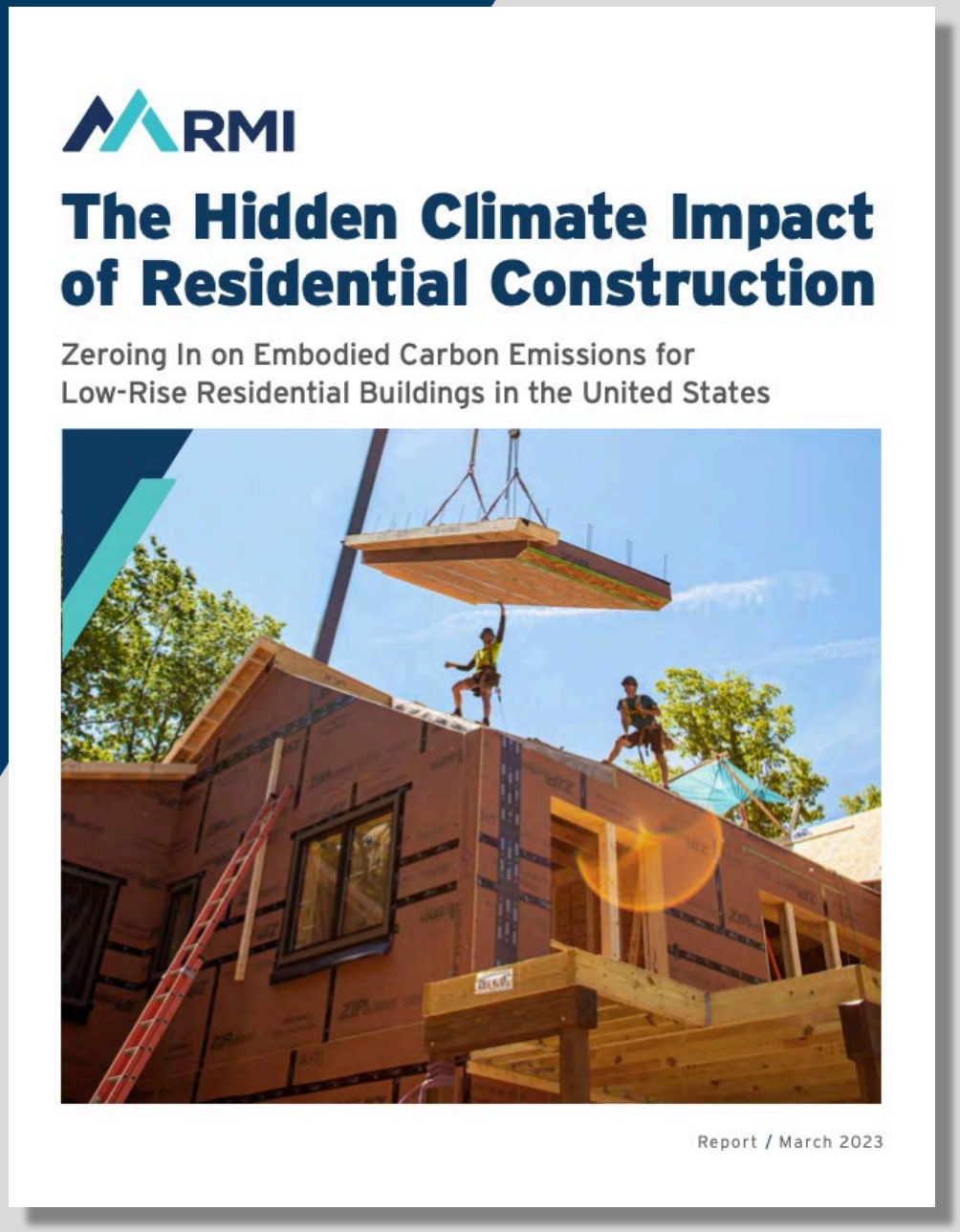
Homebuilders leading decarbonization

Chris Magwood,
RMI Carbon-Free Buildings team
January 30, 2024

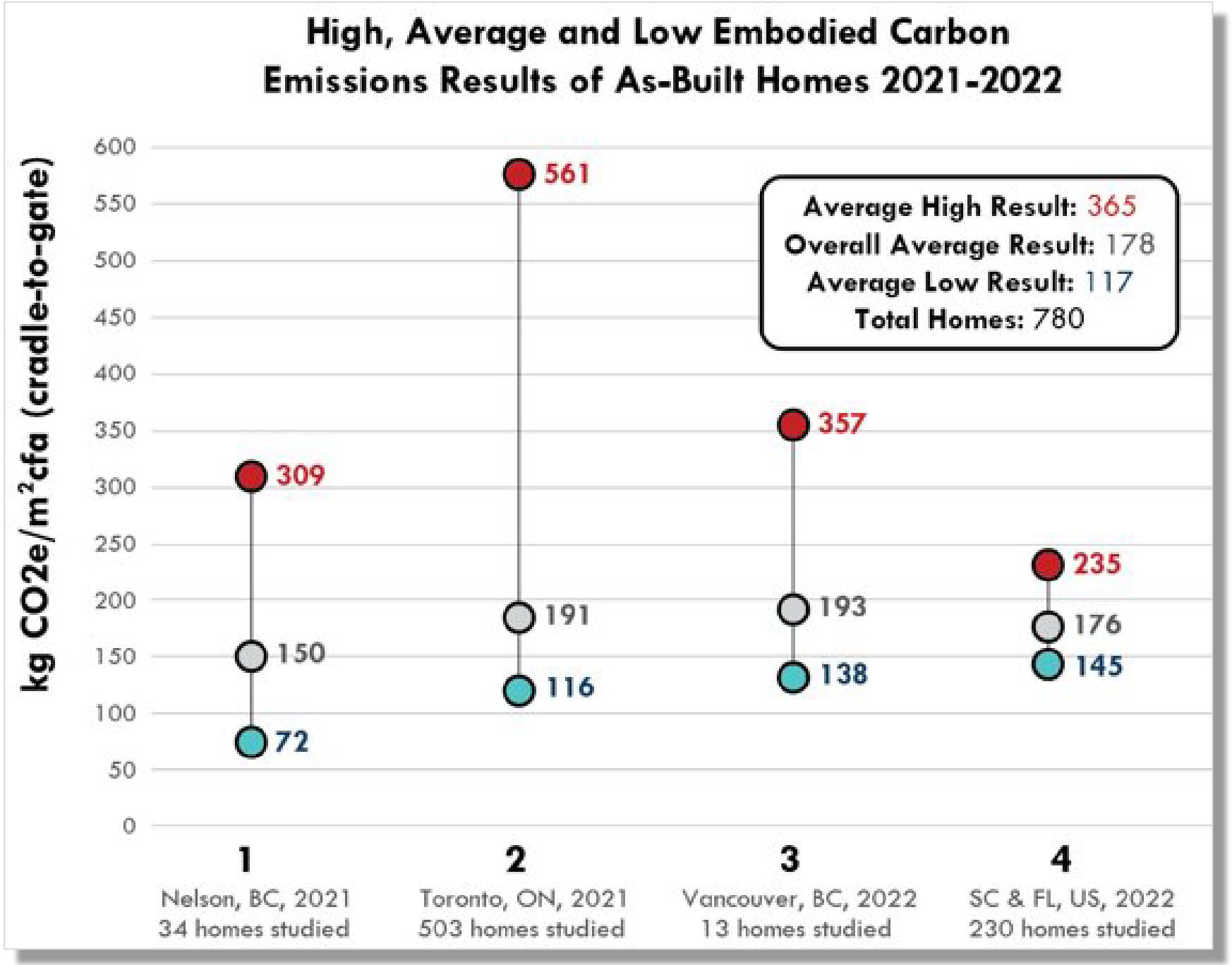


WHY SHOULD I CARE ABOUT EMBODIED CARBON?

