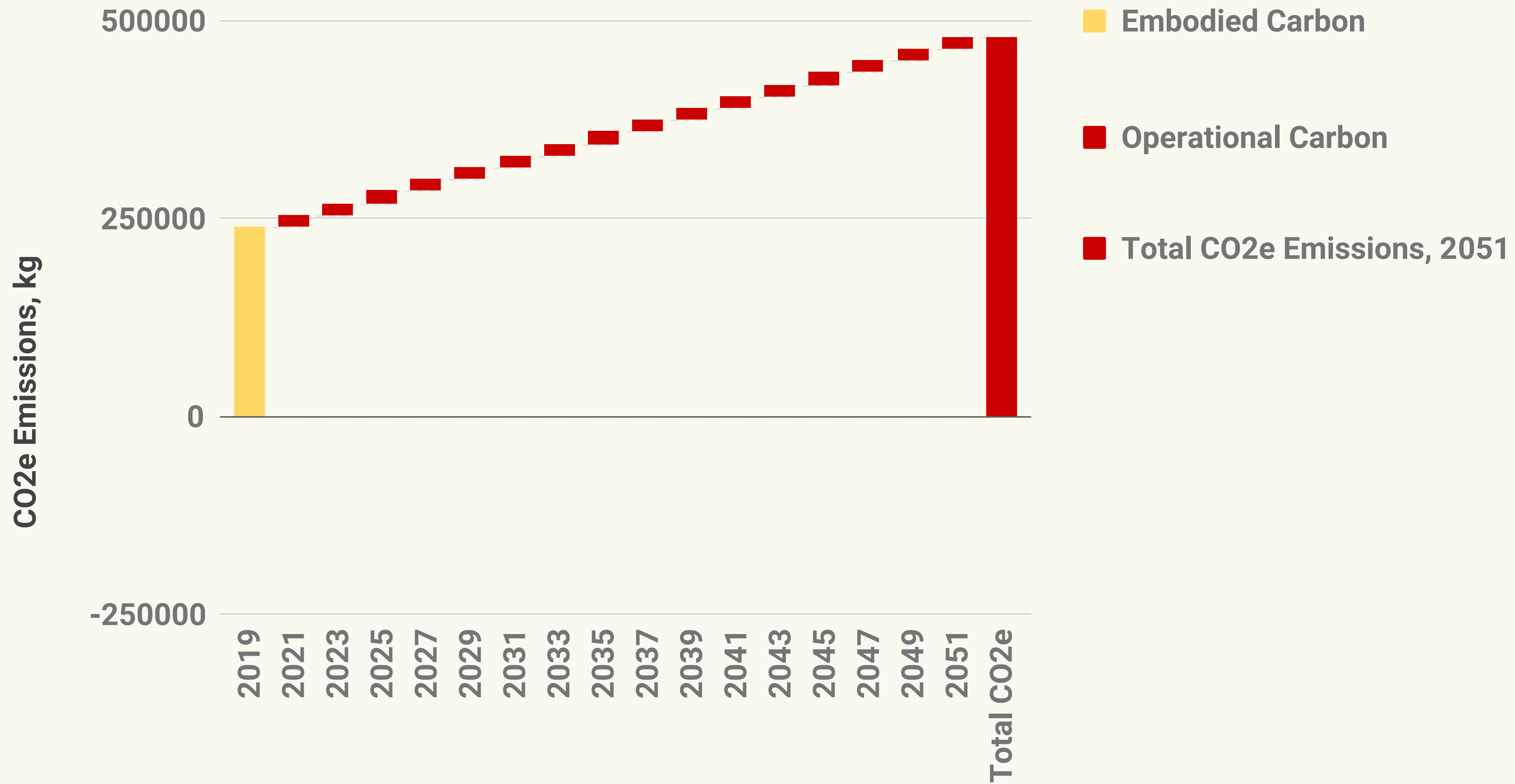
Okay, but embodied emissions are only part of the story.

What happens when we add operational emissions?

