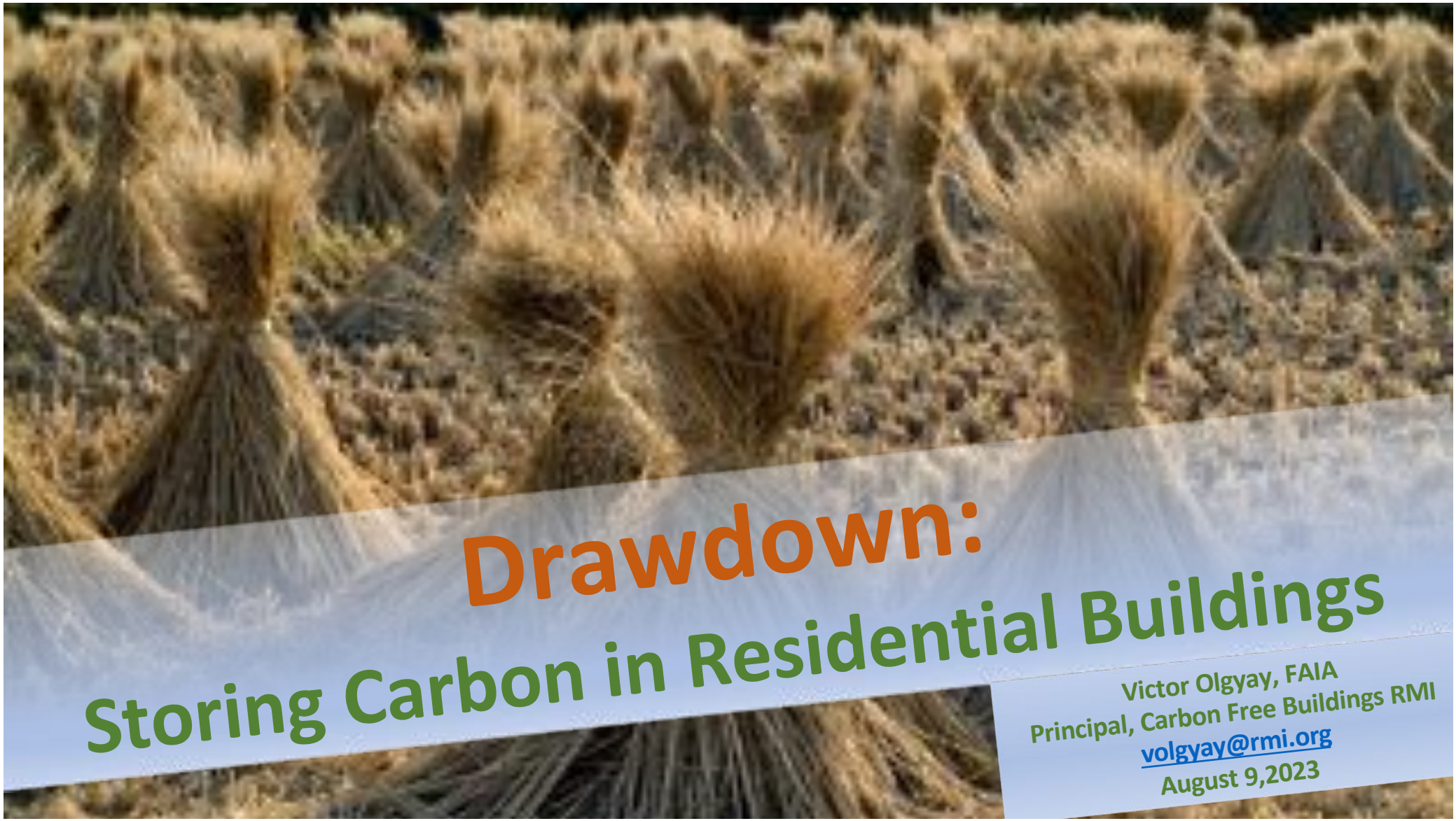

Drawdown:
Storing Carbon in Residential Buildings

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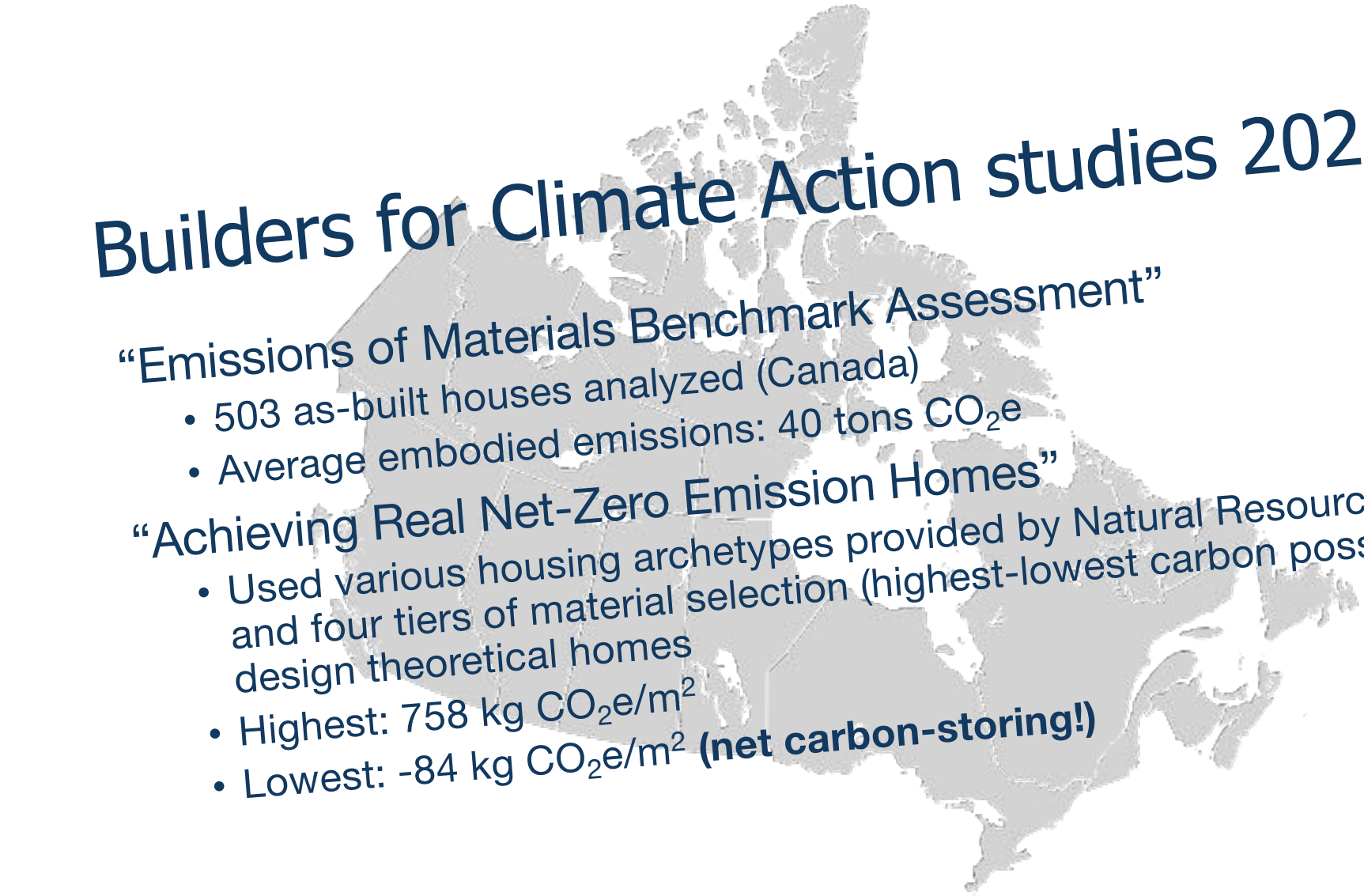
August 9,2023

Using building materials as carbon banks *to provide durable storage over the crucial next decades is not a new idea, but it has not been explored and modeled in a holistic, comprehensive way. To date, studies have focused on the potential impact of a particular material (such as mass timber) and/or specific elements of a building (such as structure) but there has not been a serious effort to* ***model the full potential for carbon storage in buildings****. We have created a model that includes most of a building's mass and applies both decarbonization pathways for conventional materials as well as feasible introduction of available and developing* ***carbon-storing materials*** *will generate inspirational results, demonstrating that this may be among* ***the most achievable and effective pathways for CDR efforts.*** *This presentation puts carbon storage in buildings on the CDR map and provide crucial first steps for the industry to galvanize around this important* ***climate solution****.*


• Average embodied emissions per US home: 36 tons CO_2e
• Total up to 55 million tons of CO_2e /yr in US from new home construction
• Solution: Avoid the 55 million tons, and sequester 50 million tons

