Better Buildings®
U.S. DEPARTMENT OF ENERGY

Better Buildings Residential Network
Peer Exchange Call Series

Insulation Update – Carbon, Hemp, Health and Air Sealing Advances

September 8, 2022

Agenda and Ground Rules

- Agenda Review and Ground Rules
- Opening Poll
- Residential Network Overview and Upcoming Call Schedule
- Featured Speakers
  - **Chris Magwood**, RMI
  - **Paul Springer**, AeroBarrier
  - **Tommy Gibbons**, Hempitecture
- Open Discussion
- Closing Poll and Announcements

Ground Rules:

1. **Sales of services and commercial messages are not appropriate** during Peer Exchange Calls.
2. Calls are a safe place for discussion; **please do not attribute information to individuals** on the call.

The views expressed by speakers are their own, and do not reflect those of the Dept. of Energy.

Join the Network

Member Benefits:

- Recognition in media, social media and publications
- Speaking opportunities
- Updates on latest trends
- Voluntary member initiatives
- One-on-One brainstorming conversations

Commitment:

- Members only need to provide *one number*: their organization's number of residential energy upgrades per year, or equivalent.

Upcoming Calls (2nd & 4th Thursdays):

- *09/22: Ups and Downs in Energy Markets: How Do Market Fluctuations and Uncertainties Affect Residential Efficiency Investments?"*
- *10/13: How to find DOE Funding for Residential Energy Efficiency*
- *10/27: 2-in-1: What Is the Potential for an Integrated Furnace & Water Heater?*

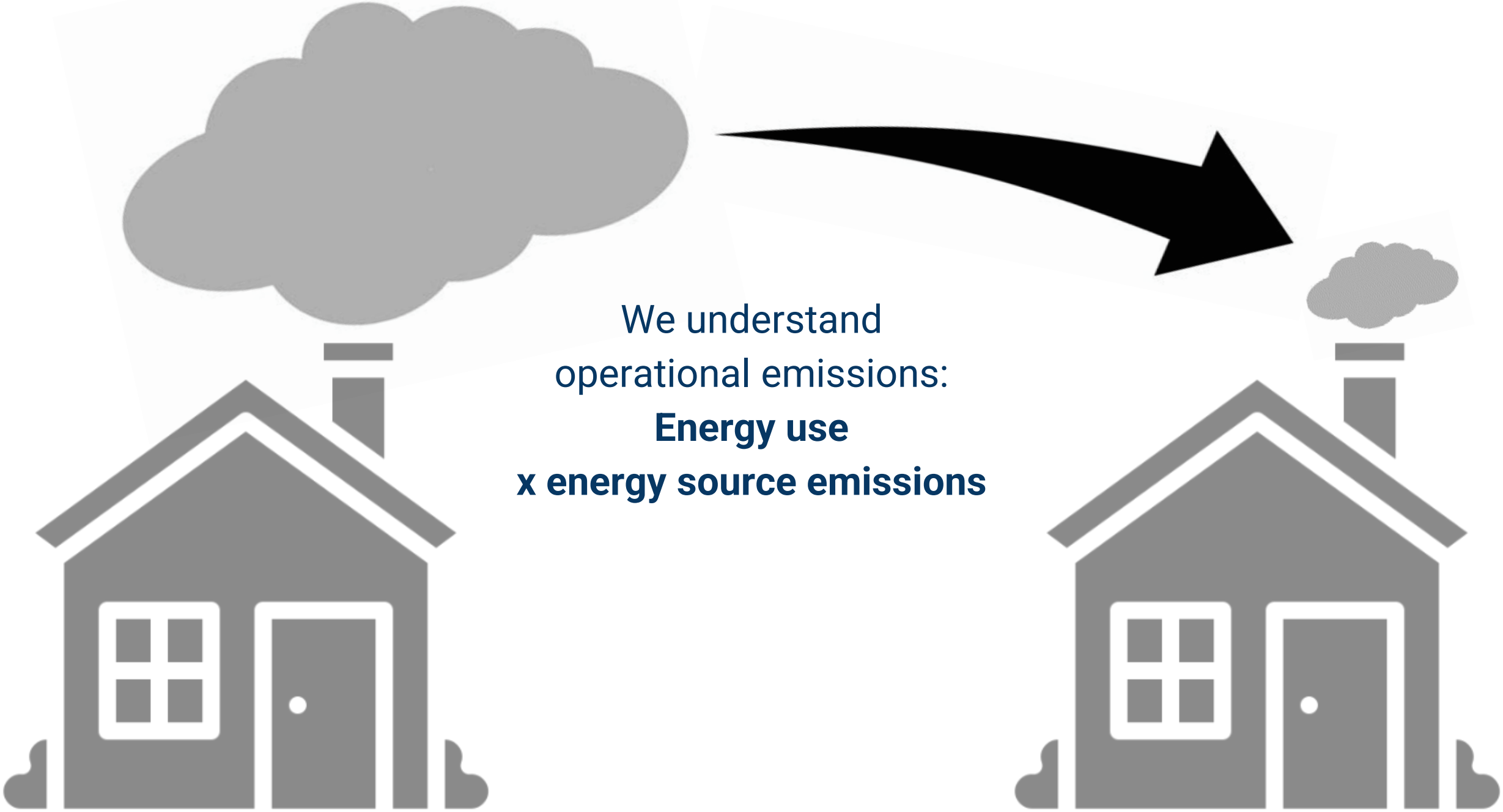
Peer Exchange Call summaries are posted on the Better Buildings website a few weeks after the call