**Embodied Emissions +
Operational Emissions**

= Overall Climate Impact

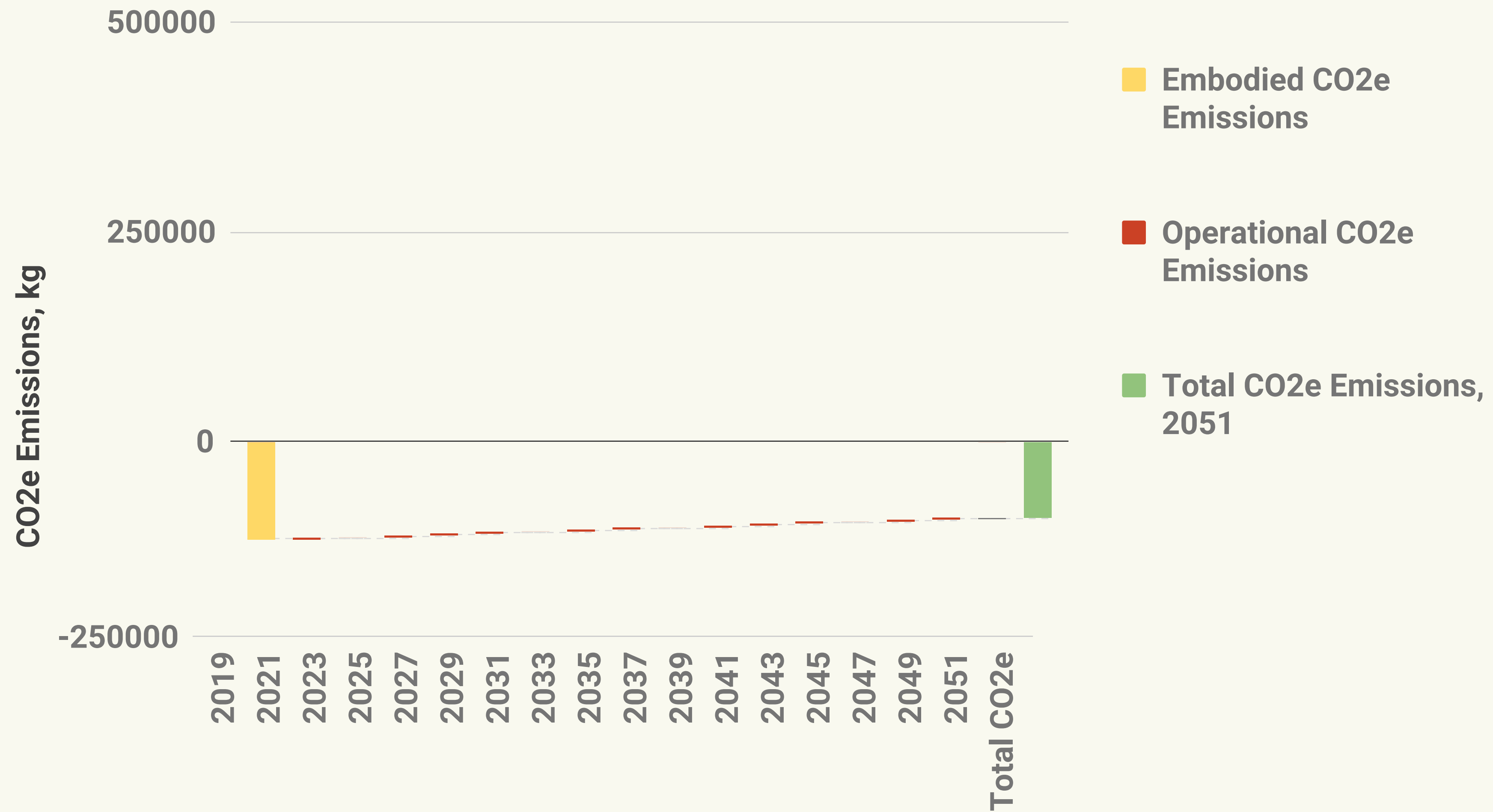




Eight Unit Residential

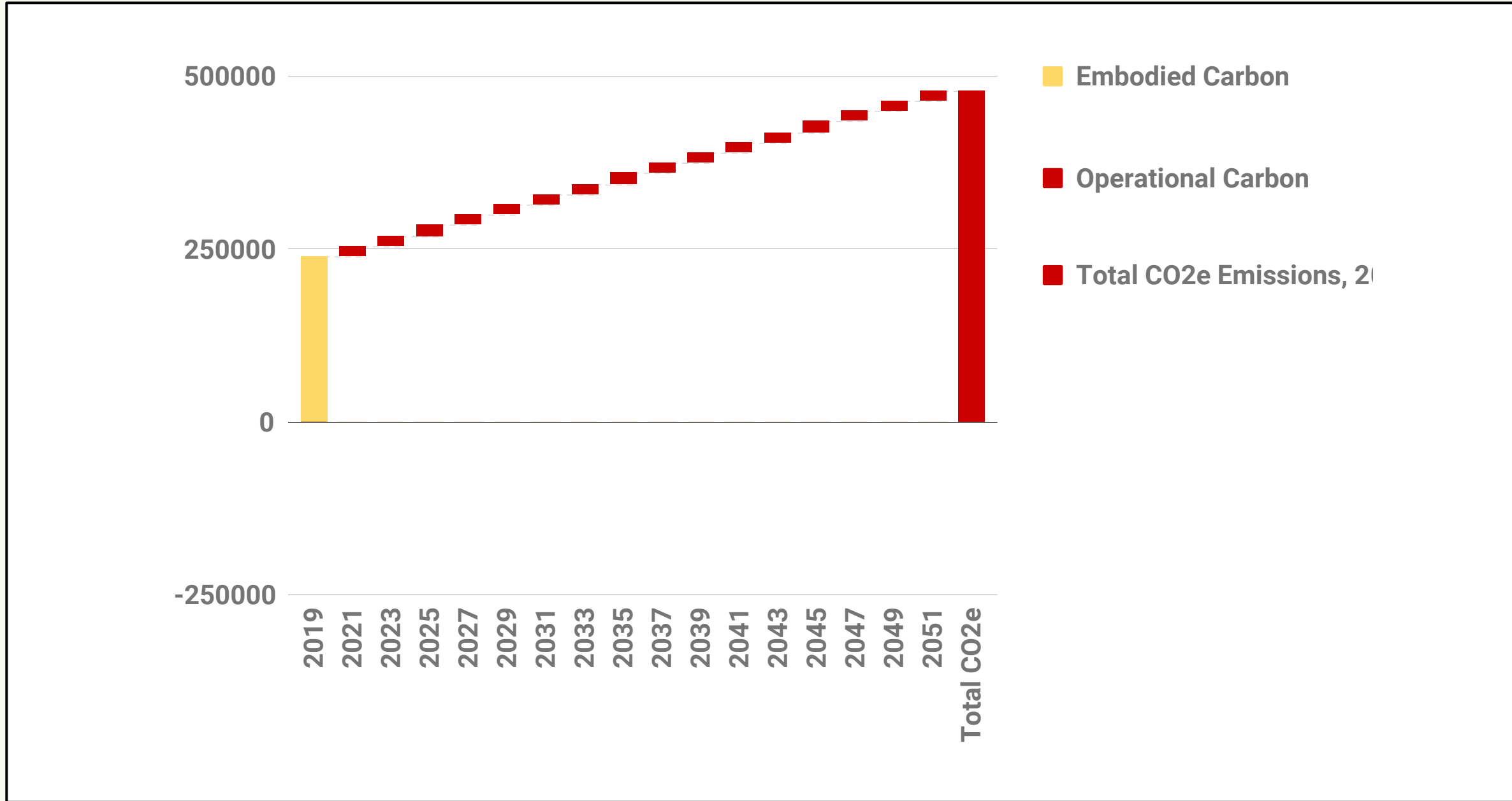
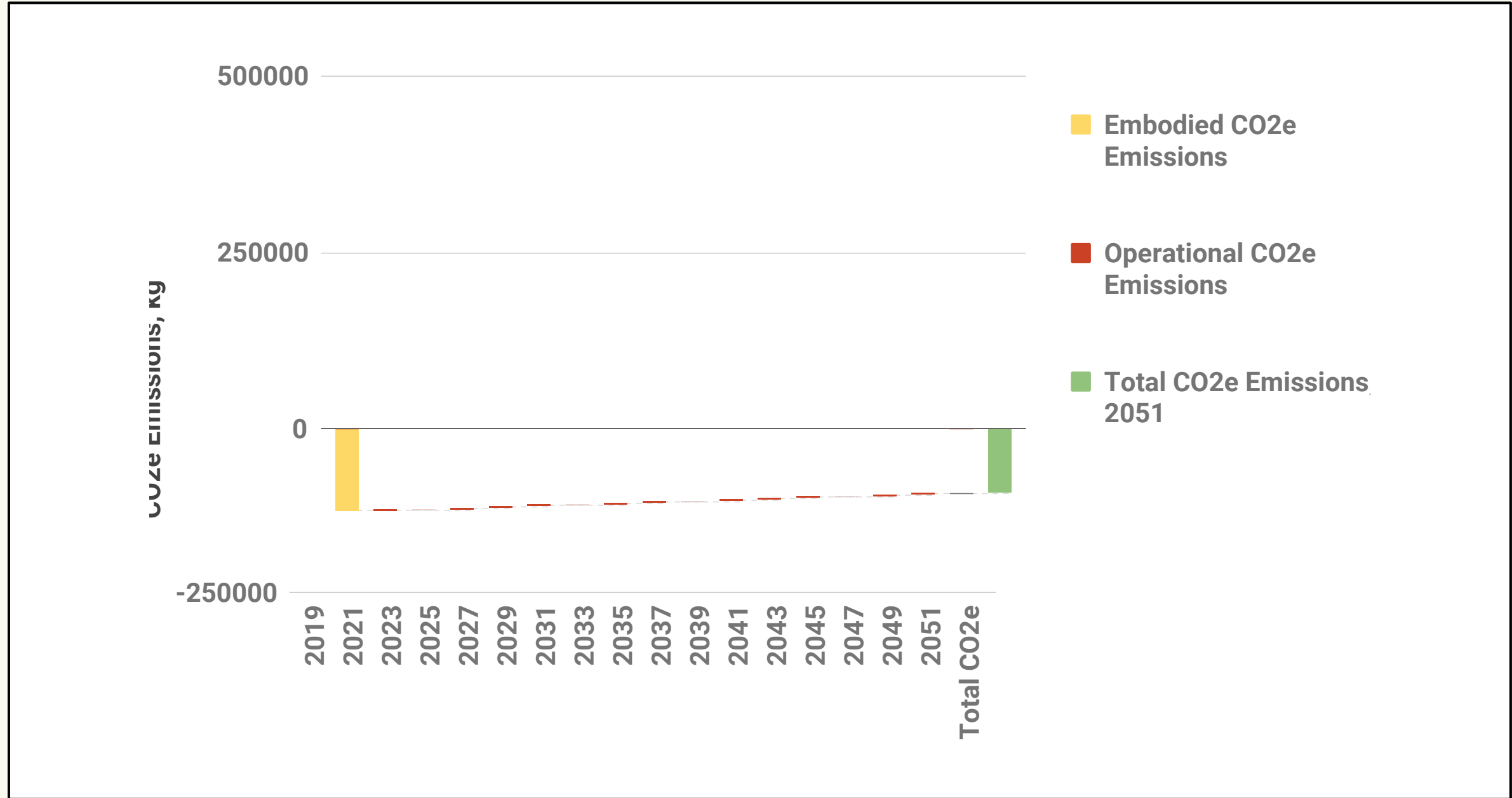
High eCO2e Building, Code Compliant, NG + ISO-NE Grid





Eight Unit Residential

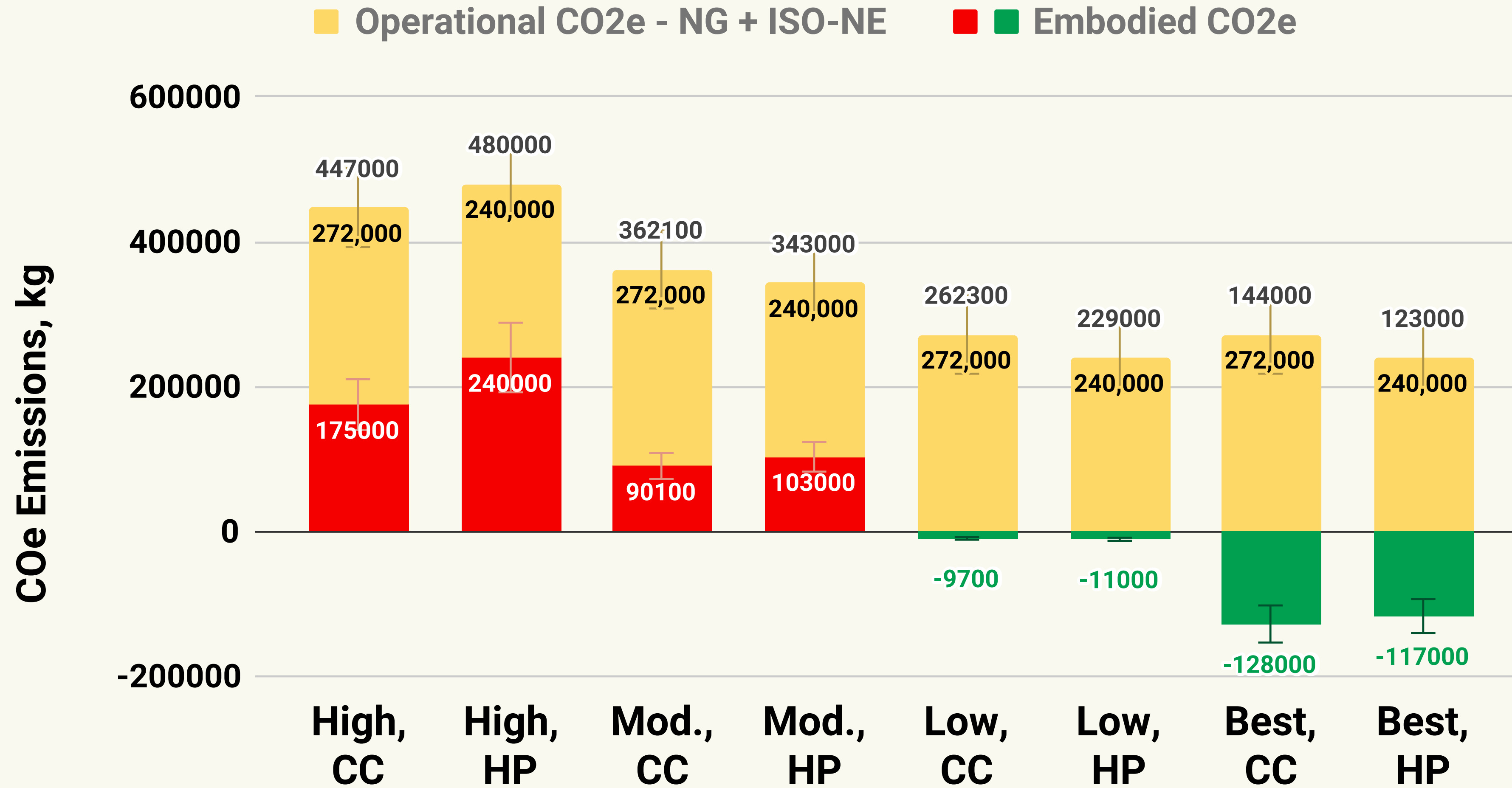
Lowest eCO2e Building, High Performance, Ontario Grid



This building can be a drawdown building!