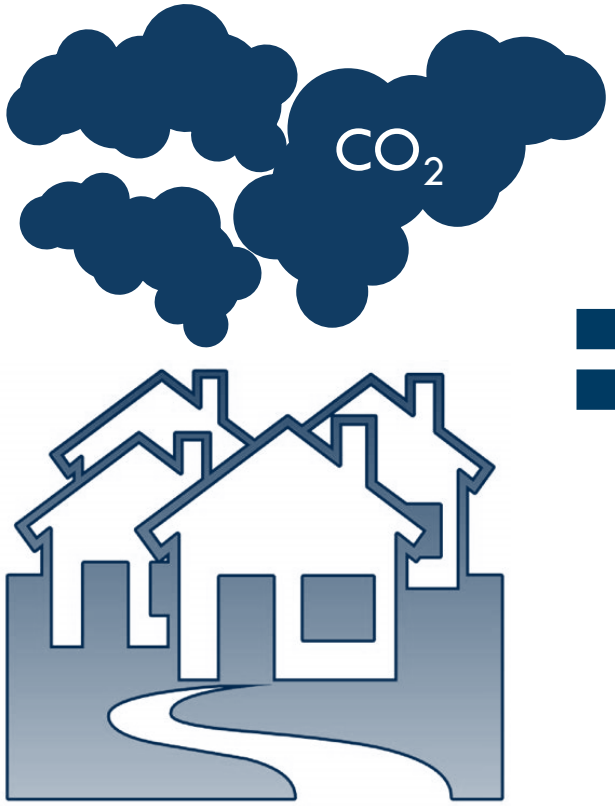
Embodied carbon average:	**44** tons CO2e
Operational carbon HERS 55:	**8** tons CO2e/year
Operational carbon HERS 30:	**4** tons CO2e/year

Embodied carbon is likely
the biggest source of emissions from
your homes for next **5-15 years**

Study results



WHY SHOULD I CARE ABOUT EMBODIED CARBON?



=

Mt CO_2e

~55

annually from new home construction

=

Entire country emissions

MtCO2e fossil emissions in 2021*

Austria	66.0
Greece	53.4
Hungary	50.7
Norway	42.3

=

13 coal-fired power plants

* https://data.jrc.ec.europa.eu/collection/edgar

Takeaways from studies

	HIGHEST RESULTS
Vancouver Study 13 as-built homes	**357** kg CO_2e/m^2
Nelson & Castlegar 34 as-built homes	**309** kg CO_2e/m^2
EMBARC Study (GTHA) 503 as-built homes	**561** kg CO_2e/m^2
FLA & SC study 230 as-built homes	**235** kg CO_2e/m^2

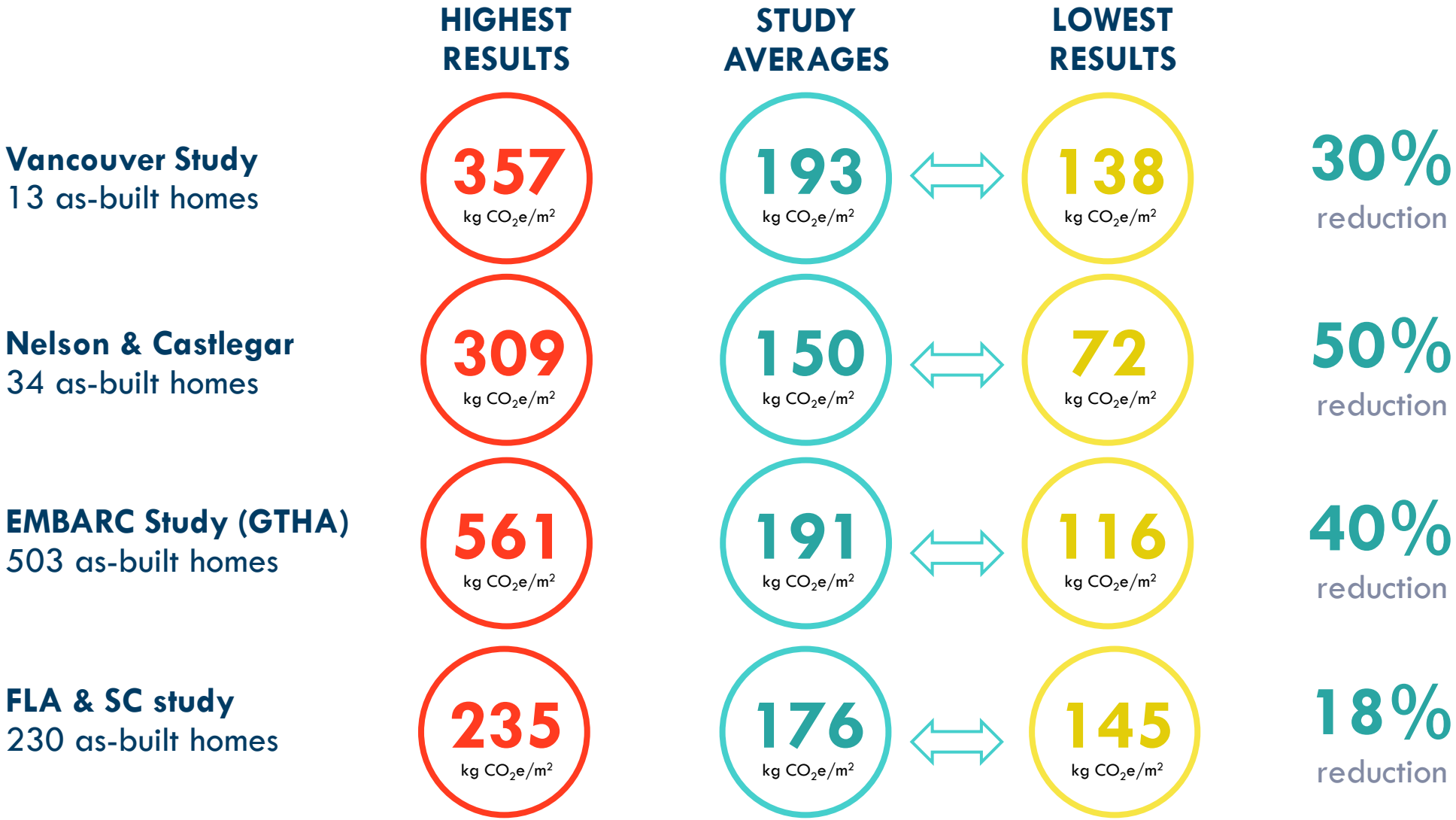
Takeaways from studies

	HIGHEST RESULTS	STUDY AVERAGES
Vancouver Study 13 as-built homes	357 kg CO_2e/m^2	193 kg CO_2e/m^2
Nelson & Castlegar 34 as-built homes	309 kg CO_2e/m^2	150 kg CO_2e/m^2
EMBARC Study (GTHA) 503 as-built homes	561 kg CO_2e/m^2	191 kg CO_2e/m^2
FLA & SC study 230 as-built homes	235 kg CO_2e/m^2	176 kg CO_2e/m^2