Chris Magwood

RMI

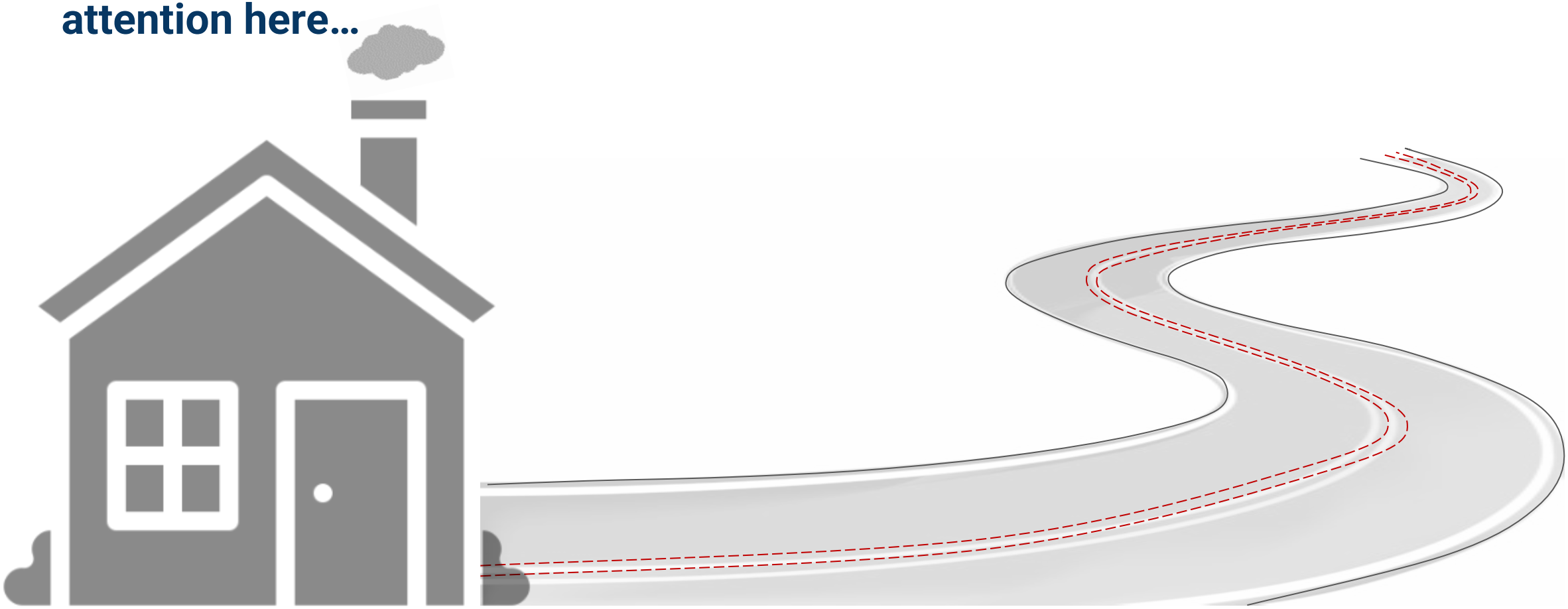
Decarbonizing Our New Homes: Thinking about carbon use intensity