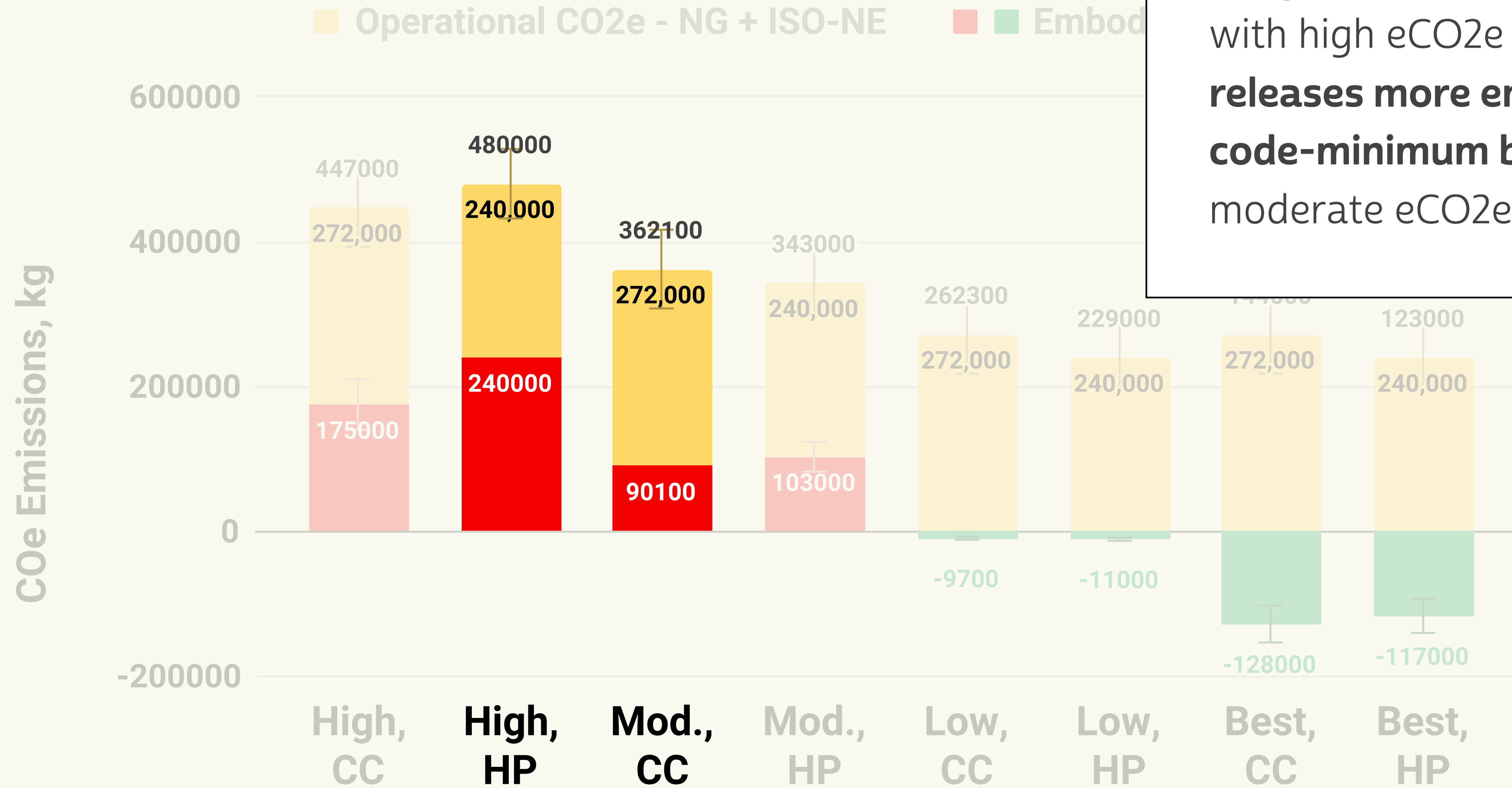


Combined GHG Emissions

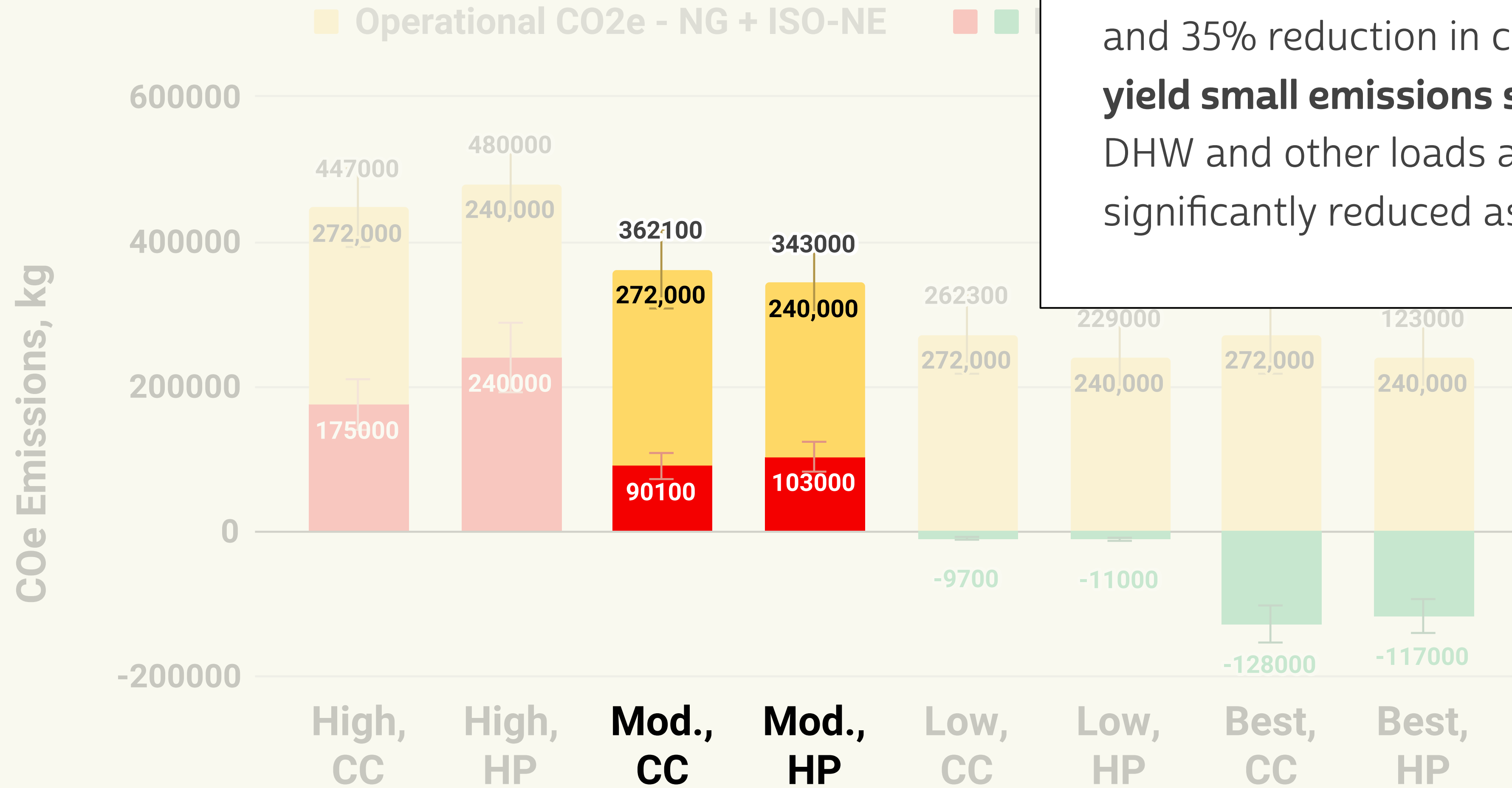


Eight Unit Residential

Natural Gas + ISO-NE Grid, 2019–2051

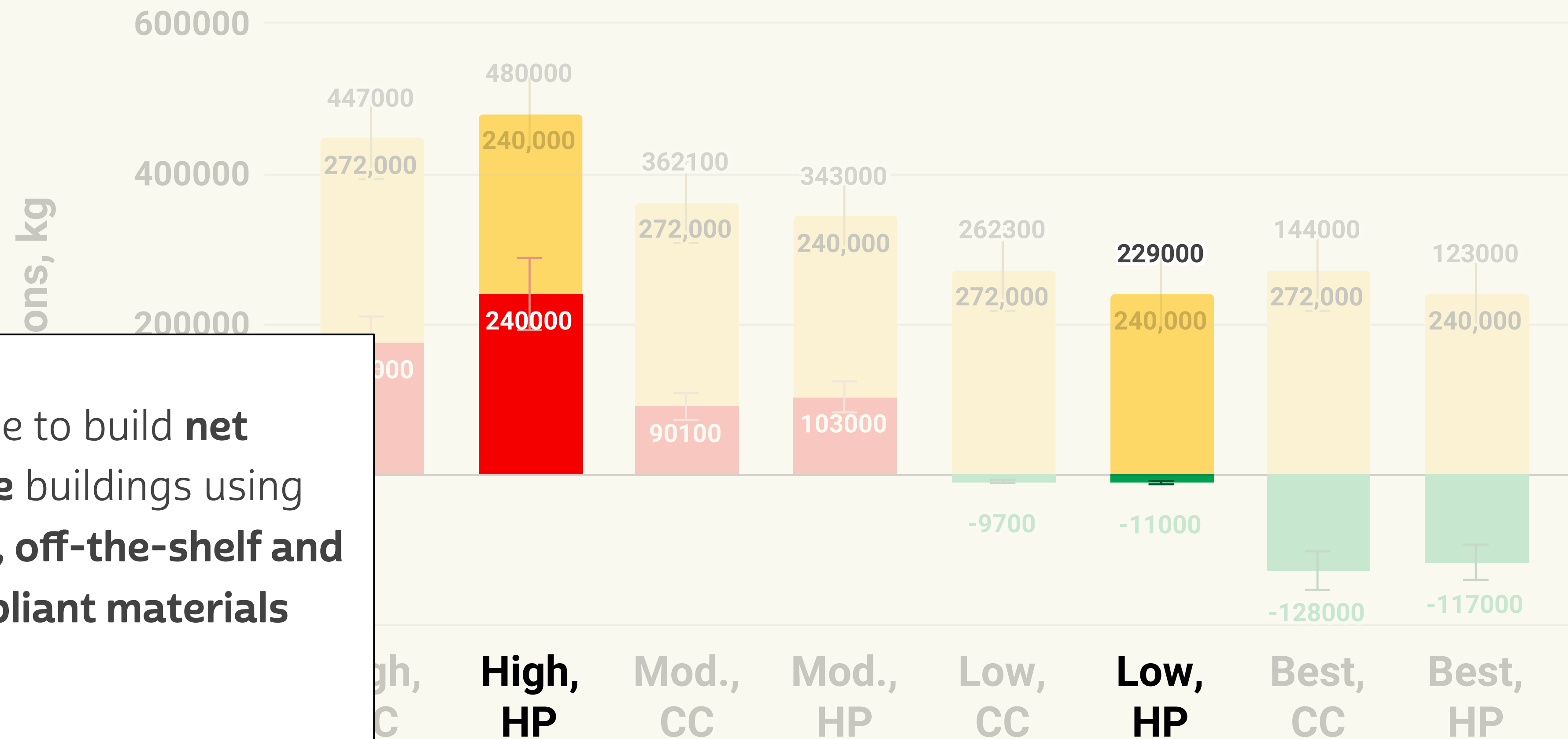


A high performance building with high eCO2e materials **releases more emissions than a code-minimum building** with moderate eCO2e materials.