Takeaways from studies

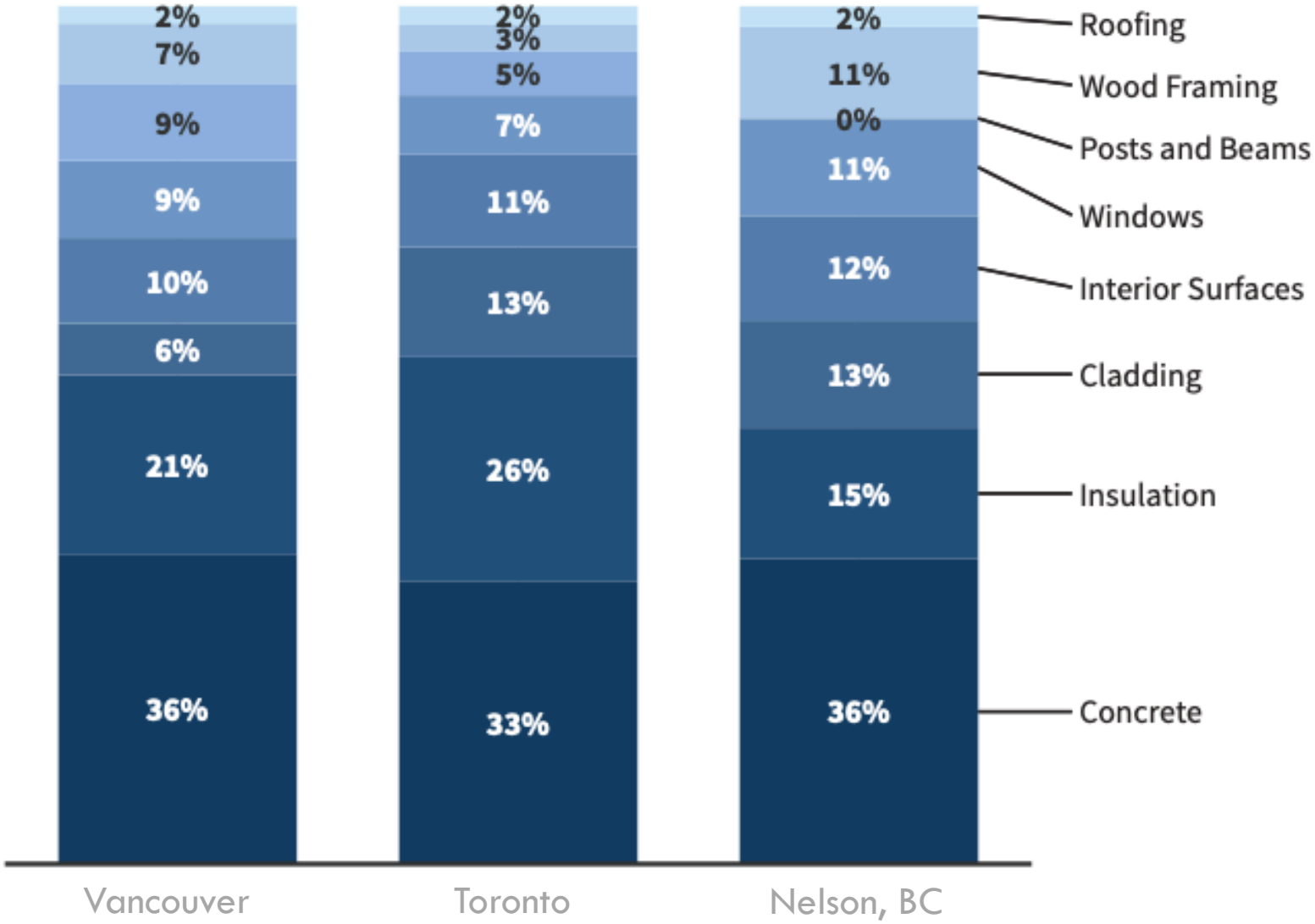
	HIGHEST RESULTS	STUDY AVERAGES	LOWEST RESULTS
Vancouver Study 13 as-built homes	357 kg CO_2e/m^2	193 kg CO_2e/m^2	138 kg CO_2e/m^2
Nelson & Castlegar 34 as-built homes	309 kg CO_2e/m^2	150 kg CO_2e/m^2	72 kg CO_2e/m^2
EMBARC Study (GTHA) 503 as-built homes	561 kg CO_2e/m^2	191 kg CO_2e/m^2	116 kg CO_2e/m^2
FLA & SC study 230 as-built homes	235 kg CO_2e/m^2	176 kg CO_2e/m^2	145 kg CO_2e/m^2

Takeaways from studies



Takeaways from studies

Concrete, insulation, cladding & interior surfaces are 70% of total



Basic embodied carbon math

Material quantity

Area-based takeoffs

MEP takeoffs

Emission factor

From EPDs or other approved data source

Product emissions

kg CO2e

per life cycle phase

Estimating material carbon emissions

Emission data sources

EPD – Product Impacts

Declared Unit: 1 m^3

Construction Material

Amount per Unit	
Global Warming Potential	450 $kgCO_2e$
Emitted	475 $kgCO_2e$
Sequestered	-25 $kgCO_2e$
Ozone Depletion	0.00 kgCFC11e
Acidification Potential	3.01 $kgSO_2e$
Eutrophication Potential	0.15 kgNe
Smog Formation	0.63 kgO_3e
Primary Energy Demand	3020 MJ
Non-renewable	3045 MJ
Renewable	25 MJ

An **Environmental Product Declaration** (EPD) "quantifies environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function."

The EPD methodology follows ISO series 14040 requirements.

Reports in kg CO2e.