Builders for Climate Action studies 2023



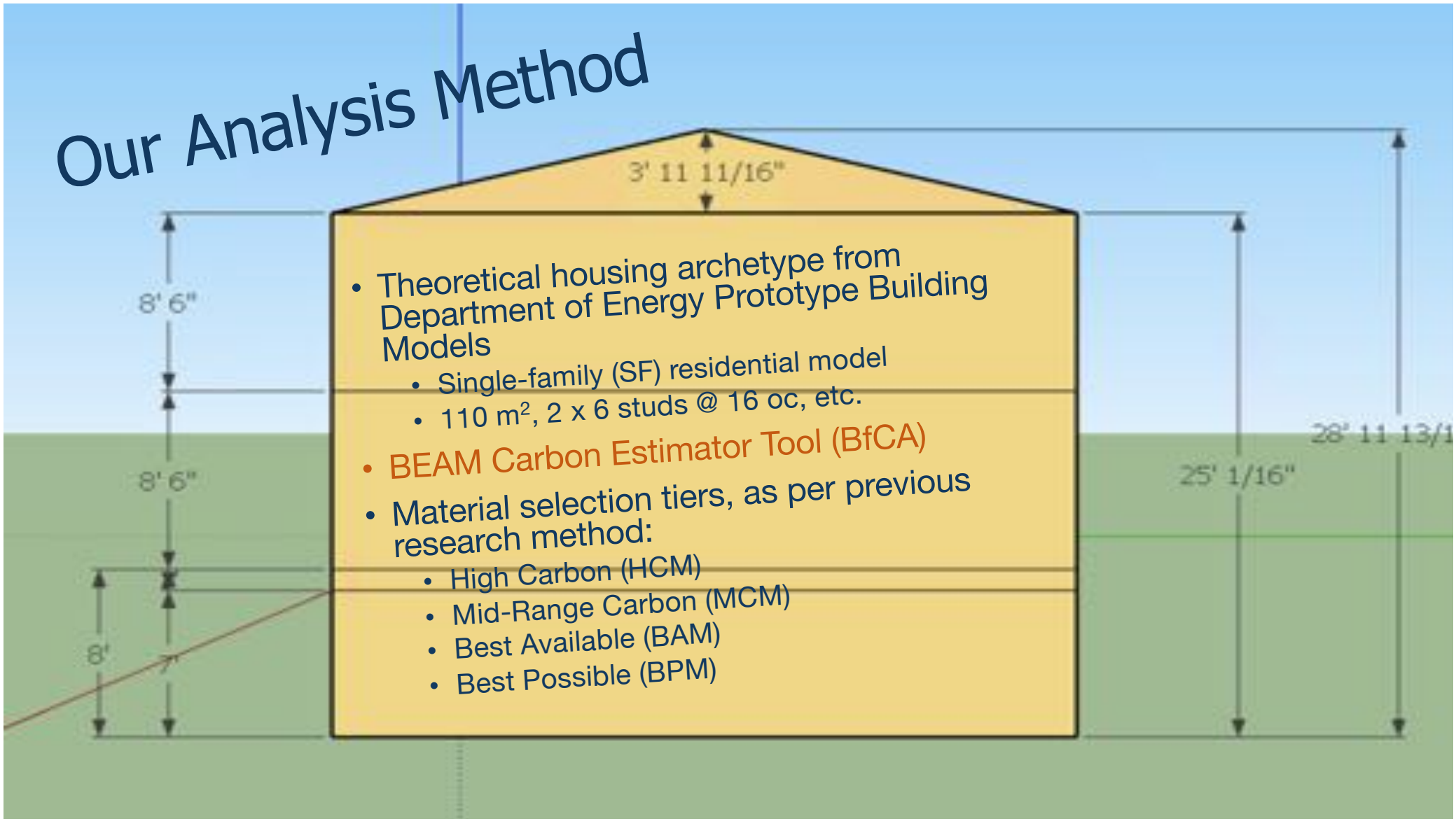
“Emissions of Materials Benchmark Assessment”

- 503 as-built houses analyzed (Canada)
- Average embodied emissions: 40 tons CO_2e

“Achieving Real Net-Zero Emission Homes”

- Used various housing archetypes provided by Natural Resources Canada and four tiers of material selection (highest-lowest carbon possible) to design theoretical homes
- Highest: 758 kg CO_2e/m^2
- Lowest: -84 kg CO_2e/m^2 **(net carbon-storing!)**