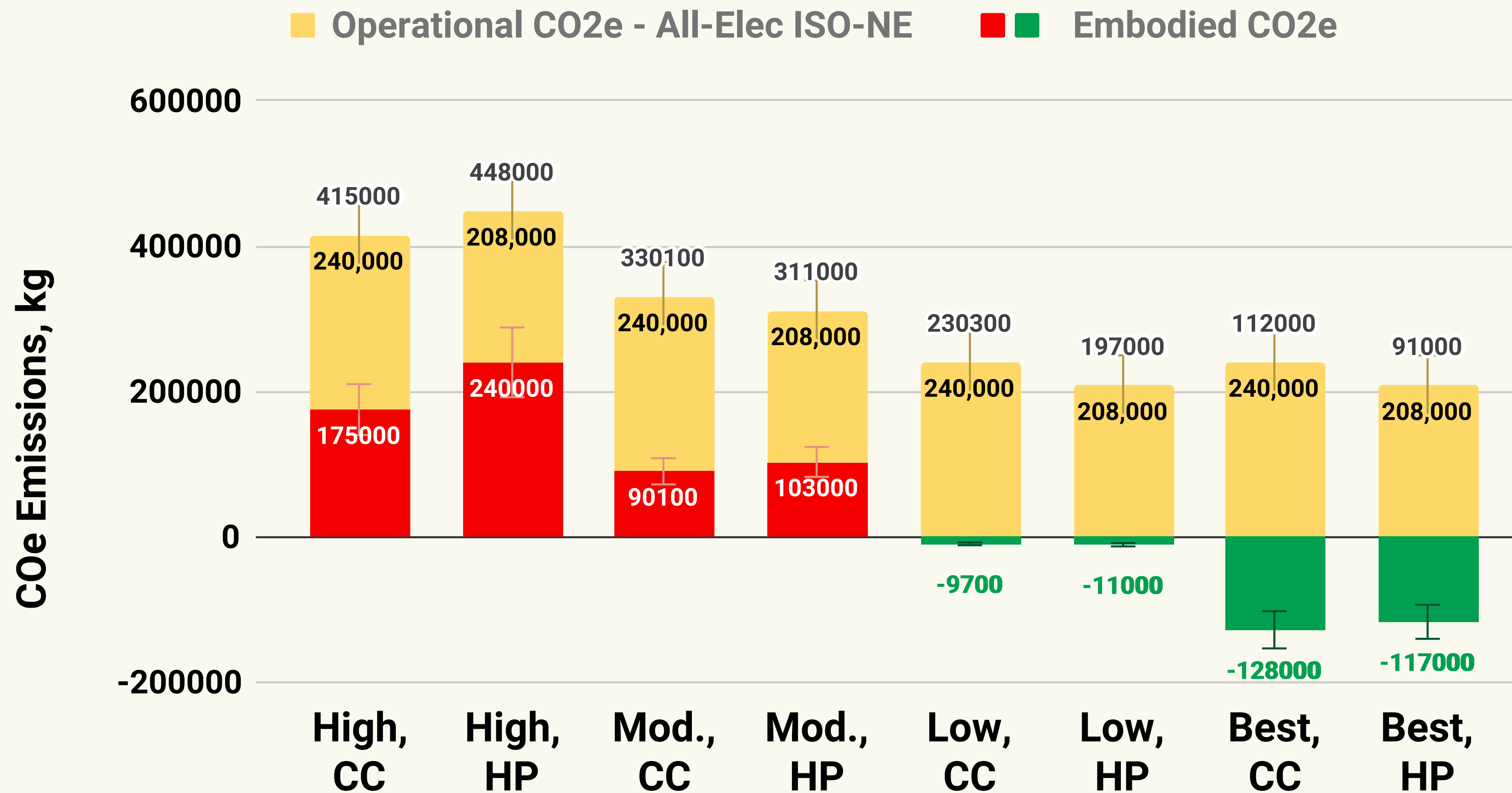
A 65% reduction in heating load and 35% reduction in cooling load, **yield small emissions savings** when DHW and other loads aren't significantly reduced as well.

Operational CO2e - NG + ISO-NE Embodied CO2e



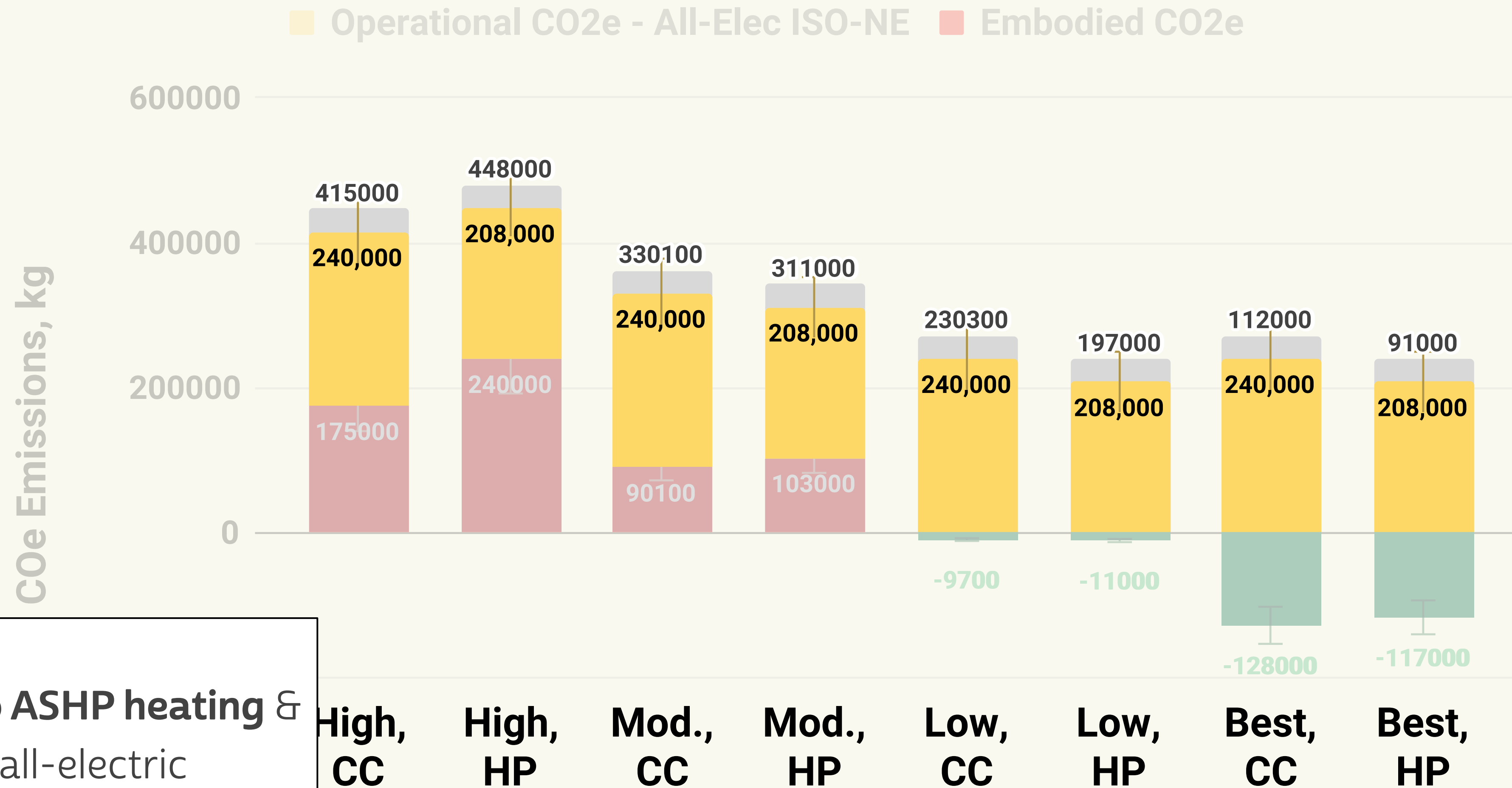
It is possible to build **net zero eCO2e** buildings using **affordable, off-the-shelf and code-compliant materials** (Low HP).

They will **release fewer total emissions** than just the eCO2e of the High HP building.