Chris Magwood
Carbon-Free Buildings
Low-Embodied Carbon Program



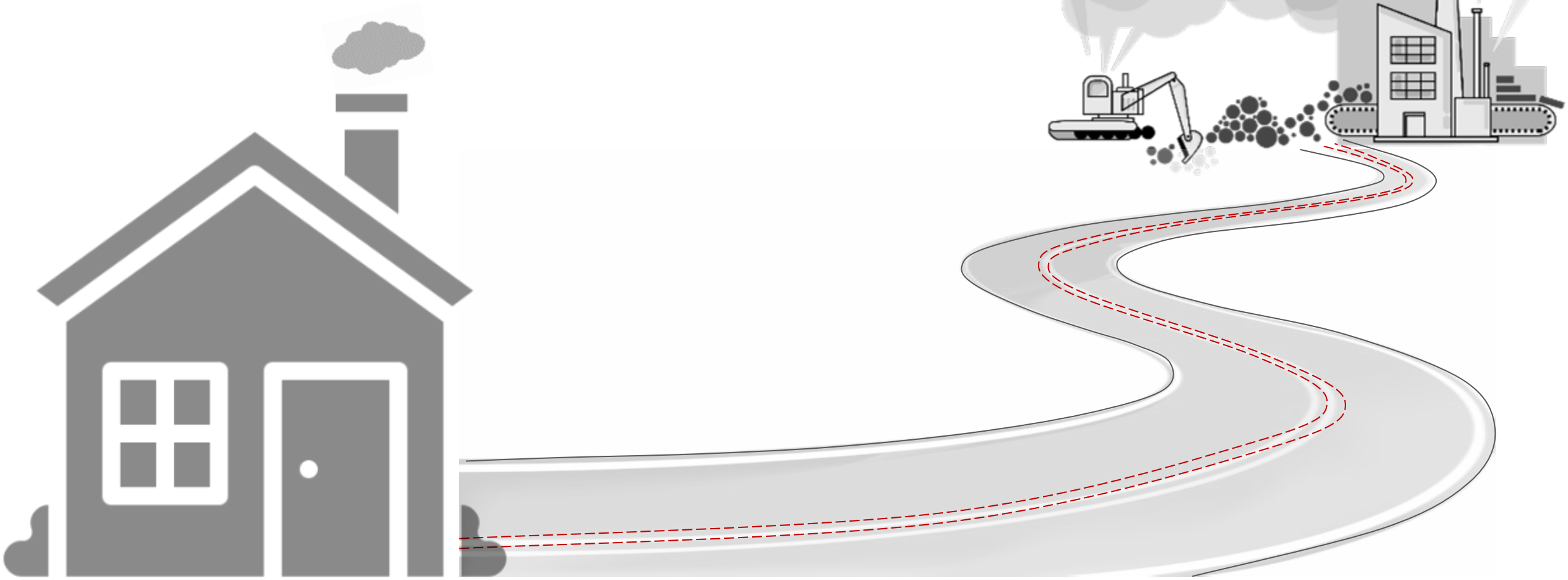
We understand
operational emissions:
Energy use
x energy source emissions

We've been focusing our attention here…



…and have missed what's going on over here

Material emissions



Material emissions over the life cycle – “embodied carbon”

Cradle to gate →

Up-front embodied carbon →

Whole life cycle →

Product emissions are the largest contributor

65-80%

6-10%

8-15%

3-15%

Estimating material carbon emissions (MCE)

EPD

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.

Estimating material carbon emissions (MCE)

EPD

Timber:

42.56 kg CO_2e/m^3

Concrete:

304.53 kg CO_2e/m^3

Steel:

1.16 t CO_2e/ton

Now what?

Estimating material carbon emissions (MCE)

BEAM
BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

A1-A3 GWP factors from EPDs

−

A1-A3 biogenic carbon storage

×

Material quantity (based on dimensions)

FOUNDATION WALL AREA	74.3	m²
FOUNDATION SLAB AREA	55.7	m²
EXTERIOR WALL AREA	100.0	m²
WINDOW AREA	18.7	m²

=

Net emissions kg CO2e

8,292

NET EMISSIONS ($kg\ CO_2e$)

Estimating material carbon emissions (MCE)

Timber:

42.56 kg CO_2e/m^3

6x6 post =

4 kg CO_2e

Concrete:

304.53 kg CO_2e/m^3

6” dia. post =

12 kg CO_2e

Steel:

1.16 t CO_2e/ton

3.5” dia. post =

73 kg CO_2e

BEAM

BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

Now we can start to make informed decisions!