Reporting material carbon emissions

Net emissions & emissions intensities

Net emissions
kg CO_2e

=

kg CO_2e

or

t CO2e

Total emissions for house

Totals for gov'ts

Totals for ESG reports

Net emissions
kg CO_2e

÷

Conditioned
floor area

=

Emissions intensity

kg CO_2e/m^2cfa

Normalizes for size

Benchmarking/targets

Prioritize living space

Net emissions
kg CO_2e

÷

Total floor
area

=

Emissions intensity

kg CO_2e/m^2

Normalizes for size

Gives advantage to unoccupied spaces

Net emissions
kg CO_2e

÷

Bedrooms

=

Emissions intensity

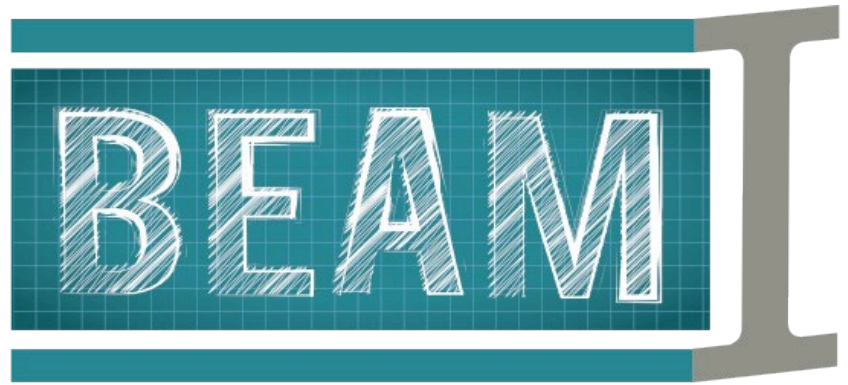
kg CO_2e/bedroom

Normalizes for occupants

Prioritize density

Important to municipalities

Tool for studies



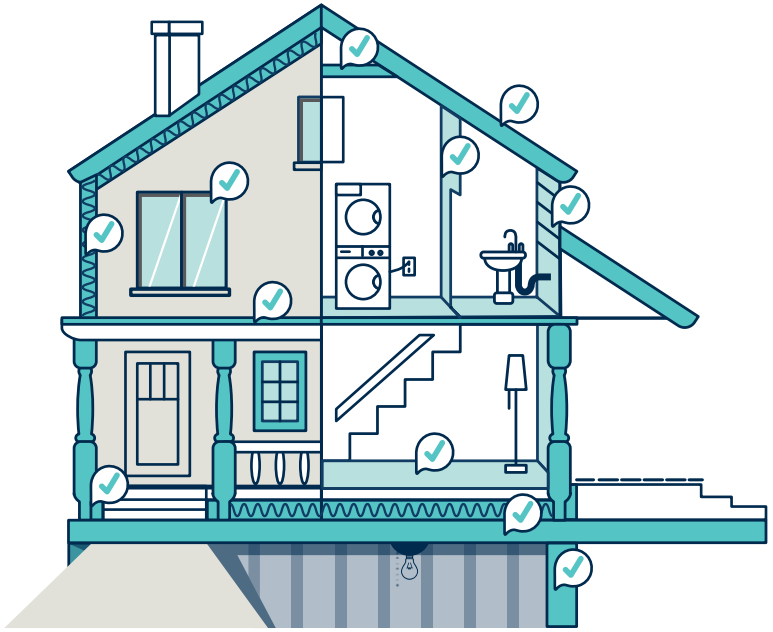
BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

Free spreadsheet tool:

EPD database and material takeoff estimation

Includes carbon storage (except timber)

Not yet counting everything...



Included:

Structure, enclosure and partition materials

Excluded:

Mechanical, electrical, plumbing, fixtures, appliances, surface finishes, millwork, site work, infrastructure

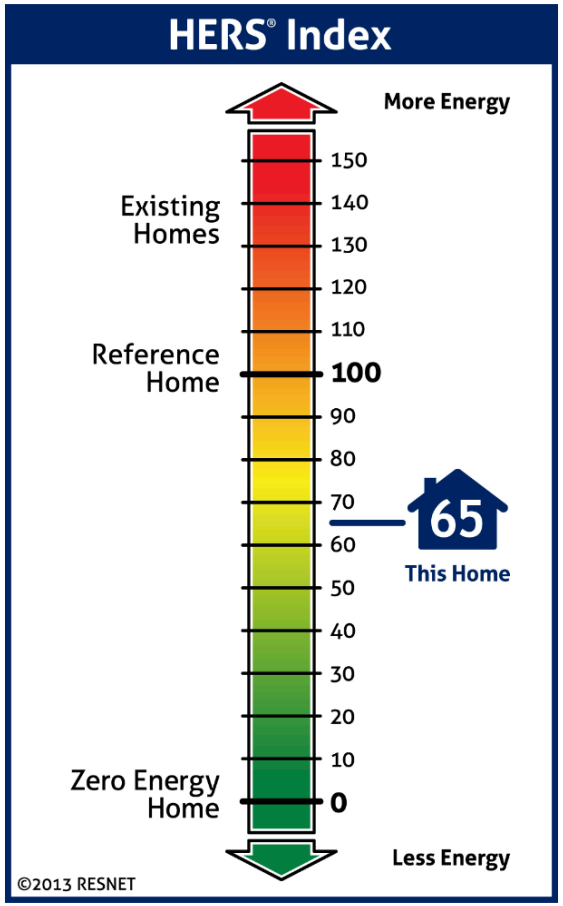
Estimations for missing elements

Element	For 200 m² house (2150 ft²)
Electric heat pump or condensing gas boiler 15-20 kW/h	500 kg CO2e
HRV/ERV, central system 1000 m3/h	370 kg CO2e
Ductwork 110 ft / 1000 ft²	100 kg CO2e
Wiring 1000 ft of 12/2, 2000 ft of 14/2 and 750 ft of 14/3	1900 kg CO2e
Toilets, sinks, and tubs 3 each	1200 kg CO2e
Hot water tank 60 gallons	200 kg CO2e
Countertops 4m² assumed	250 kg CO2e
Paint 600 m² of interior walls and ceilings; average of 3.5 kg CO2e/m²	2100 kg CO2e
Exterior Doors 3 assumed	1100 kg CO2e
Interior Doors 12 assumed	1250 kg CO2e
Appliances 4 assumed (dishwasher, oven/range, clothes washer/drier)	600 kg CO2e
TOTAL	**9,570** kg CO2e
TOTAL PER m²	**48 kg CO2e/m²**