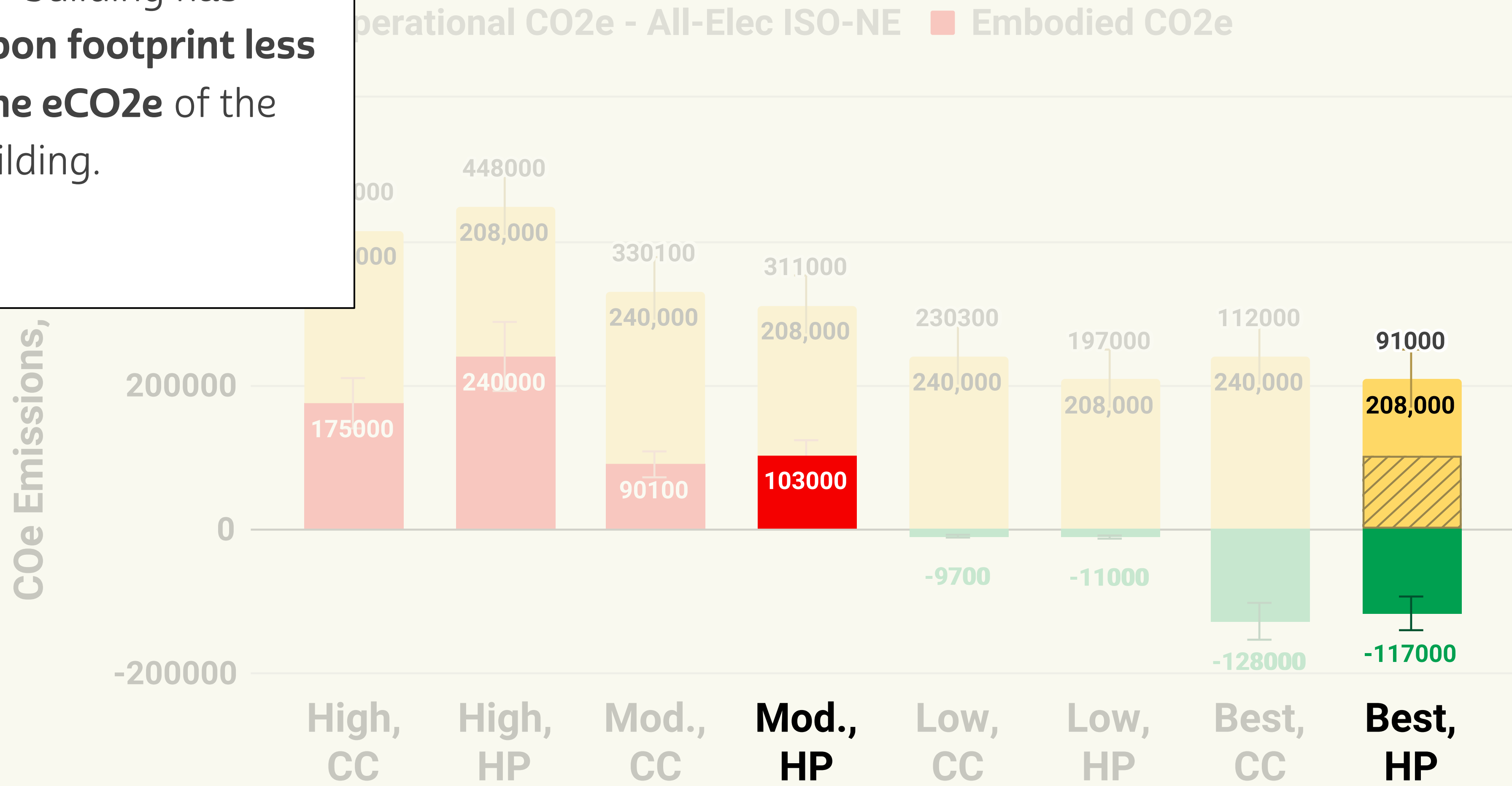
Eight Unit Residential

All Electric, ISO-NE Grid, 2019–2051

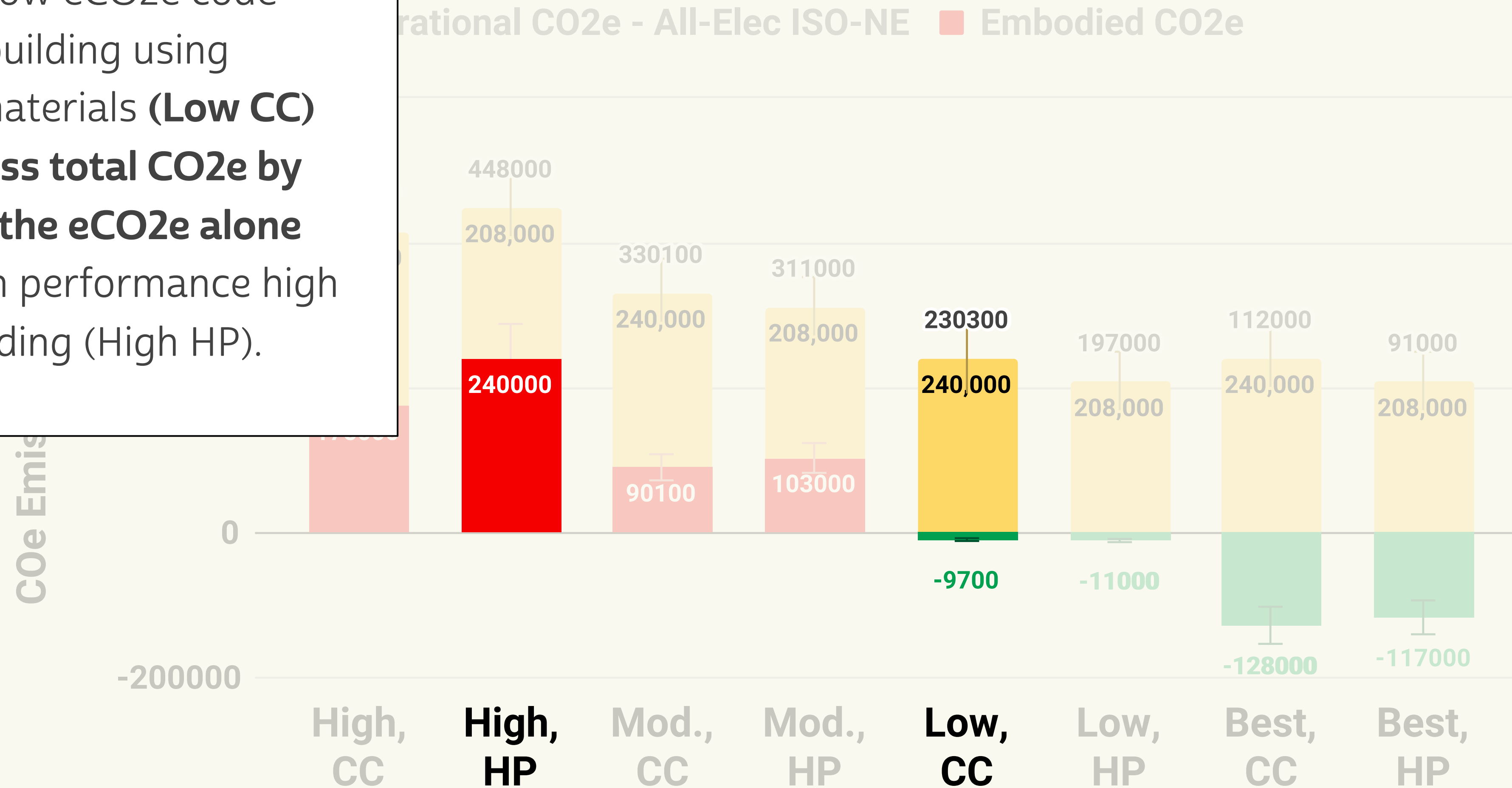


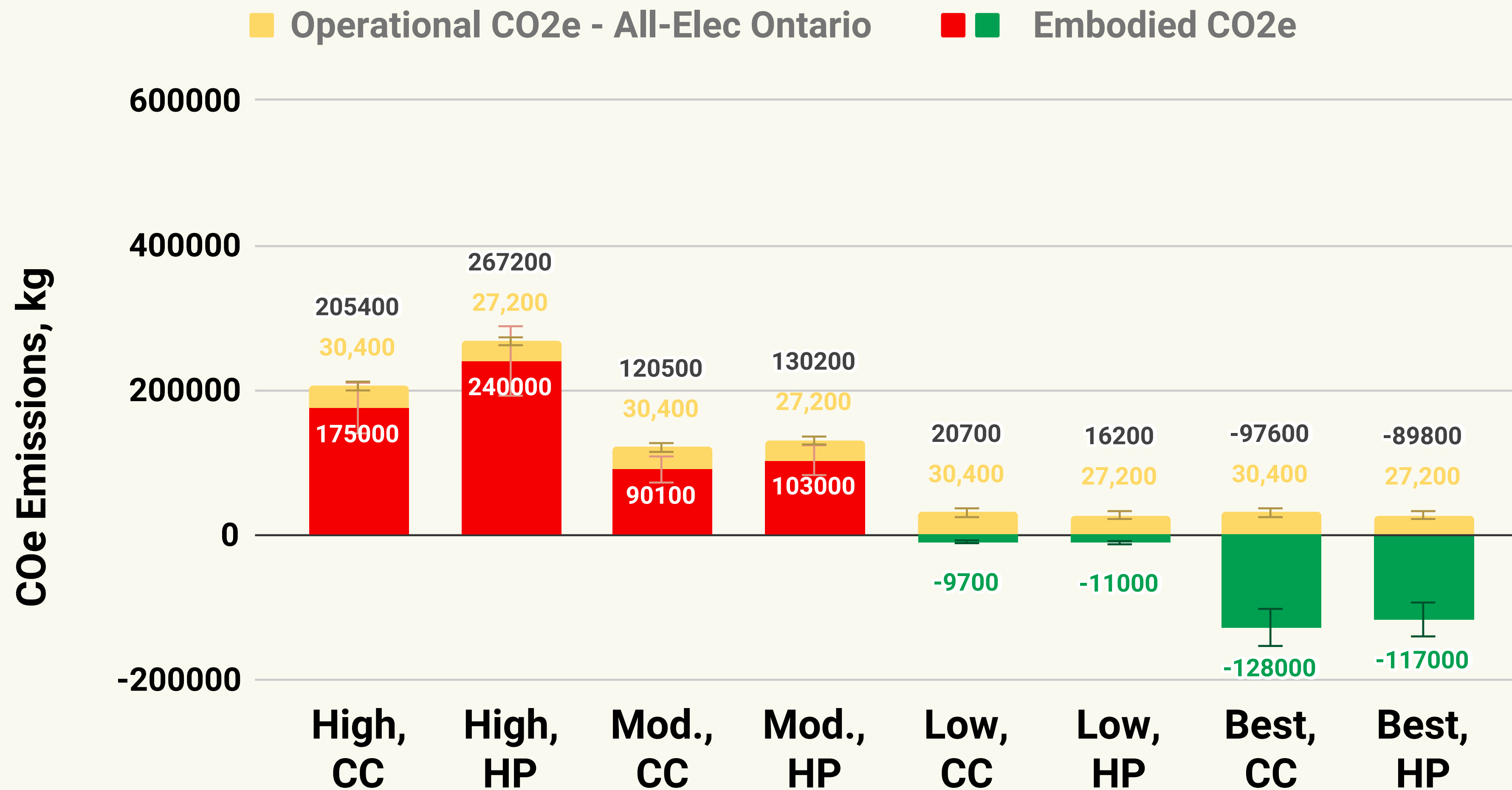
A **switch to ASHP heating & cooling** for all-electric building is **only a 13% oCO₂e emissions savings** on the ISO-NE grid.

The Best HP building has
a **total carbon footprint less**
than just the eCO2e of the
Mod HP building.