Our Analysis Method



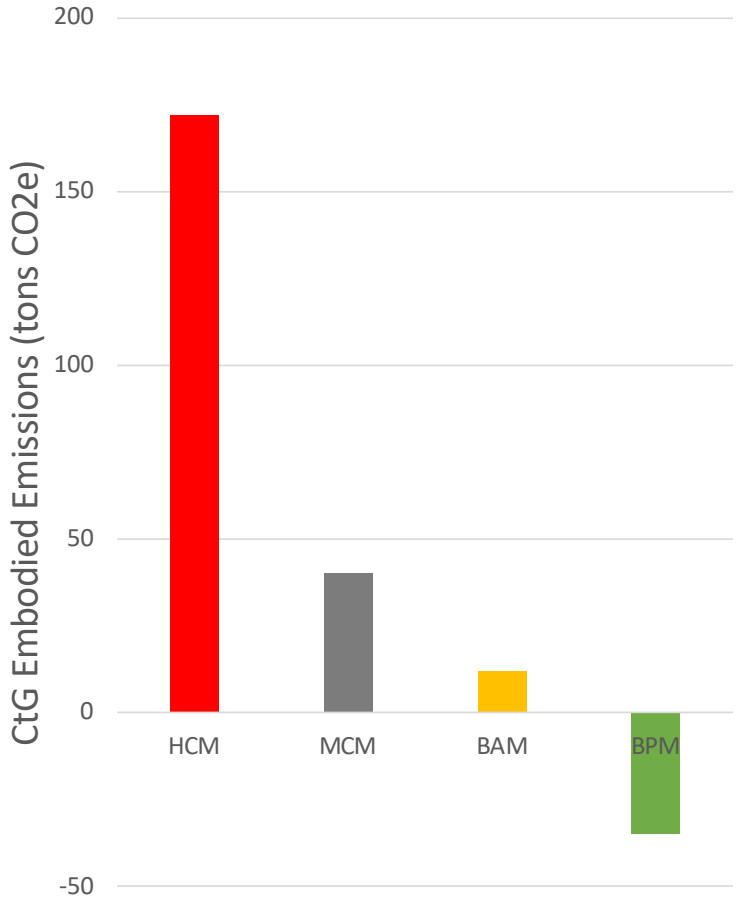
- Theoretical housing archetype from Department of Energy Prototype Building Models
  - Single-family (SF) residential model
  - 110 m^2, 2 x 6 studs @ 16 oc, etc.
- BEAM Carbon Estimator Tool (BfCA)
- Material selection tiers, as per previous research method:
  - High Carbon (HCM)
  - Mid-Range Carbon (MCM)
  - Best Available (BAM)
  - Best Possible (BPM)

Material Selection Tiers

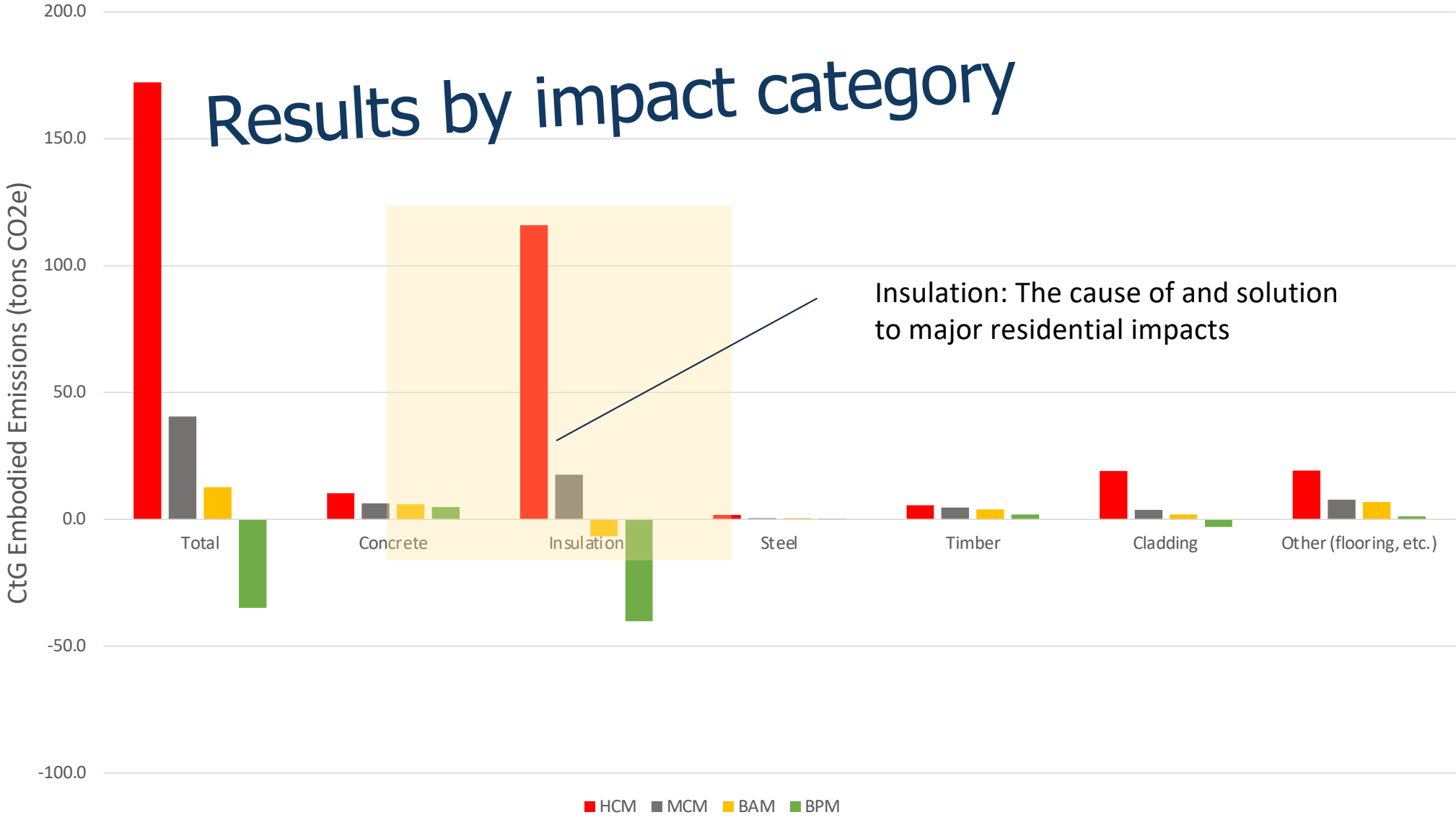
- High Carbon (HCM)
  - Highest possible emission materials on BEAM tool, worst-case scenario but all commonly used
  - Heavyweight concrete (31-35 MPa) <14% FA/SL, aerogel insulation, etc.
- Mid-Range Carbon (MRM)
  - Most used mid-range emission materials
  - 0-25 MPa concrete 30-40% fly ash, mineral wool batt insulation, etc.
- Best Available (BAM)
  - Low carbon widely available materials
  - Linoleum flooring, cellulose insulation, etc.
- Best Possible (BPM)
  - Lowest possible emission materials in BEAM, some not yet available in mainstream market
  - Lightweight concrete (<2500 psi) >50% SCM, straw bale insulation, bamboo flooring and cladding, etc.