Compare materials:

BEAM
BUILDING EMISSIONS ACCOUNTING FOR MATERIALS

CAVITY INSULATION	R-VALUE 20.0			
HIGH R-VALUE CAVITY INSULATION				
Aerogel blanket / Aspen Aerogels / R9.6/inch	100.0 m²	100%	☐	6,499
SPRAY POLYURETHANE FOAM – HIGH DENSITY				
Spray polyurethane foam - High Density (HFC gas) / R 6.3/inch / SPFA [Industry Avg | US & CA]	100.0 m²	100%	☐	5,995
Spray polyurethane foam - High Density (HFO gas) / R 6.5/inch / SPFA [Industry Avg | US & CA]	100.0 m²	100%	☐	1,744
SPRAY POLYURETHANE FOAM – CLOSED CELL				
Spray polyurethane foam - Closed Cell (HFC gas) / R 6.6/inch / SPFA [Industry Avg | US & CA]	100.0 m²	100%	☐	4,635
Spray polyurethane foam - Closed Cell (HFO gas) / R 6.6/inch / SPFA [Industry Avg | US & CA]	100.0 m²	100%	☐	1,465
Spray polyurethane foam - Closed Cell (HFO gas) / Huntsman / Heatlok Soya HFO & Heatlok HFO / R 6.5/inch	100.0 m²	100%	☐	882
SPRAY POLYURETHANE FOAM – OPEN CELL				
Spray polyurethane foam - Open Cell / R 4.1/inch / SPFA [Industry Avg | US & CA]	100.0 m²	100%	☐	500
SHEEP WOOL INSULATION				
Wool / Havelock Wool / Loose-fill / R 4.4/inch	100.0 m²	100%	☐	271
Wool / Havelock Wool / Batts / R 3.6/inch	100.0 m²	100%	☐	354
MINERAL WOOL BATT INSULATION				
Mineral wool batt / Owens Corning / Thermafiber UltraBatt / R 4.3/inch	100.0 m²	100%	☐	1,409
Mineral wool batt / Rockwool / ComfortBatt R24 (5.5") / R 4.4/inch	100.0 m²	100%	☐	600
Mineral wool batt / [BEAM Avg]	100.0 m²	100%	☐	597
Mineral wool batt / Rockwool / ComfortBatt R15 (3.5") / R 4.3/inch	100.0 m²	100%	☐	461
Mineral wool batt / Rockwool / Safe'n'Sound, ComfortBatt / R 3.8/inch	100.0 m²	100%	☐	461
Mineral wool batt / Rockwool / ComfortBatt R14 (3.5") / R 4.0/inch	100.0 m²	100%	☐	415
Mineral wool batt / Rockwool / ComfortBatt R22 (5.5") / R 4.0/inch	100.0 m²	100%	☐	415

Compare assemblies:

ASSEMBLY 1

1,564	1,564	0

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]	220	220	0
Exterior Walls	STRUCTURAL SHEATHING	OSB sheathing / 5/8" / AWC & CWC [Industry Avg | US & CA]	385	385	0
Exterior Walls	CAVITY INSULATION	Mineral wool batt / [BEAM Avg]	627	627	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]	332	332	0

ASSEMBLY 2

6,533	6,533	0

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)	2,480	2,480	0
Exterior Walls	EPS FOAM ICF WALLS	Concrete – 0-25 MPa, 30-40% Fly Ash, GU / CRMCA [Industry Avg | CA]	4,053	4,053	0

ASSEMBLY 3

2,542	2,542	0

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	2,542	2,542	0

Compare whole houses:

CLIMATE ACTION BEAM

REVIEW OF SELECTED MATERIALS

			81,510	83,421	1,911
SECTION	CATEGORY	MATERIAL	NET CARBON FOOTPRINT [kg CO2e]	CARBON EMISSIONS [kg CO2e]	CARBON STORAGE [kg CO2e]
Footings & Slabs	CRUSHED STONE BASE	Aggregate / / / Avg construction aggregate (gravel & sand)	1	1	0
Footings & Slabs	FOOTINGS & PADS	Concrete - 0-25 MPa, Canadian Benchmark Average / CRMCA / Can.	3,049	3,049	0
Footings & Slabs	REBAR FOR FOOTINGS & PADS	Rebar / Concrete Reinforcing Steel Institute / / 15M	322	322	0
Footings & Slabs	REINFORCING MESH FOR SLAB	Welded wire mesh / Serfas / / 6" x 6" x 6/6g / Norway	160	160	0
Footings & Slabs	CONCRETE SLAB FLOOR(S)	Concrete - 0-25 MPa, Canadian Benchmark Average / CRMCA / Can.	2,258	2,258	0
Foundation Walls	CONCRETE WALLS	Concrete - 0-25 MPa, Canadian Benchmark Average / CRMCA / Can.	9,572	9,572	0
Foundation Walls	REBAR FOR FOUNDATION WALLS	Rebar / Concrete Reinforcing Steel Institute / / 15M	1,420	1,420	0
Foundation Walls	CONTINUOUS INSULATION	XPS foam board - AVERAGE (excludes new NGX 250)	25,813	25,813	0
Structural Elements	HEAVY TIMBER FRAMING	Wood framing & siding - SPF / American Wood Council & Canadian	94	94	0
Structural Elements	HEAVY TIMBER FRAMING	Laminated strand lumber / American Wood Council & Canadian Woo	14	14	0
Structural Elements	HEAVY TIMBER FRAMING	Laminated veneer lumber / American Wood Council & Canadian Woo	85	85	0
Structural Elements	HEAVY STEEL COMPONENTS	Steel beam / W200x27 (W8x18) / American Institute of Steel Construc	276	276	0
Structural Elements	HEAVY STEEL COMPONENTS	Steel beam / W310x39 (W12x26) / American Institute of Steel Constru	252	252	0
Structural Elements	HEAVY STEEL COMPONENTS	Steel beam / W250x33 (W10x22) / American Institute of Steel Constru	219	219	0
Structural Elements	HEAVY STEEL COMPONENTS	Steel post / Generic / / 3.5 x 0.216" (89 x 5.5 mm), Sched 40 STD	408	408	0
Ext. Walls	WOOD FRAME CONSTRUCTION	Wood framing & siding - SPF / American Wood Council & Canadian	501	501	0
Ext. Walls	STRUCTURAL SHEATHING	OSB sheathing / American Wood Council & Canadian Wood Council	37	37	0
Ext. Walls	STRUCTURAL SHEATHING	Plywood / American Wood Council & Canadian Wood Council / / 1/2"	595	595	0
Ext. Walls	CAVITY INSULATION	Fiberglass batt / Owens Corning / EcoTouch Pink batt and roll / R 3.6	278	278	0
Ext. Walls	CAVITY INSULATION	Mineral wool batt / Owens Corning / Thermafiber UltraBatt / R 4.3/inc	800	800	0
Ext. Walls	CONTINUOUS INSULATION (EXT. or INT.)	XPS foam board / Owens Corning / Foamular 250 / R 5/inch	10,098	10,098	0
Ext. Walls	GARAGE ATTACHMENT WALL INSULATI	Fiberglass batt / Owens Corning / EcoTouch Pink batt and roll / R 3.6	81	81	0
Ext. Walls	GARAGE ATTACHMENT WALLS	Wood framing & siding - SPF / American Wood Council & Canadian	91	91	0
Cladding	EXTERIOR CLADDING	Brick, Clay, Generic Modular / Brick Industry Association / US-Canad	10,053	10,053	0
Cladding	EXTERIOR CLADDING	Brick, Stone / Arriscraft / Natural Limestone Masonry / Weighted ave	108	108	0
Cladding	EXTERIOR CLADDING	Vinyl Siding / Vinyl Siding Institute / 0.040" Double 4.5"	67	67	0
Cladding	INTERIOR CLADDING for EXTERIOR WAL	Drywall 1/2" Typical - CertainTeed - AVERAGE	328	328	0
Cladding	INTERIOR CLADDING for EXTERIOR WAL	Drywall 5/8" / / Includes American Gypsum, CertainTeed, Continenta	200	200	0
Windows	DOUBLE PANE WINDOWS - GENERIC	Window - double pane / Vinyl frame / / USA & CAN	2,325	2,325	0
Int. Walls	WOOD FRAME CONSTRUCTION	Wood framing & siding - SPF / American Wood Council & Canadian	16	16	0
Int. Walls	WOOD FRAME CONSTRUCTION	Wood framing & siding - SPF / American Wood Council & Canadian	40	40	0
Int. Walls	WOOD FRAME CONSTRUCTION	Wood framing & siding - SPF / American Wood Council & Canadian	153	153	0