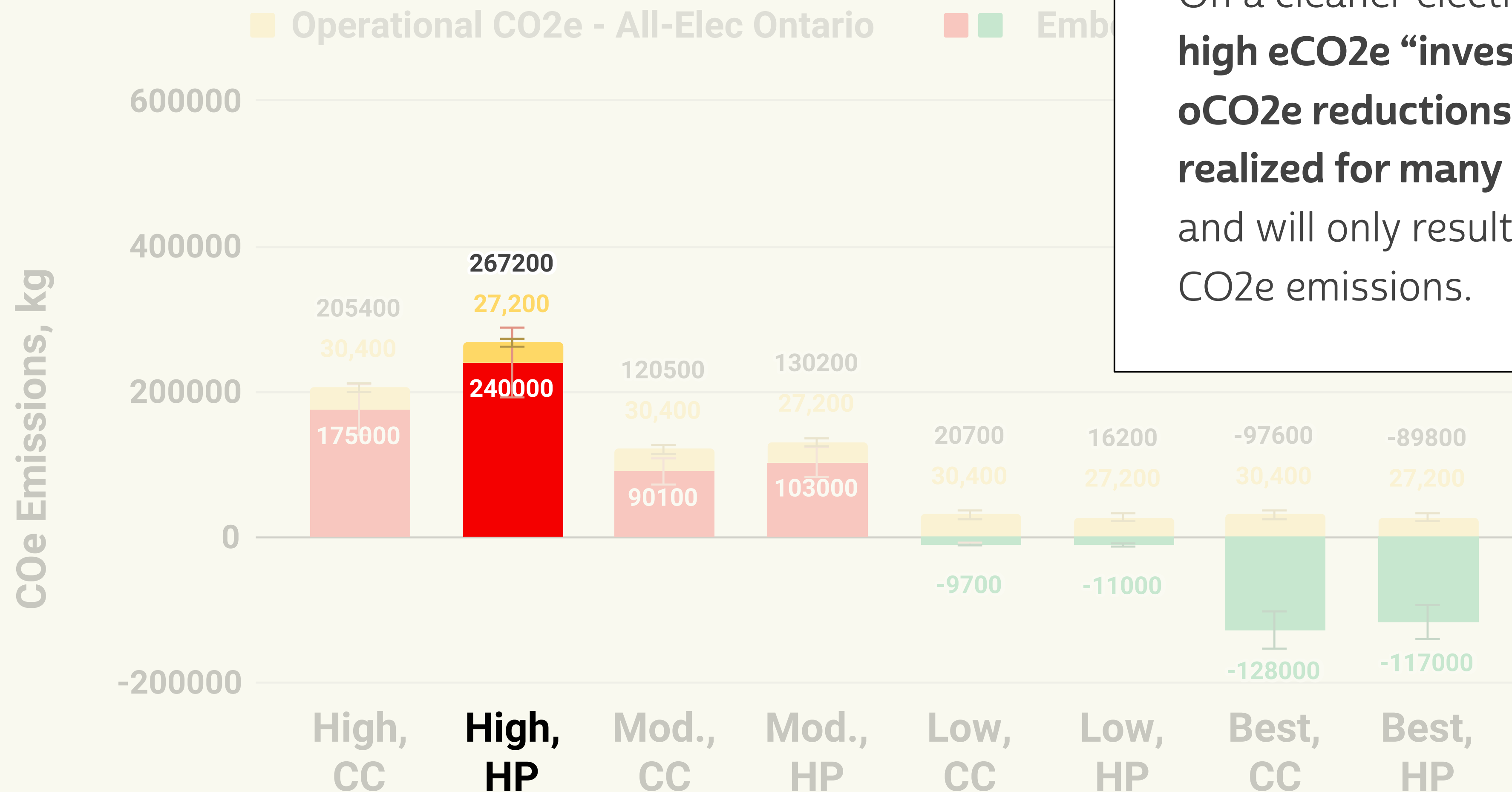
Building a low eCO2e code minimum building using common materials (**Low CC**) will emit less total CO2e by 2050 than the eCO2e alone from a high performance high eCO2e building (High HP).





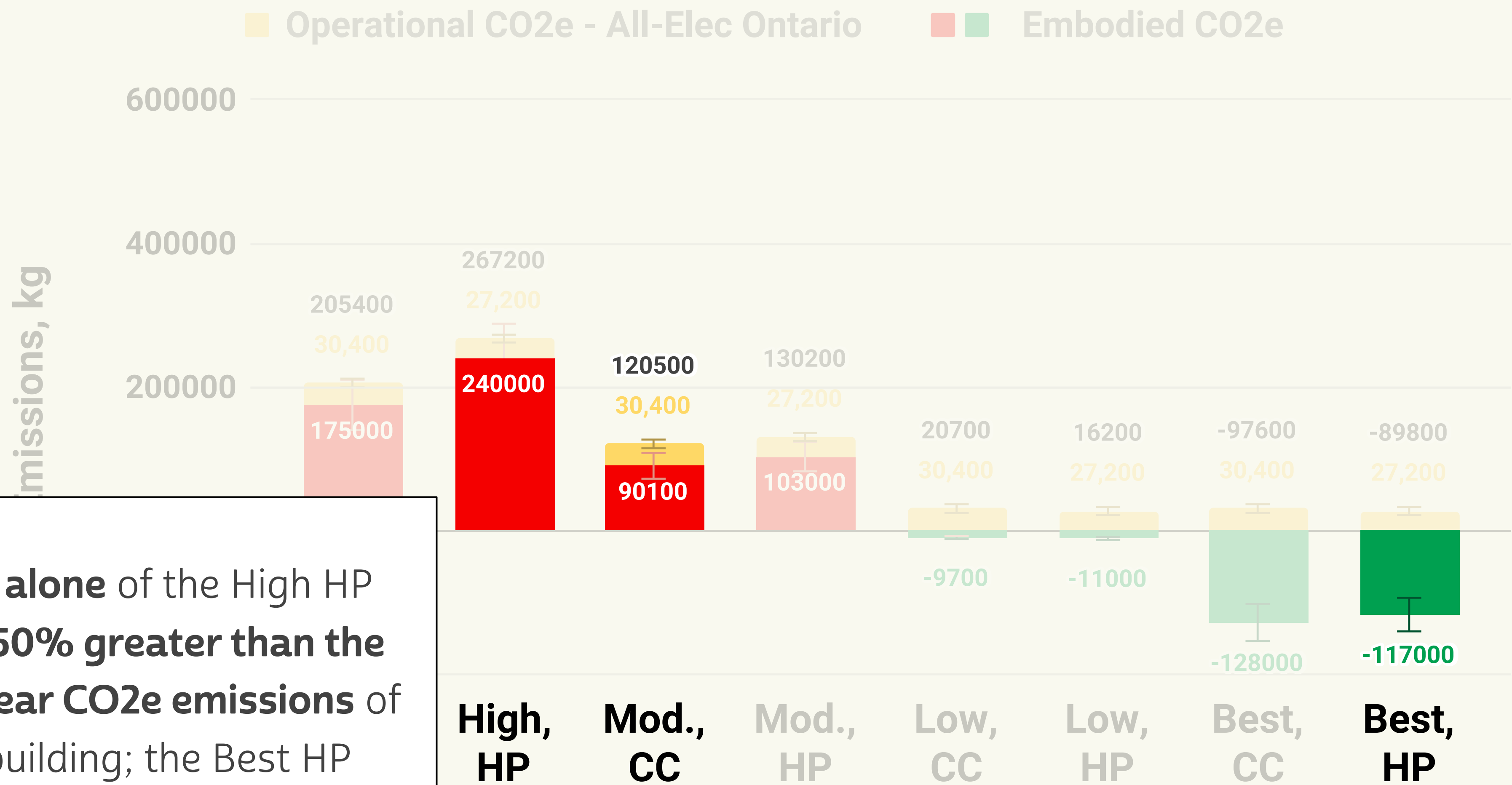
Eight Unit Residential

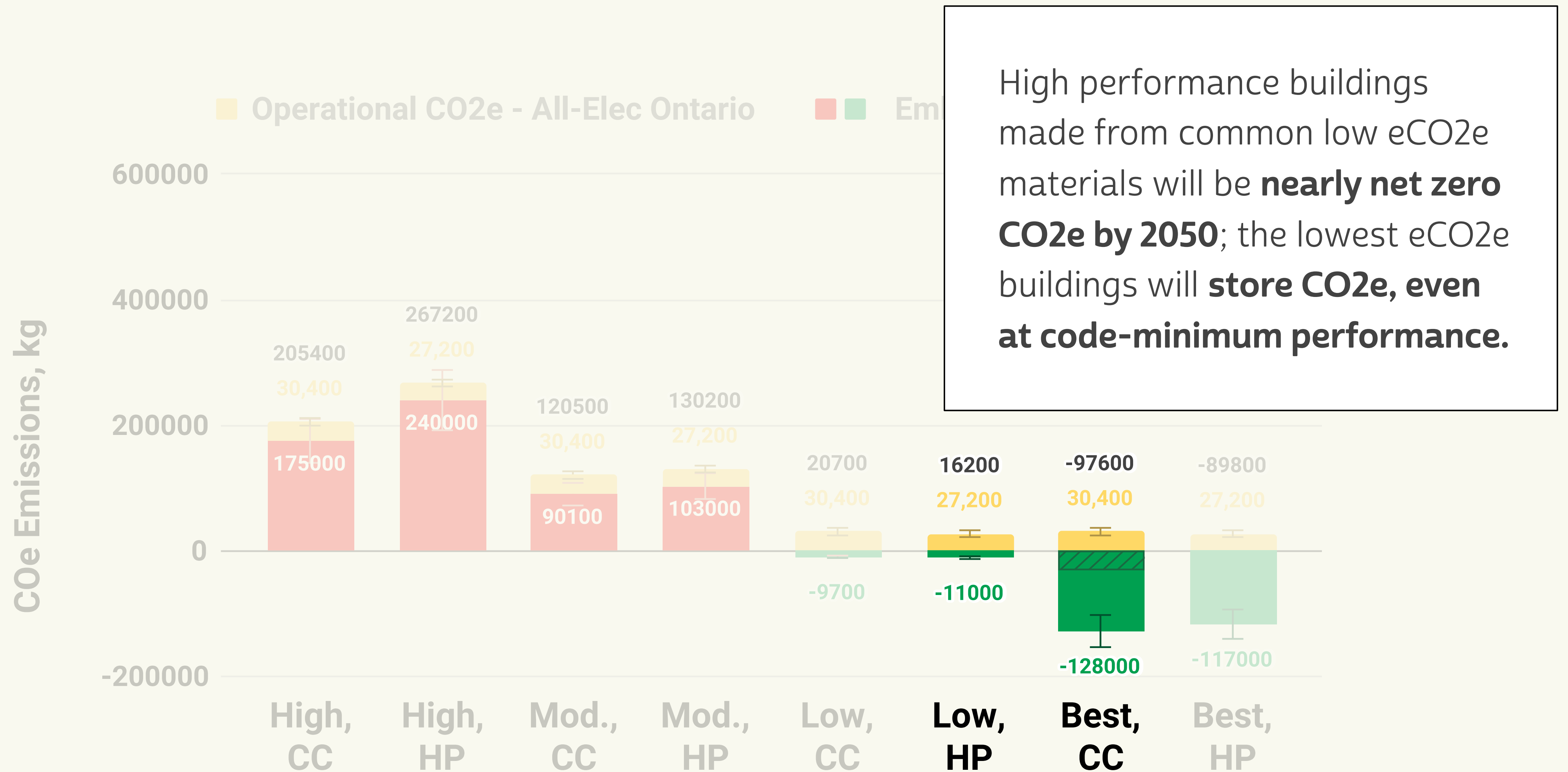
All Electric, Ontario Grid, 2019–2051



On a cleaner electric grid, **high eCO2e “investments” in oCO2e reductions will not be realized for many decades,** and will only result in increased CO2e emissions.