Overall Results

- High Carbon (HCM)
  - 172 tons CO_2e, 1560 kg CO_2e/m^2
- Mid-Range Carbon (MRM)
  - 40 tons CO_2e, 360 kg CO_2e/m^2
- Best Available (BAM)
  - 12 tons CO_2e, 110 kg CO_2e/m^2
- Best Possible (BPM)
  - -35 tons CO_2e, -320 kg CO_2e/m^2

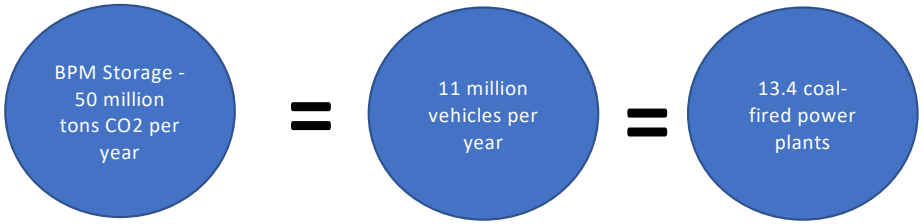


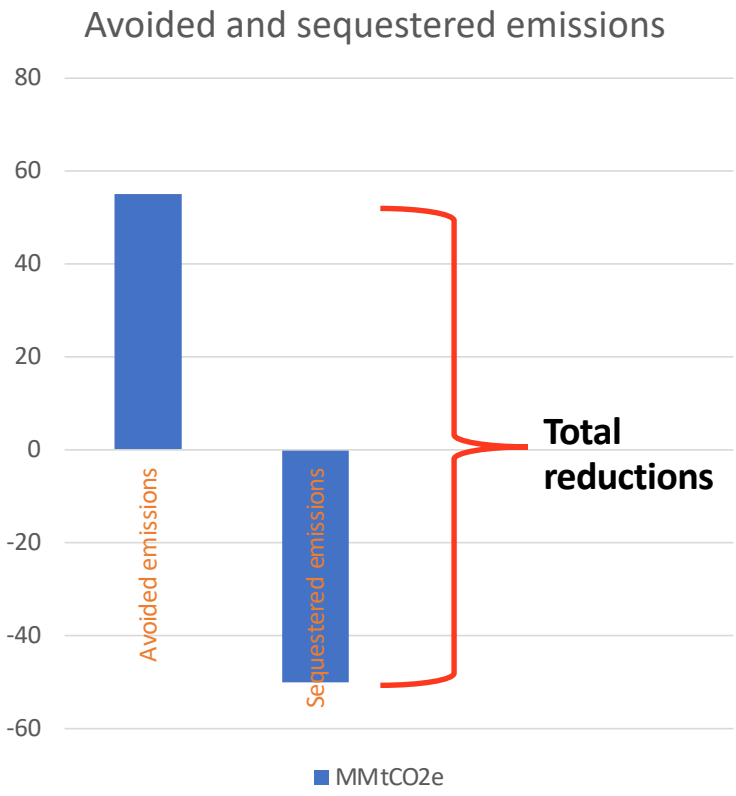
Results by impact category



Annual potential US emissions reductions

- Building using Best Available (BAM) material selection could **reduce embodied emissions by 70% per year**, from 55 to 16.5 million tons
- Building using Best Possible (BPM) materials acts as net carbon storage, could theoretically **store up to 50 million tons of CO_2e per year** (equivalent to annual emission of 11 million vehicles!)
- Easy switches: switching from mid-range insulation (mineral wool) to cellulose saves 24 tons alone, **switching to straw insulation saves 57 tons CO_2e**