20-25% more than studies reported

Myth-busting embodied carbon

Data isn't good enough

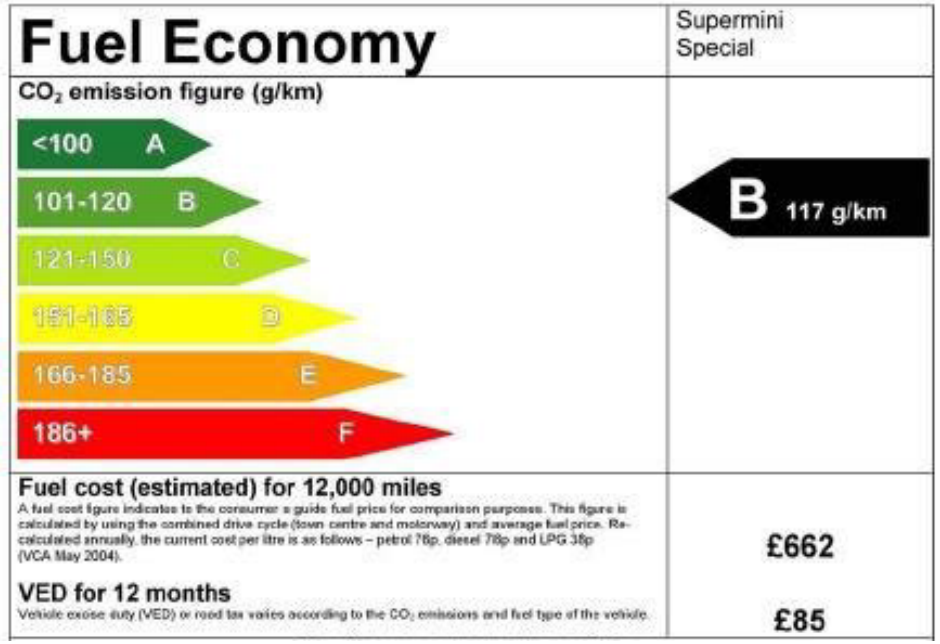


IT'S A LOT LIKE ENERGY MODELING

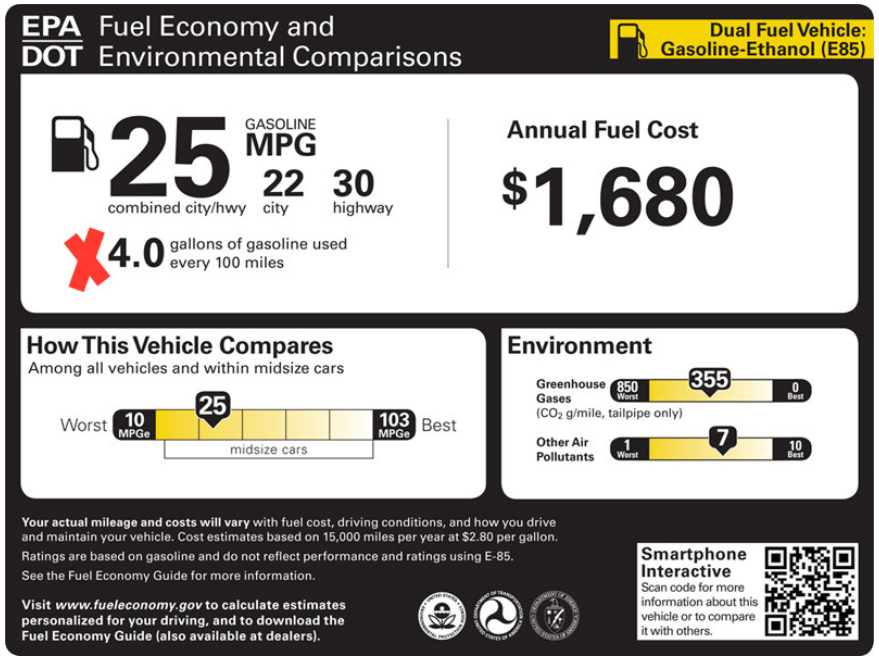
- Prediction using standardized assumptions
- Allows for comparisons of interventions
- Enables decisions based on scale of intervention

Myth-busting embodied carbon

Data isn't good enough



vs.



Myth-busting embodied carbon

Data isn't good enough

Using embodied carbon tools

BEAM / BUILDERS FOR CLIMATE ACTION	REVIEW PROJECT MATERIALS	4,439	4,570	130
SECTION	**CATEGORY**	**MATERIAL**	**NET EMISSIONS ($kg\ CO_2e$)**	**CARBON EMISSIONS ($kg\ CO_2e$)**	**CARBON STORAGE ($kg\ CO_2e$)**
Exterior Walls	STRUCTURAL INSULATED PANELS	SIP panel - R30 8.25" - EPS 7.25" @ R4/in. core, 2 sheets 1/2" OSB	2,975	2,975	0
Exterior Wall Cladding	EXTERIOR WALL CLADDING	Fiber Cement siding / Cembrit / Patina / 8 mm (5/16")	1,179	1,309	130
Exterior Wall Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	285	285	0

Using embodied carbon tools

BEAM | BUILDERS FOR CLIMATE ACTION

REVIEW PROJECT MATERIALS | **4,439** | **4,570** | **130**

SECTION	CATEGORY	MATERIAL	NET EMISSIONS (kg CO_2e)	CARBON EMISSIONS (kg CO_2e)	CARBON STORAGE (kg CO_2e)
Exterior Walls	STRUCTURAL INSULATED PANELS	SIP panel - R30 8.25" - EPS 7.25" @ R4/in. core, 2 sheets 1/2" OSB	2,975	2,975	0
Exterior Wall Cladding	EXTERIOR WALL CLADDING	Fiber Cement siding / Cembrit / Patina / 8 mm (5/16")	1,179	1,309	130
Exterior Wall Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	285	285	0

BEAM | BUILDERS FOR CLIMATE ACTION

REVIEW PROJECT MATERIALS | **2,748** | **2,879** | **130**

SECTION	CATEGORY	MATERIAL	NET EMISSIONS (kg CO_2e)	CARBON EMISSIONS (kg CO_2e)	CARBON STORAGE (kg CO_2e)
Exterior Walls	LIGHT WOOD FRAME WALLS	Wood / SPF / 2x6 Lumber / AWC & CWC [Industry Avg | US & CA]	258	258	0
Exterior Walls	STRUCTURAL SHEATHING	OSB sheathing / 1/2" / AWC & CWC [Industry Avg | US & CA]	361	361	0
Exterior Walls	CAVITY INSULATION	Fiberglass batt / R 3.6/inch [BEAM Avg]	277	277	0
Exterior Walls	CONTINUOUS INSULATION	EPS foam board / R 4.0/inch, Type II, 15 psi (100 kPa) / EPS Industry Alliance [Industry Avg | US & CA]	389	389	0
Exterior Wall Cladding	EXTERIOR WALL CLADDING	Fiber Cement siding / Cembrit / Patina / 8 mm (5/16")	1,179	1,309	130
Exterior Wall Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	285	285	0

Using embodied carbon tools

BEAM | BUILDERS FOR CLIMATE ACTION

REVIEW PROJECT MATERIALS | **4,439** | **4,570** | **130**

SECTION	CATEGORY	MATERIAL	NET EMISSIONS (kg CO_2e)	CARBON EMISSIONS (kg CO_2e)	CARBON STORAGE (kg CO_2e)
Exterior Walls	STRUCTURAL INSULATED PANELS	SIP panel - R30 8.25" - EPS 7.25" @ R4/in. core, 2 sheets 1/2" OSB	2,975	2,975	0
Exterior Wall Cladding	EXTERIOR WALL CLADDING	Fiber Cement siding / Cembrit / Patina / 8 mm (5/16")	1,179	1,309	130
Exterior Wall Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	285	285	0