CLIMATE ACTION BEAM

REVIEW OF SELECTED MATERIALS

			20,380	31,008	10,628
SECTION	CATEGORY	MATERIAL	NET CARBON FOOTPRINT [kg CO2e]	CARBON EMISSIONS [kg CO2e]	CARBON STORAGE [kg CO2e]
Footings & Slabs	CRUSHED STONE BASE	Aggregate / Martin Marietta / / Avg construction aggregate (gravel &	1	1	0
Footings & Slabs	FOOTINGS & PADS	Concrete - 0-25 MPa, 35-50% Slag, GU / CRMCA / Can. Avg. /	2,393	2,393	0
Footings & Slabs	REBAR FOR FOOTINGS & PADS	Rebar / Concrete Reinforcing Steel Institute / / 15M	322	322	0
Footings & Slabs	REINFORCING MESH FOR SLAB	Welded wire mesh / Serfas / / 6" x 6" x 6/6g / Norway	160	160	0
Footings & Slabs	CONCRETE SLAB FLOOR(S)	Concrete - 0-25 MPa, 35-50% Slag, GU / CRMCA / Can. Avg. /	1,772	1,772	0
Foundation Walls	CONCRETE WALLS	Concrete - 0-25 MPa, 35-50% Slag, GU / CRMCA / Can. Avg. /	7,512	7,512	0
Foundation Walls	REBAR FOR FOUNDATION WALLS	Rebar / Concrete Reinforcing Steel Institute / / 15M	1,420	1,420	0
Foundation Walls	INTERIOR FRAMING - WOOD	Wood framing & siding - SPF / American Wood Council & Canadian	191	191	0
Foundation Walls	CAVITY INSULATION	Cellulose - batt / CMS / R 3.6/inch / EcoCell	-1,331	318	1,649
Foundation Walls	INTERIOR WALL CLADDING	Drywall 1/2" / CertainTeed / Easi-Lite / 1/2" (12.7 mm)	14	14	0
Structural Elements	HEAVY TIMBER FRAMING	Wood framing & siding - SPF / American Wood Council & Canadian	94	94	0
Structural Elements	HEAVY TIMBER FRAMING	Laminated strand lumber / American Wood Council & Canadian Woo	14	14	0
Structural Elements	HEAVY TIMBER FRAMING	Laminated veneer lumber / American Wood Council & Canadian Woo	85	85	0
Structural Elements	HEAVY STEEL COMPONENTS	Steel beam / W200x27 (W8x18) / American Institute of Steel Construc	276	276	0
Structural Elements	HEAVY STEEL COMPONENTS	Steel beam / W310x39 (W12x26) / American Institute of Steel Constru	252	252	0
Structural Elements	HEAVY STEEL COMPONENTS	Steel beam / W250x33 (W10x22) / American Institute of Steel Constru	219	219	0
Structural Elements	HEAVY STEEL COMPONENTS	Steel post / Generic / / 3.5 x 0.216" (89 x 5.5 mm), Sched 40 STD	408	408	0
Ext. Walls	WOOD FRAME CONSTRUCTION	Wood framing & siding - SPF / American Wood Council & Canadian	501	501	0
Ext. Walls	STRUCTURAL SHEATHING	OSB sheathing / American Wood Council & Canadian Wood Council	37	37	0
Ext. Walls	STRUCTURAL SHEATHING	Plywood / American Wood Council & Canadian Wood Council / / 1/2"	595	595	0
Ext. Walls	CAVITY INSULATION	Cellulose - batt / CMS / R 3.6/inch / EcoCell	-1,628	390	2,018
Ext. Walls	CONTINUOUS INSULATION (EXT. or INT.)	Wood fiber board - AVERAGE	-1,505	1,323	2,827
Ext. Walls	GARAGE ATTACHMENT WALL INSULATI	Cellulose - batt / CMS / R 3.6/inch / EcoCell	-355	85	440
Ext. Walls	GARAGE ATTACHMENT WALLS	Wood framing & siding - SPF / American Wood Council & Canadian	91	91	0
Cladding	EXTERIOR CLADDING	Vinyl Siding / Vinyl Siding Institute / 0.040" Double 4.5"	67	67	0
Cladding	EXTERIOR CLADDING	Engineered Wood Siding & Trim / LP / SmartSide / 5/16" (8 mm)	599	599	0
Cladding	INTERIOR CLADDING for EXTERIOR WAL	Drywall 1/2" / CertainTeed / AirRenew / 1/2" (12.7 mm)	299	299	0
Cladding	INTERIOR CLADDING for EXTERIOR WAL	Drywall 5/8" / USG / EcoSmart Firecode / 5/8"	139	139	0
Windows	DOUBLE PANE WINDOWS - GENERIC	Window - double pane / Vinyl frame / / USA & CAN	2,325	2,325	0
Int. Walls	WOOD FRAME CONSTRUCTION	Wood framing & siding - SPF / American Wood Council & Canadian	16	16	0
Int. Walls	WOOD FRAME CONSTRUCTION	Wood framing & siding - SPF / American Wood Council & Canadian	40	40	0
Int. Walls	WOOD FRAME CONSTRUCTION	Wood framing & siding - SPF / American Wood Council & Canadian	153	153	0
Int. Walls	WOOD FRAME CONSTRUCTION	Wood framing & siding - SPF / American Wood Council & Canadian	16	16	0
Int. Walls	INTERIOR WALL CLADDING	Drywall 1/2" / CertainTeed / AirRenew / 1/2" (12.7 mm)	434	434	0
Floors	WOOD FLOOR FRAMING	Wood I joist / American Wood Council & Canadian Wood Council / /	463	463	0
Floors	SUB FLOORING	OSB sheathing / American Wood Council & Canadian Wood Council	1,105	1,105	0