Manufactured carbon storing panels, made from agricultural byproducts

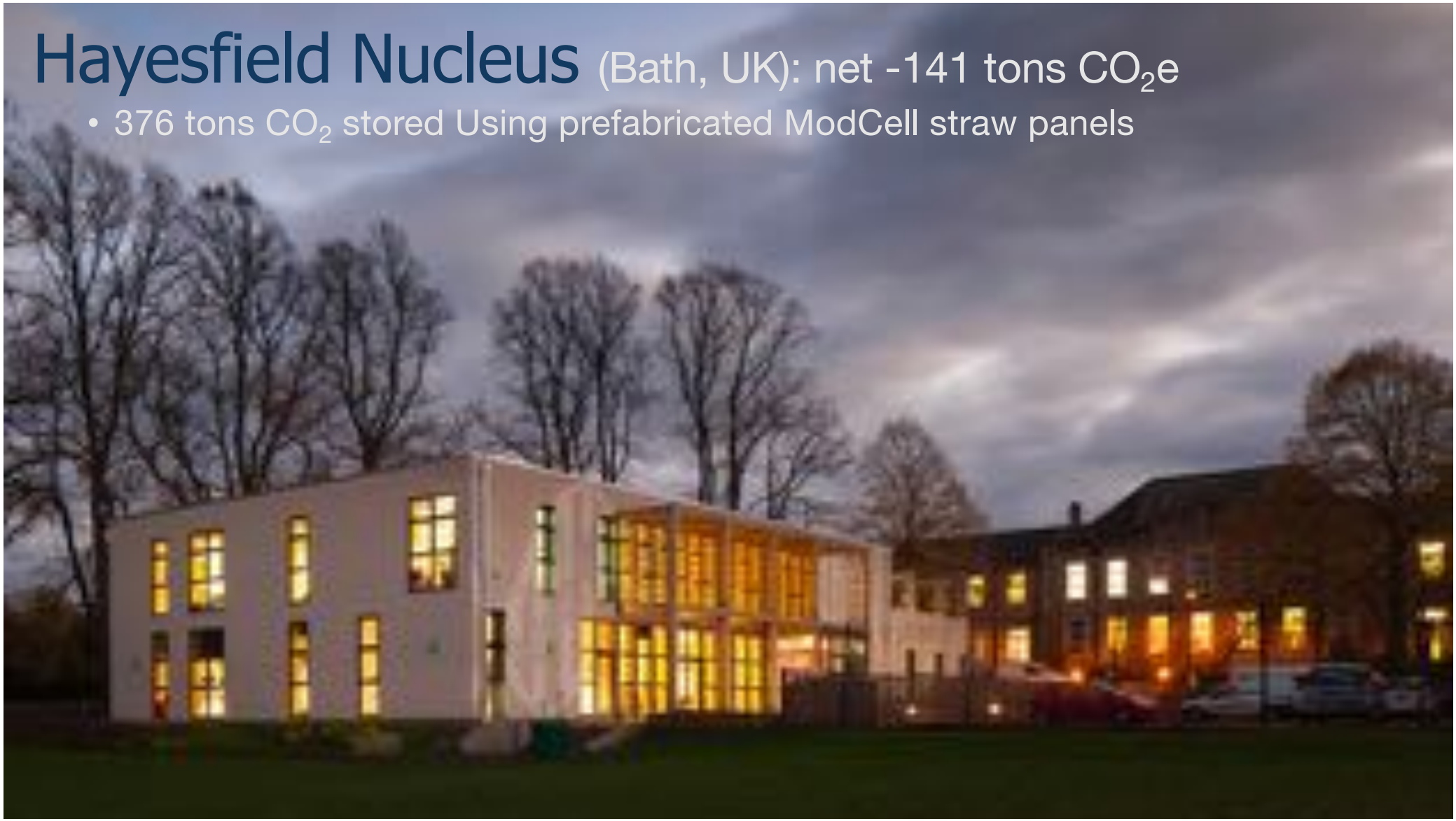