BEAM | BUILDERS FOR CLIMATE ACTION

REVIEW PROJECT MATERIALS | **9,241** | **9,371** | **130**

SECTION	CATEGORY	MATERIAL	NET EMISSIONS (kg CO_2e)	CARBON EMISSIONS (kg CO_2e)	CARBON STORAGE (kg CO_2e)
Exterior Walls	EPS FOAM ICF WALLS	EPS FOAM ICF R-23, 2 Sheets of 2.75"@R4/in., webbing, 15M rebar (not incl. 6" concrete core)	2,903	2,903	0
Exterior Walls	EPS FOAM ICF WALLS	Concrete – 0-25 MPa, 25-34% Slag, GU / CRMCA [Industry Avg | CA]	4,873	4,873	0
Exterior Wall Cladding	EXTERIOR WALL CLADDING	Fiber Cement siding / Cembrit / Patina / 8 mm (5/16")	1,179	1,309	130
Exterior Wall Cladding	INTERIOR CLADDING FOR EXTERIOR WALLS	Drywall 1/2" [BEAM Avg | US & CA]	285	285	0

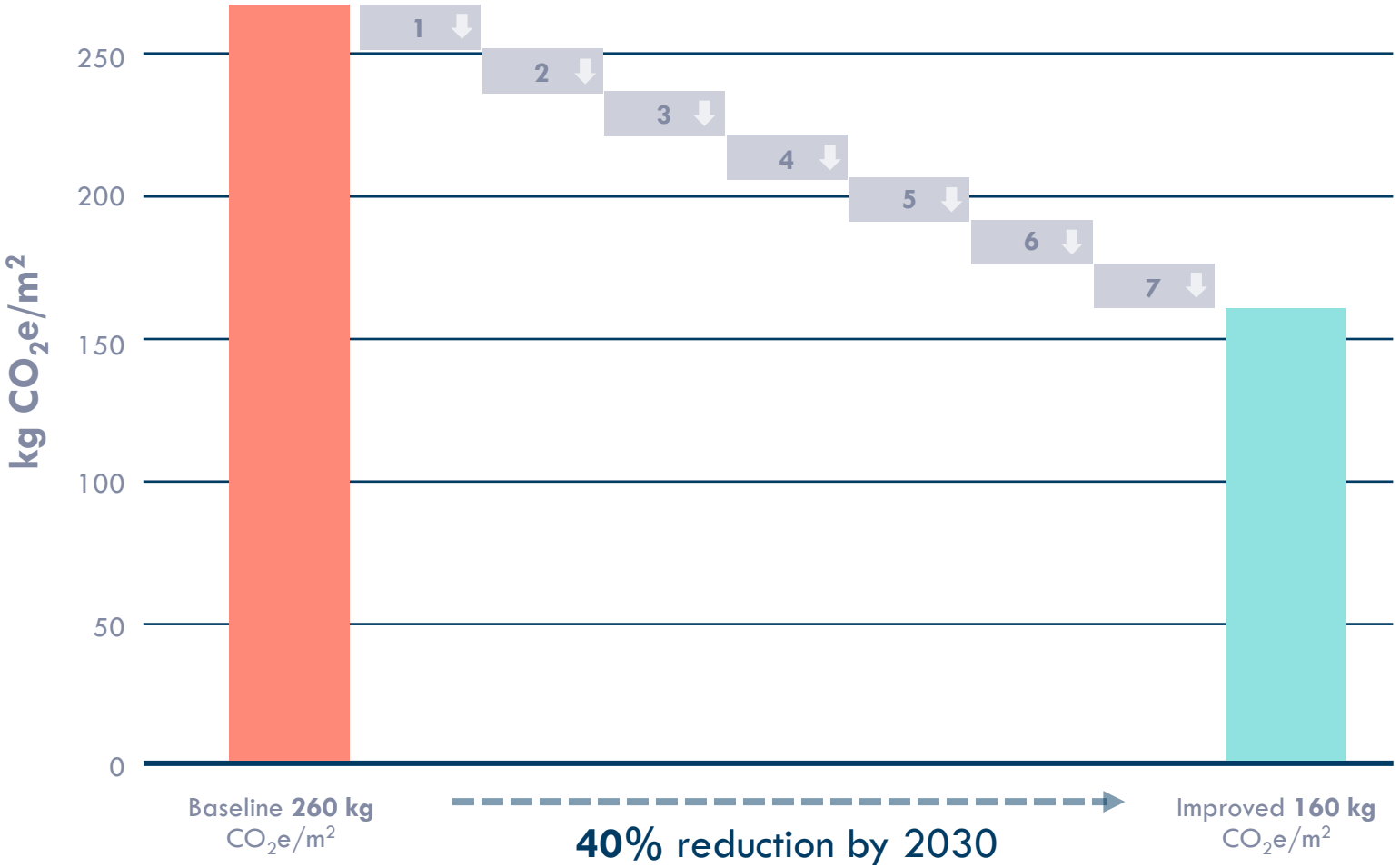
Embodied carbon reduction study

Doug Tarry Homes

Rosewood 'A' Model					
EC Model	AS-BUILT	AS-BUILT Lowest insulation brands	NEAR TERM 1:1 SUBSTITUTIONS	MEDIUM-TERM 2-5 YEARS	FUTURE SCENARIO 5-10 YEARS
Total kg CO_2e	**66,087**	**52,087**	**22,854**	**11,309**	**183**
Percent reduction		**21%**	**65%**	**83%**	**99.7%**