The **eCO2e alone** of the High HP building is **50% greater than the entire 30 year CO2e emissions** of a Mod CC building; the Best HP building **stores 75% of those emissions**.





People & Planet Impact Studies

This can be done now, affordably.



Trillium-Lakelands Elementary Teachers' Union

Office Building

Lindsay, Ontario

2,400 sf, \$208/sq.ft.

86 tons of net CO2 storage

- Zero toxins
- 105% net energy production on site
- 90% of materials from 250km radius
- 80% less construction waste

Zero House Project

Clarksburg, Ontario

1,100 square feet, \$254/sq.ft.

24 tons of CO2 storage

- Zero toxins
- 75% net energy production on site
- 90% of materials from 250km radius
- 95% less construction waste





Unicorn Farm Residence

Middlesex, Vermont 1,650 sf, \$303/sq.ft.
Off-grid, fossil fuel and foam-free
600 kg of net CO₂e storage

Beyond carbon-by-the-numbers

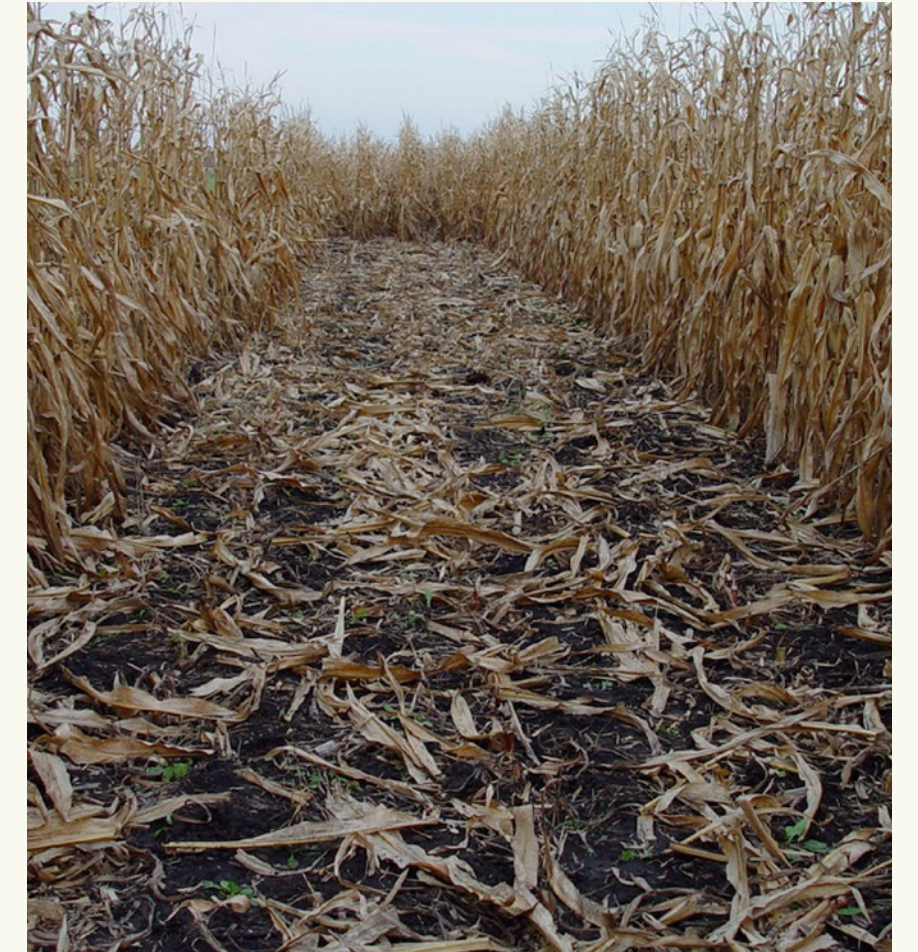
The bigger picture involves making carbon-storing buildings **AND**:

- Crew working directly with foresters and farmers
- Using all-renewable energy on site
- Taking care of waste
- Crew diversity



**How do we think about
carbon-storing materials?**

How do we think about
carbon-storing materials?




Waste Stream
Agriculture Residue
Factory Grown
Forestry Products



Waste Stream

- **Cellulose (newsprint/cardboard)**
- **Textiles**
- **Drinking cartons/Tetra paks**

- How large are the stocks?
How long will we have them?
- Carbon emissions from collection/transportation?
- What else would happen to that waste?



Agricultural Residue

- Grain/hemp/sunflower straw
- Rice hulls
- Coconut/palm kernel/banana leaf

- How large and where are the stocks?
- Environmental and soil impacts from farming practices?
- Land use changes to match demand?

Factory Grown

- **Mycofoam & Mycoboard**
- **BioMASON Brick**

- What kind of factory inputs?
- GMO organisms?
- Centralized production or distributed regionally?

Forestry Products

- **Timber**
- **Timber by-products**
- **Bamboo**

- Management strategies for long-term viability
- Carbon emissions from soil disruption
- What happens to slash and by-products?

How do we design for carbon-storing materials?

Design strategies

Product data and transparency

Regional industry

End-of-life issues





Design strategies for carbon storage

- Low carbon foundations
- Panelization & disassembly

- Rammed earth materials
- New cement formulations
- Post/pier foundations

Product data and transparency

- Availability of EPD data
- Quantifying additional benefits and harms

- More & better harmonized EPDs featuring biogenic carbon
- Assistance to produce EPDs for small manufacturers
- Better tools for builders and designers



Regional industry

- **Farm/forest to building**
- **Allied industry, many partners**

- Direct partnerships between farmers/foresters and builders
- Local/regional sourcing
- Co-investment in material production/distribution



End-of-life issues

- **What happens to stored carbon?**
- **Full Life Cycle Analysis**
- **“Buying Time”**

- Biochar, with heat/power generation
- Avoid composite materials that can't be separated
- Policies and regulation to manage stored carbon

What are the barriers to
carbon-storing materials?

Affordability
Replicable & scalable
Existing buildings
Codes & permits



Affordability

- **Material & labor costs** –
redefine relationship
between these costs
- **New models of ownership**
– partnerships to offer
rent-to-own and other
models
- **Housing for climate
refugees** – anticipation of
human movement and
appropriate housing plans



Replicable and scalable

- **Training for existing workers**
 - widespread programs for use of carbon-storing materials
- **Open-source sharing at design and construction level**
 - best practices developed rapidly
- **Disruptive manufacturing** – “pop-up” and micro-industry manufacturing

The background of the slide is a photograph of a residential building. On the left, a portion of a house with light-colored siding and a window is visible. On the right, a larger section of the house is shown, featuring a brown roof with solar panels, a window with a decorative glass insert, and a small black outdoor light fixture. A large white rectangular box is overlaid on the left side of the image, containing the title text.

Existing Buildings

- **Retrofits with carbon storing materials** – immediate benefits for carbon-storing insulation and structure
- **Mitigating hazards** – dealing with inherited toxins and performance problems

Codes and permits

- **Carbon pricing** - financial rewards for carbon storage, a level economic playing field
- **Policies to encourage innovation** - simplified alternative compliance pathways
- **“Greening” the codes** - alternative materials and performance-based code

No more “externalities”

Off-site emissions

Heat pumps

“Clean” power

Renewable & storage



Uncalculated Emissions

- Energy source emissions - often greater than the assigned “carbon factor”
- Methane leakage from natural gas, hydro dam reservoirs
- Nuclear energy is not “zero carbon”



What about heat pumps?

- How much accidental refrigerant leakage during installation?
- How much during decommissioning?
- CO2 and alternate refrigerants
- Best practices and trades support

The background of the slide features a photograph of solar panels installed on a roof, with green foliage visible at the bottom and sides. A large white rectangle is overlaid on the left side of the image, containing the title text.

Renewable & Storage

- Do on-site, grid-tied renewables offset emissions or create more?
- What is the embodied carbon of storage technologies?
Is it worth it?

**Where do we go
from here?**

We need each other.

- Professional communities of praxis
- Community connections with diverse groups



We need empowerment

- Citizen scientists, public intellectuals
- Democratic control of resources



Greta Thunberg, Climate Activist



Climate crisis is real and upon us - we do not need permission, we need bold action and conviction to make radical changes in our practice.

By taking immediate action, **everyone in this room can become a part of carbon drawdown**, reversing the imbalance to the planetary carbon cycle that has become known as the driver of “Climate Change”.