Case Studies: it is being done today

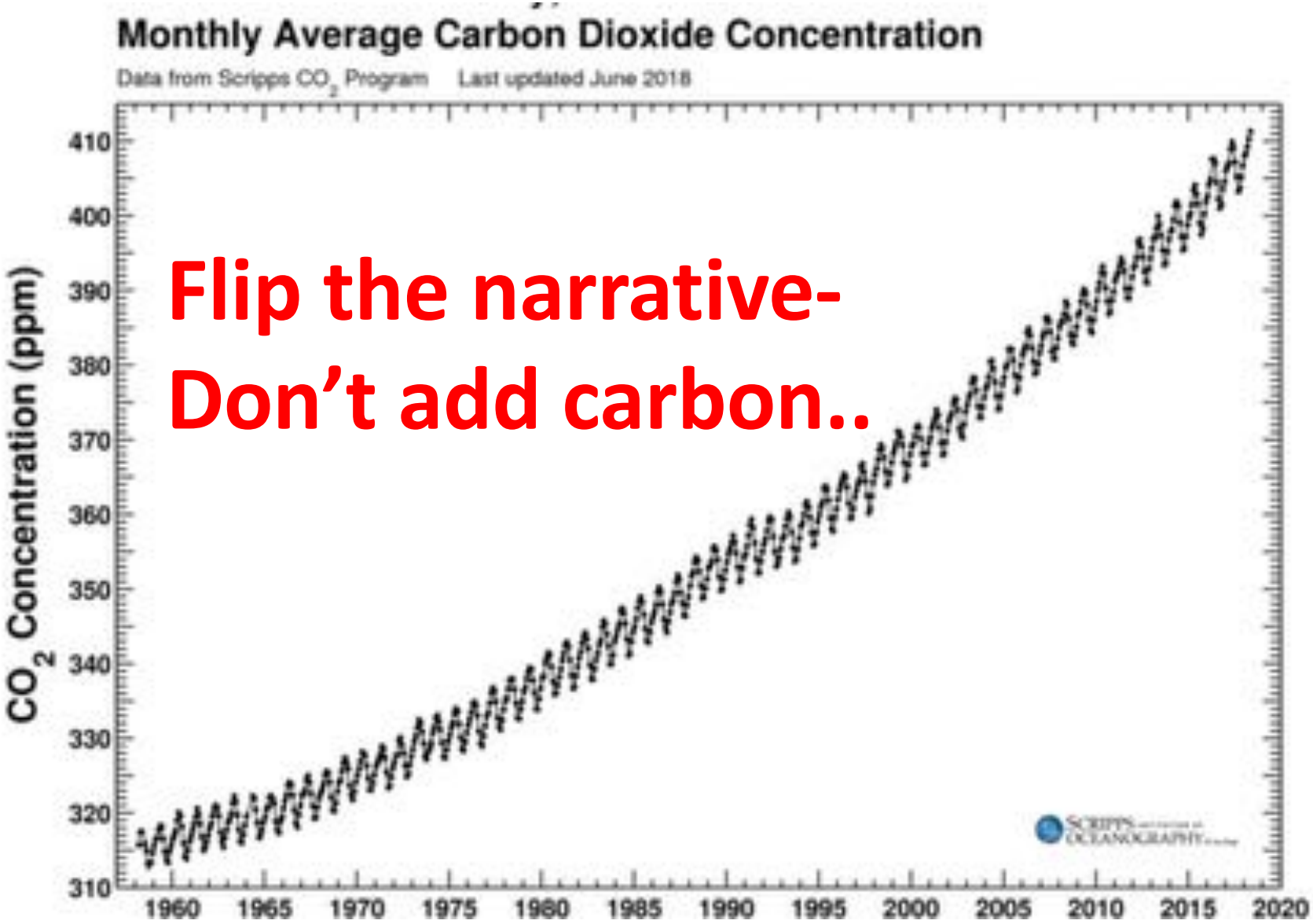
Net negative material emissions in 45 Danish Buildings