Embodied carbon reduction pathway

Only 5% reduction per year required for 40% reduction by 2030



Year 1: Concrete mix improvement

Year 2: One insulation best available

Year 3: Drywall best available

Year 4: One insulation best available

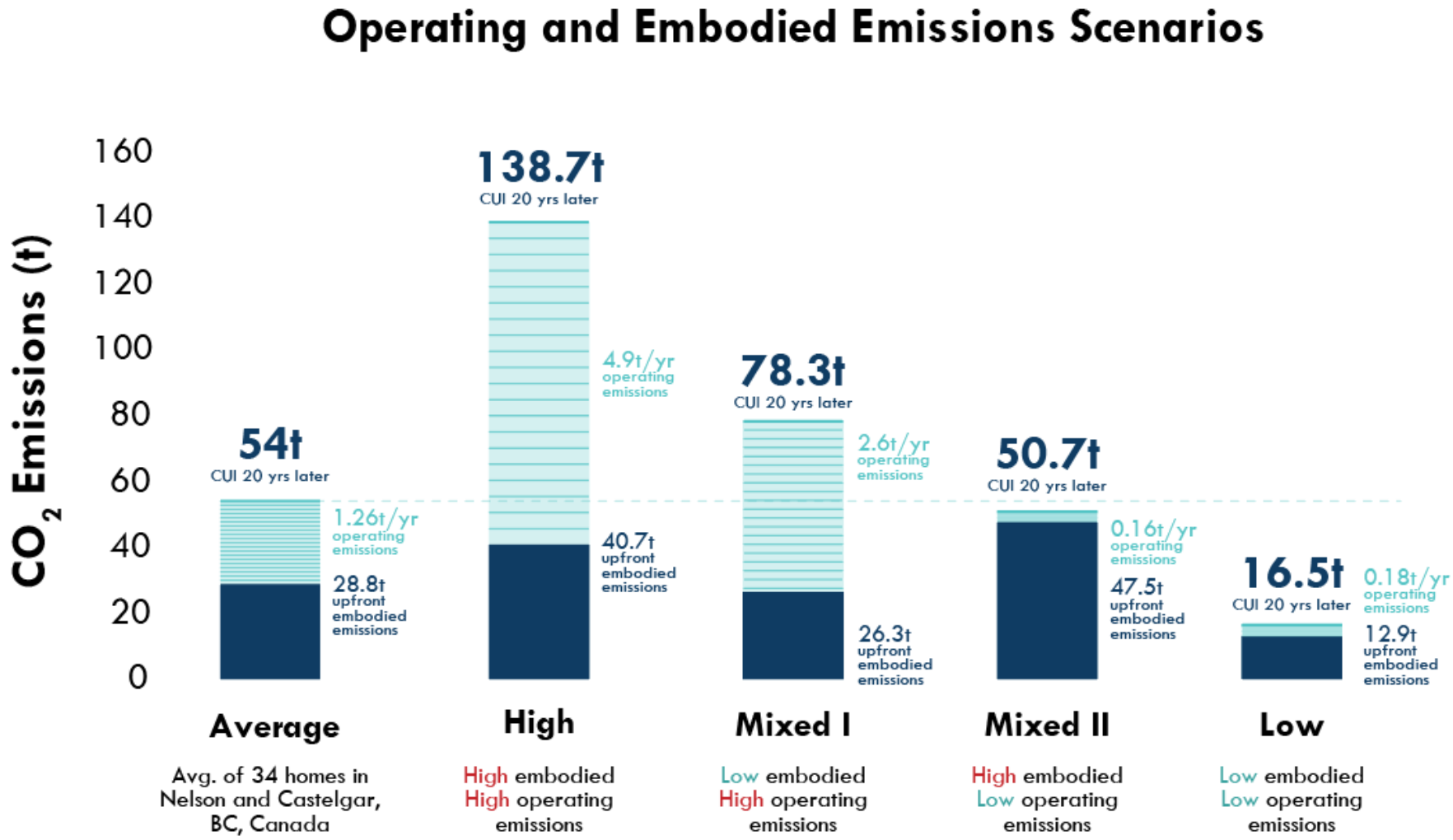
Year 5: Cladding best available

Year 6: Flooring best available

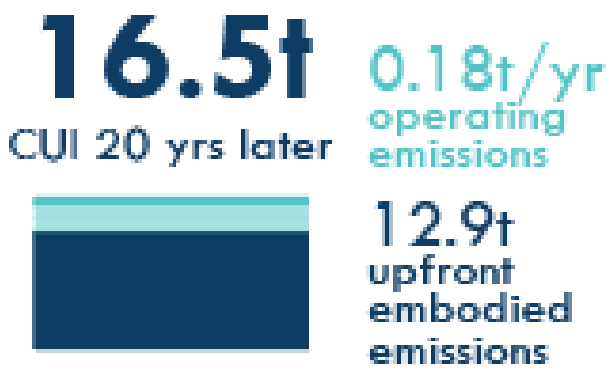
Year 7: Change one insulation type

Operational and embodied emissions balance

HERS raters ideally suited to examine both

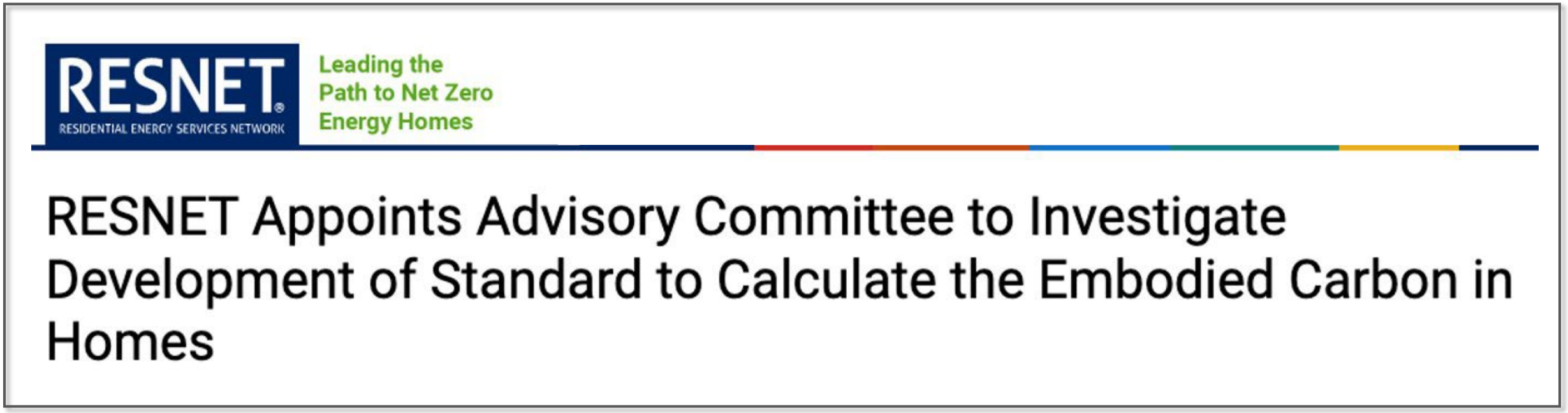


This is homebuilders leading decarbonization:



Low embodied
Low operating
emissions

Standardizing calculations



Working toward ANSI standard for residential construction

HomebuildersCAN

HOMEBUILDERS CARBON ACTION NETWORK

1

Increase performance on embodied emissions from new homes

2

Advocate for alignment across the sector including: regulators, lenders and energy efficiency programs

3

Adopt and scale profitable climate-smart building practices

HomebuildersCAN will support homebuilders to:

1

Increase performance on embodied emissions from new homes

HOW:

- Support energy raters, designers & builders understand how to quantify embodied carbon using forthcoming RESNET/ANSI/ICC standard
- Assist homebuilders to benchmark their current designs and understand where they stand
- Work with energy efficiency programs to balance and align increases in embodied with operational performance
- Help create demonstration homes at different levels of performance, share case studies & construction details

2

Advocate for alignment across the sector including: regulators, lenders and energy efficiency programs

HOW:

- Provide standardized reports for home buyers, regulators & ESG
- Adopt RESNET/ANSI/ICC standard for embodied carbon measurement
- Expand support from customers, investors, and regulators for climate smart homes
- Host and promote success stories of members and demonstration homes
- Conduct policy work to align commitment with new regulations
- Provide common definitions of terms like ‘net zero’ and ‘zero carbon’

3

Adopt and scale profitable climate-smart building practices

HOW:

- Assist participants in meeting performance commitments with education, training, technical support
- Ensure affordability of performance increases with resources and consultation
- Expand supply chain engagement by matching builders with material suppliers
- Support design & construction of archetype projects
- Share best practices, exemplary projects, and lessons learned

What are the benefits for homebuilders?