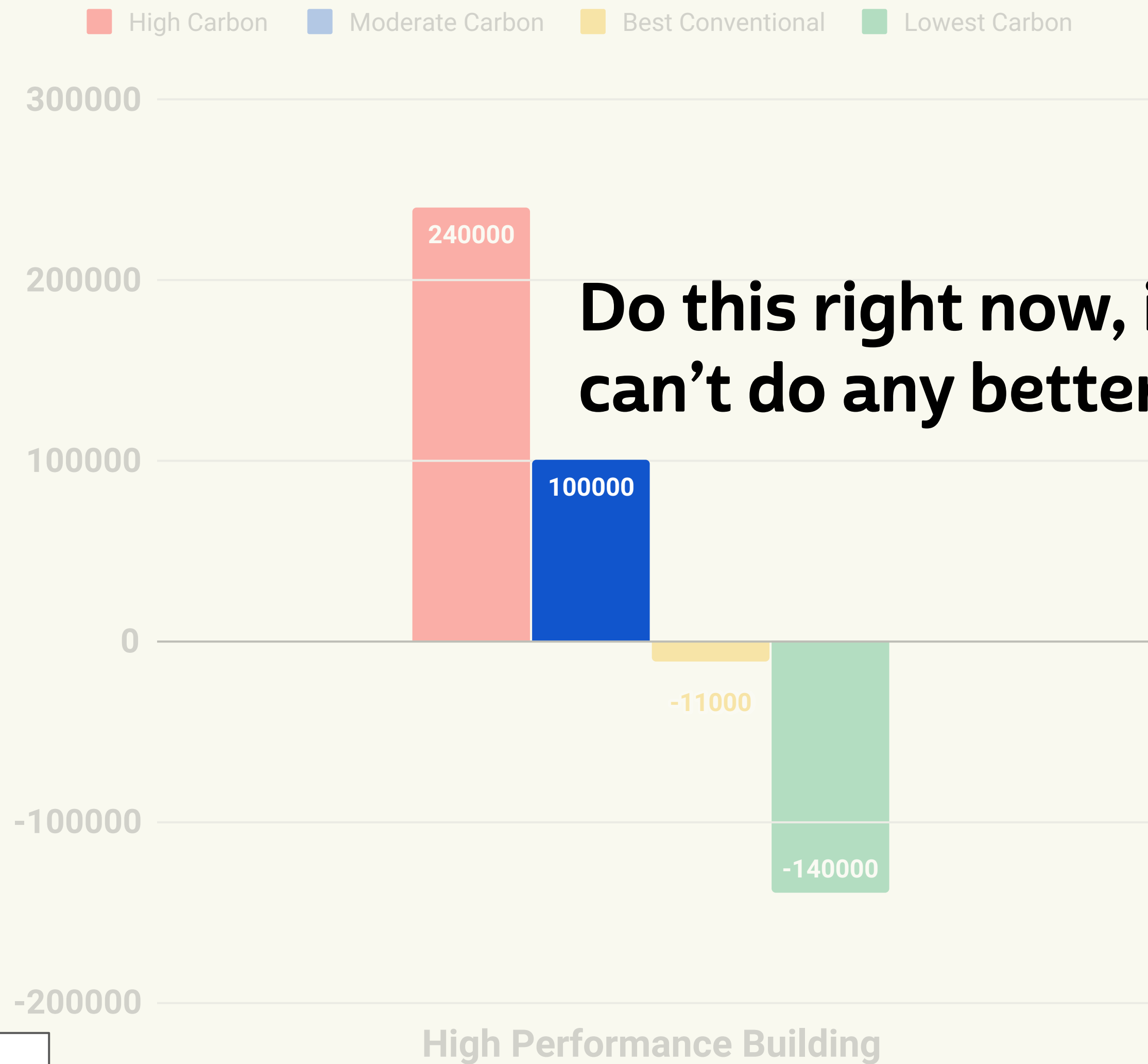
1. Build with plants that build soil, and rocks made from the sky.
2. Fix what we have.
3. Focus on where materials come from and how we get them.
4. Focus on where energy comes from and its total climate impact.
5. Do what we can with current technology and make better technology.
6. Change the codes and educate everybody quickly.
7. Learn how to count carbon, and what the numbers mean.
8. Build relationships of mutual aid with people beyond profit.
9. Build understanding of and relationships with ecological and earth cycles we depend on.
10. Act with great urgency, tremendous passion, and abundant joy.

It's 2024...

Multi-Unit Building
Embodied CO2e Emissions

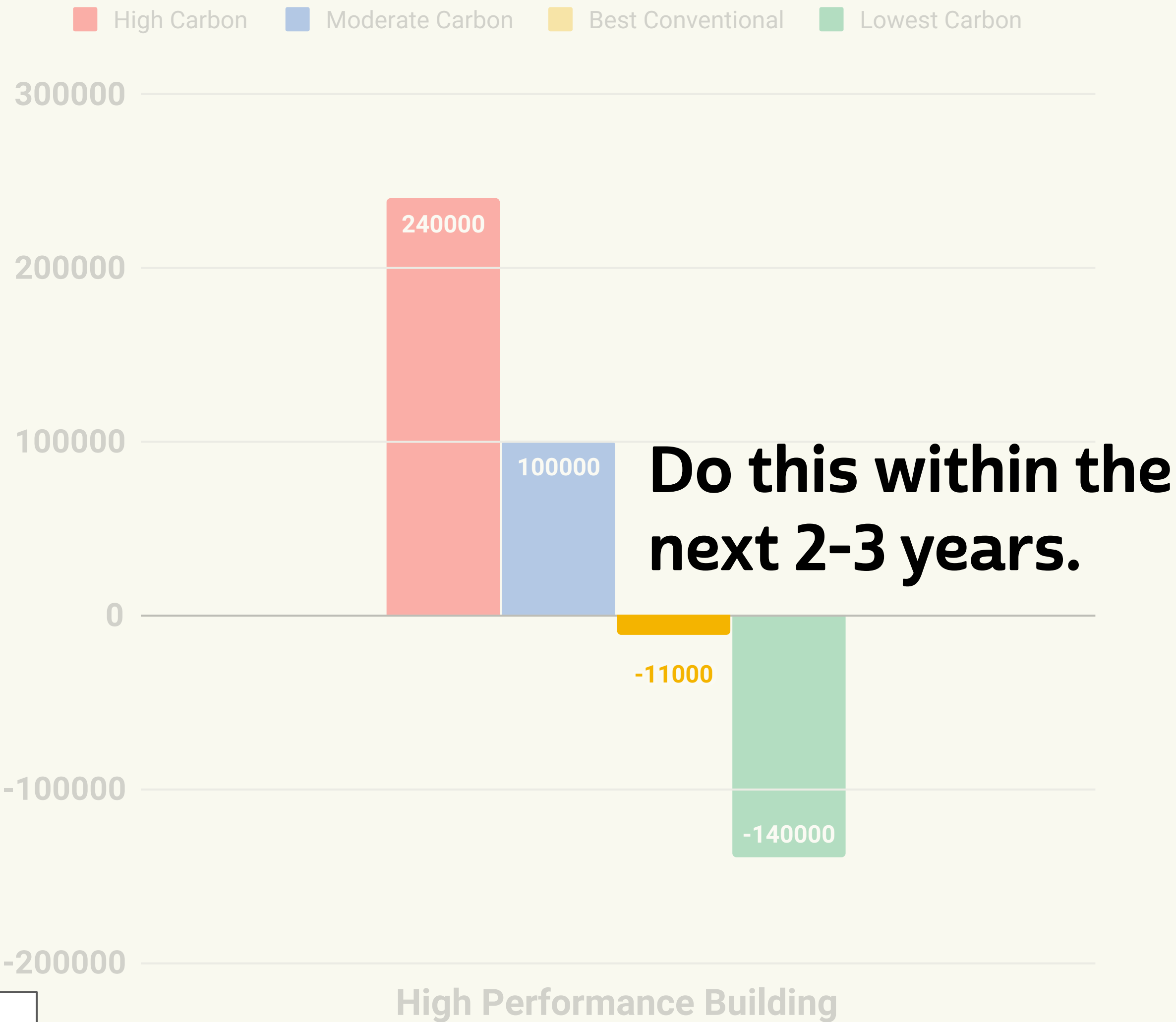


Multi-Unit Building
Embodied CO2e Emissions

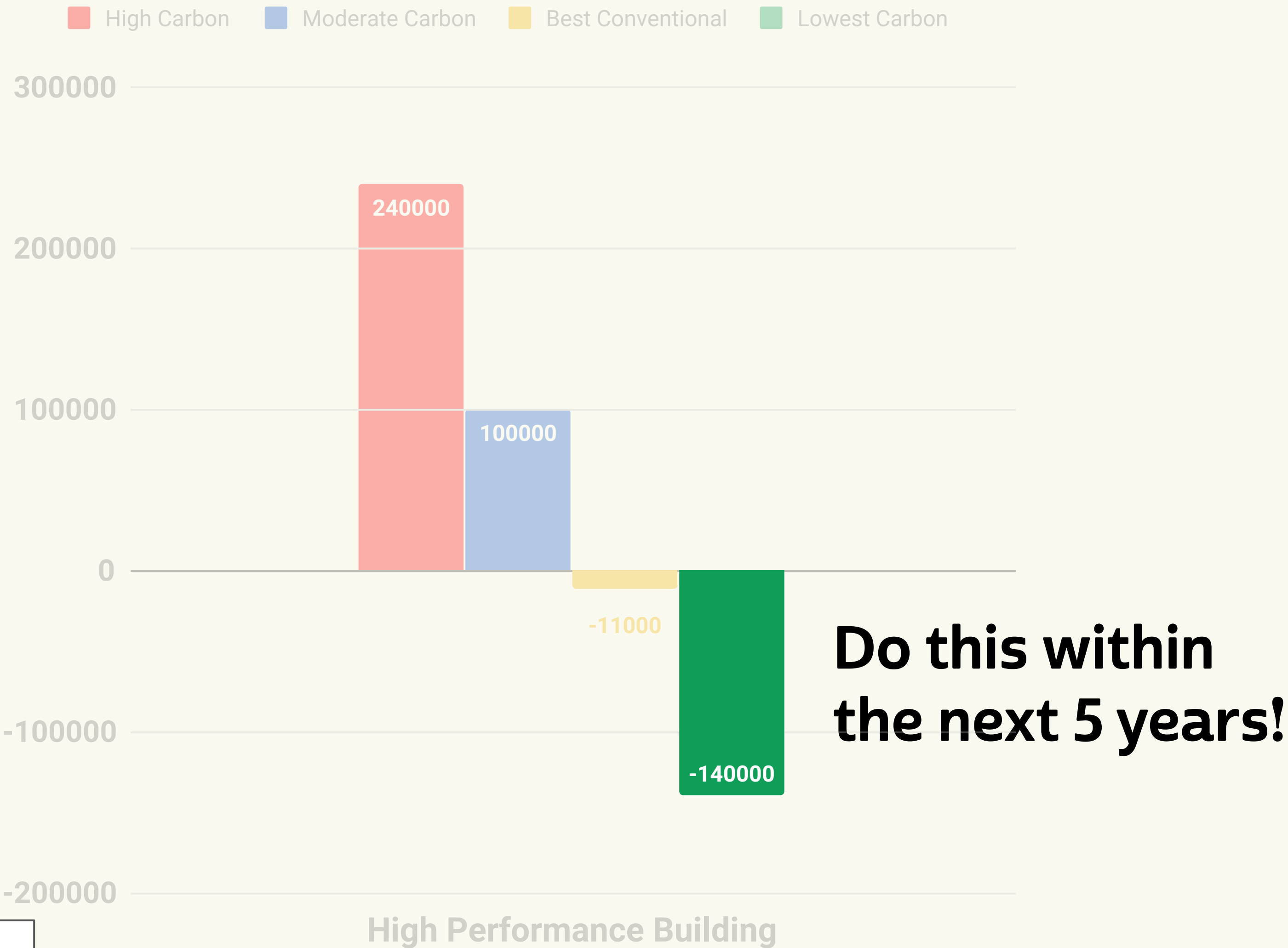


Do this right now, if you
can't do any better

Multi-Unit Building
Embodied CO2e Emissions



Multi-Unit Building
Embodied CO2e Emissions



Resources for Getting There

- Embodied Carbon Network
- Carbon Leadership Forum
- Architecture 2030
- International Living Future Institute -
“Zero Carbon” Certification
- Powerhouse Certification
- One Click LCA
- Tally LCA (Revit)
- Athena Impact Estimator
- BEES Online Database
- ICE Database



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