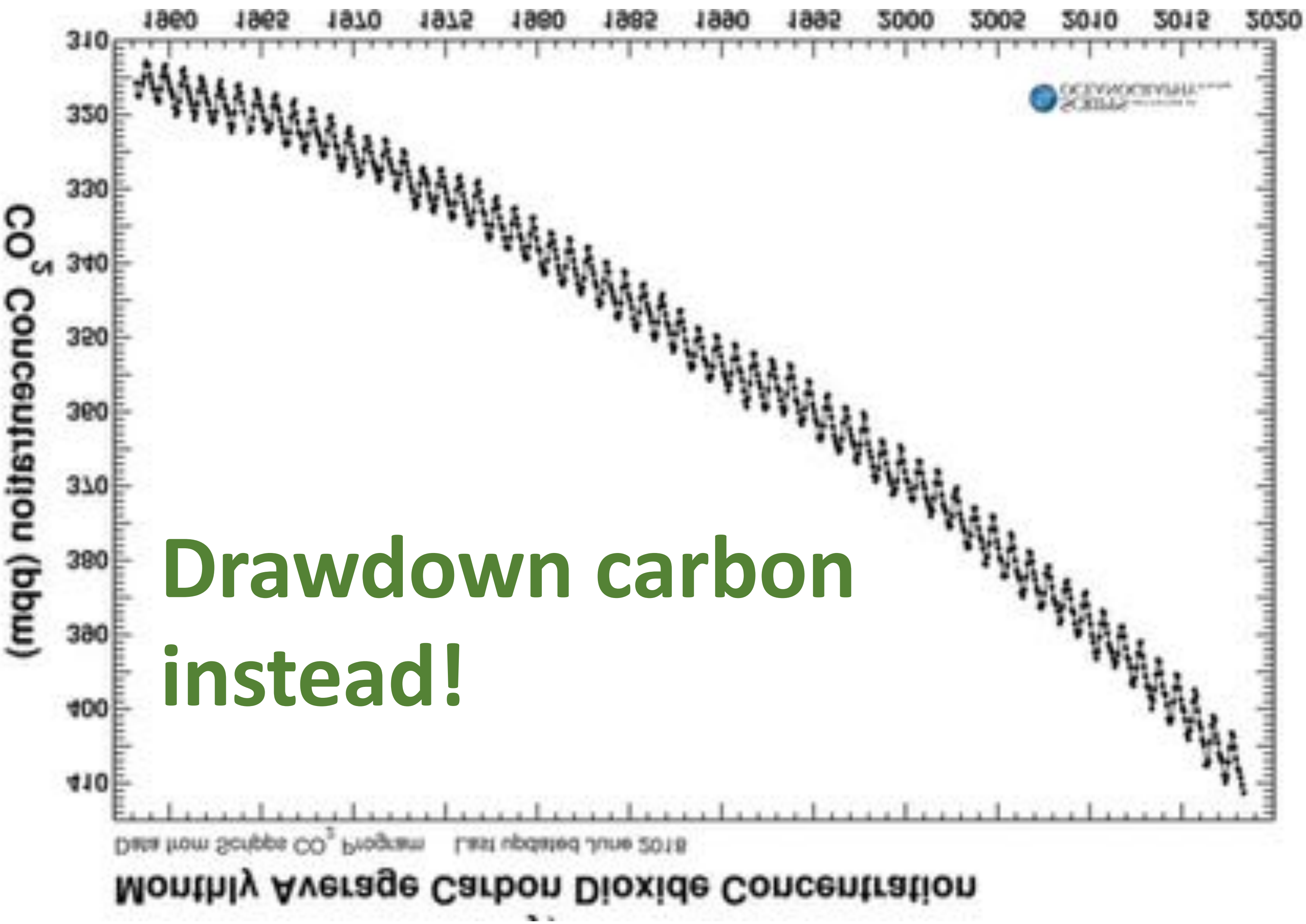
"Ebeltoft Straw Building" (Ebeltoft, Denmark): -15 tons CO_2e
147 m^2, -105 kg CO_2e/m^2
"Freeland" (Rønde, Denmark): -25 tons CO_2e
143 m^2, -175 kg CO_2e/m^2
"Broader" (Stevns, Denmark): -30 tons CO_2e
100 m^2, -295 kg CO_2e/m^2

Hayesfield Nucleus (Bath, UK): net -141 tons CO_2e

- 376 tons CO_2 stored Using prefabricated ModCell straw panels




Monthly Average Carbon Dioxide Concentration
Data from Scripps CO2 Program Last updated June 2018
CO2 Concentration (ppm)
410
400
390
380
370
360
350
340
330
320
310
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Flip the narrative-
Don’t add carbon..


Drawdown carbon instead!
CO2 Concentration (ppm)
Data from Scripps CO2 Program Last updated June 2018
Monthly Average Carbon Dioxide Concentration

Thank you!

With your help,
we will use building construction to draw down atmospheric carbon

For more information visit
rmi.org/buildings

Credit to
Chris Magwood,
Bruce King,
Luca Brown,
And many , many others.

Fire and Ice

By Robert Frost

Some say the world will end in fire,
Some say in ice.
From what I've tasted of desire
I hold with those who favor fire.
But if it had to perish twice,
I think I know enough of hate
To say that for destruction ice
Is also great
And would suffice.