Telling a clear and positive story as a company and in alignment with others

Sales & Public Relations

- Let buyers know about your improved performance
- Highlight your commitments and turn them into relatable stories
- Provide trusted third-party promotion and support

Strategic Alignment

- Meet regulator needs with a format that works for builders across jurisdictions
- Work for embodied carbon alignment with all energy efficiency programs
- Standardize reporting for programs and incentives
- Advocate for inclusion of embodied carbon performance in green mortgages

ESG Reporting

- Create data & reports suitable for scope 3 ESG reporting
- Commitment recognized by investors as reliable reporting

HomebuildersCAN

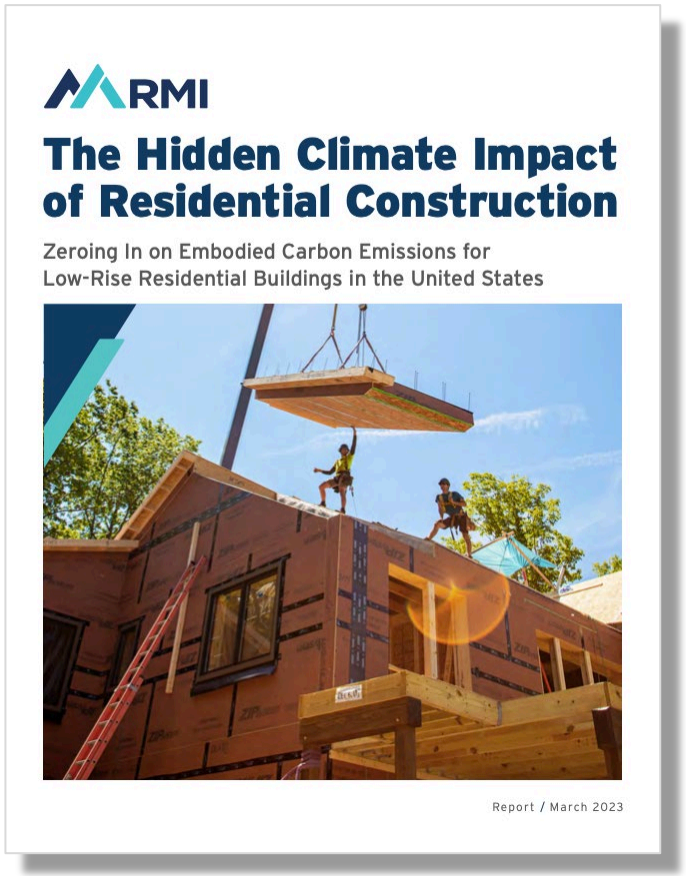
HOMEBUILDERS CARBON ACTION NETWORK

Introductory webinar:

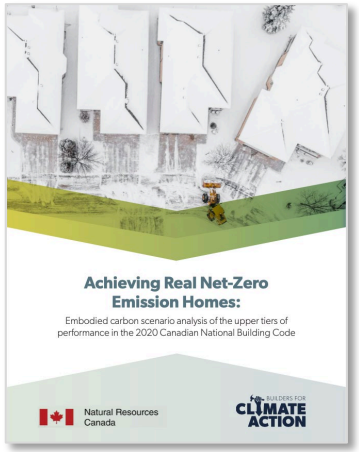
November 14, 11 am eastern

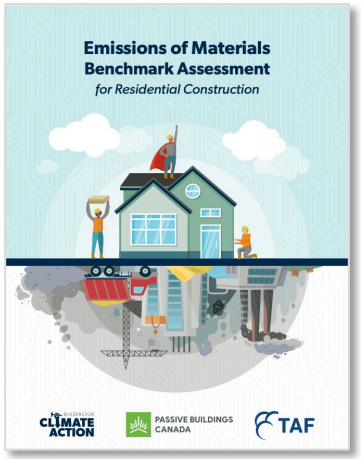
www.rmi.org/homebuildersCAN

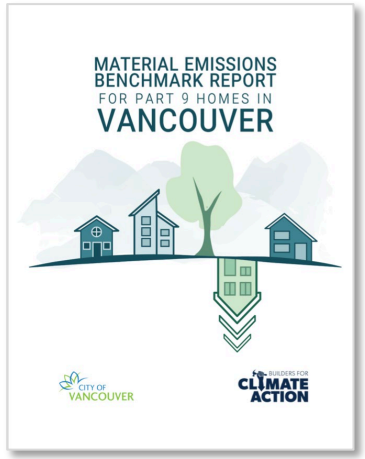
Resources

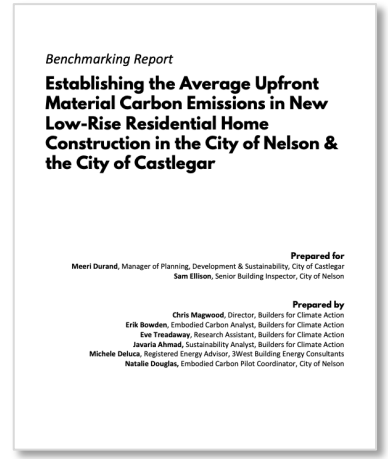


https://rmi.org/insight/hidden-climate-impact-of-residential-construction/

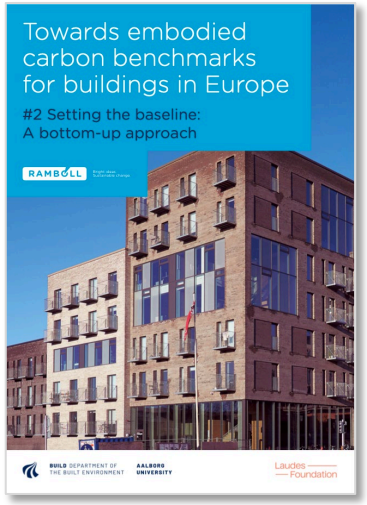




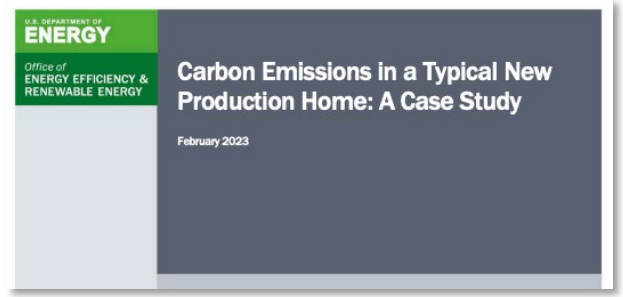




https://www.buildersforclimateaction.org/our-work.html



https://fs.hubspotusercontent00.net/hubfs/7520151/RMC/Content/EU-ECB-Summary-Report.pdf



https://www.nrel.gov/docs/fy23osti/84227.pdf

BEAM
BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

https://www.buildersforclimateaction.org/beam-estimator.html