BEAM methodology for benchmark studies

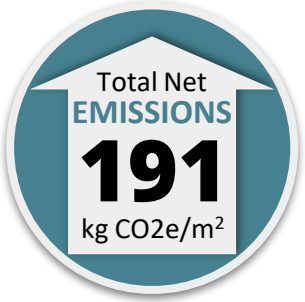
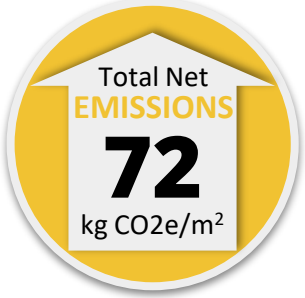
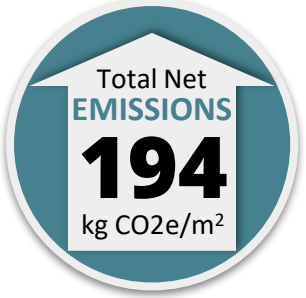
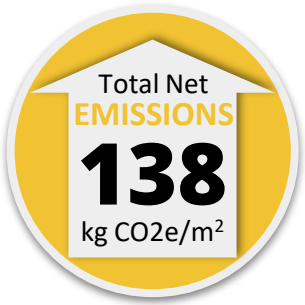
Structure, enclosure & partitions

- Largest data set
- Long life span for materials
- Most actionable analysis for users

MEP, appliances, finishes, millwork, yardwork

- Lack of data
- Less actionable analysis for users

Study results*

	Highest result	Average result	Lowest result
EMBARC (Toronto region) 503 As-built homes			
Nelson & Castlegar, BC Study 34 As-built homes			
Vancouver 13 as-built homes			

*All results based on A1-A3 analysis of structure, enclosure and partitions.
Area based on heated floor area.

How much do material emissions matter?

(Average of 800 new homes across Canada)

250 million m^2

(2.7 billion ft^2)
new low-rise
residential in US

~50 million tonnes

annual emissions

Finland	46.846
Bulgaria	49.568
Hungary	50.856
Sweden	50.874
Norway	52.492
Singapore	55.018
Peru	55.931
Portugal	56.771
Libya	57.584
Morocco	61.584

What are the “side effects” of reducing embodied carbon?

“The result shows no direct correlation between the cost and MCE of materials.”

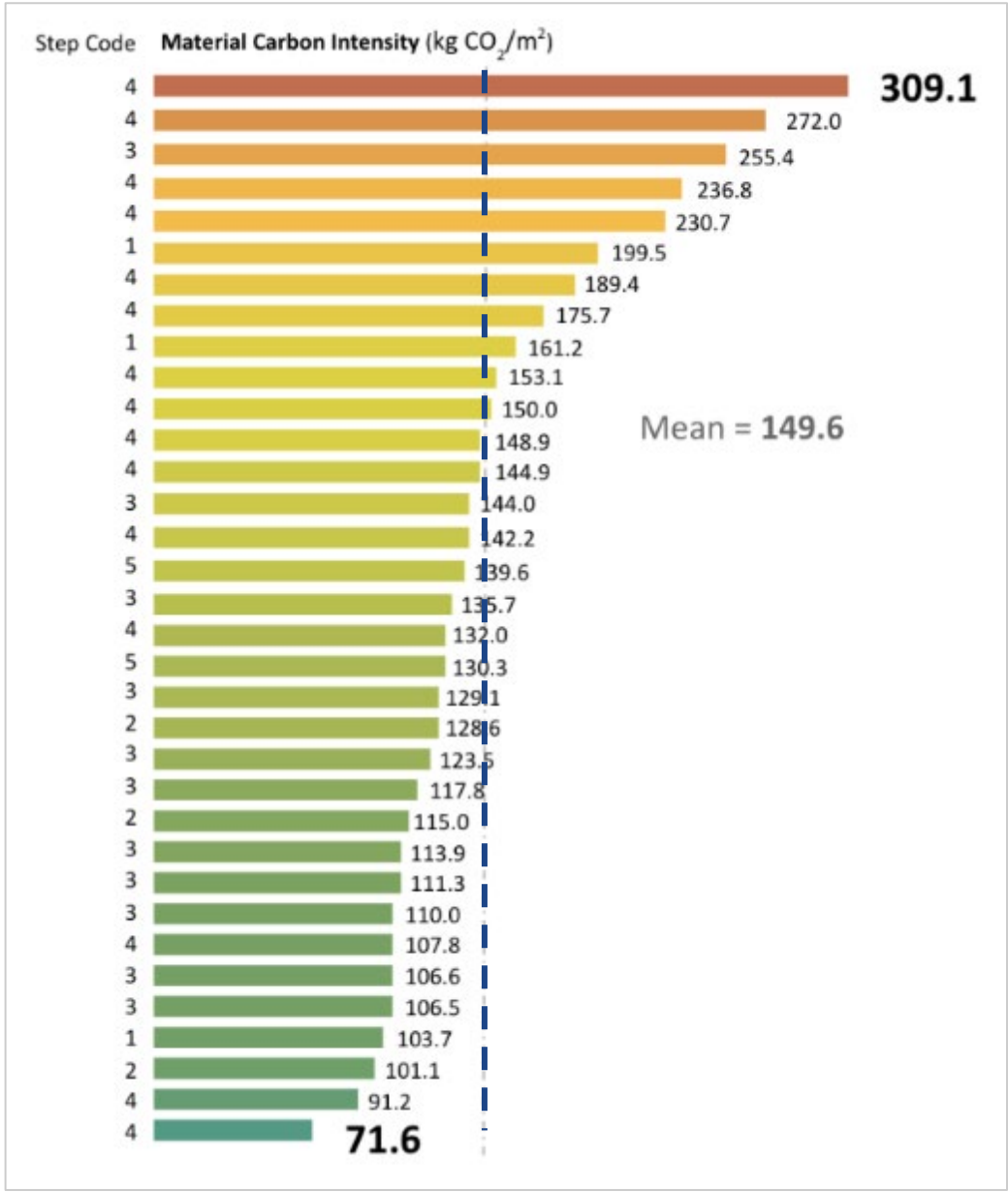
– *NRCan embodied carbon study, 2021*

Cost and MCE Comparison of Exterior Cladding Options			
Cladding	**Material**	**kgCO_2e for 10 m²**	**Cost for 10 m²**
	Wood - SPF (unfinished)	12	$489.52
	Wood - WRC (unfinished)	17	$525.81
	Synthetic stucco	35	$77.50
	Vinyl - avg of all products	54	$370.50
	Lime stucco	96	$12.34
	Steel panel - corrugated & painted	150	$133.01
	Fiber-cement - avg of all products	170	$616.42
	Brick	472	$753.48

What are the “side effects” of reducing embodied carbon?

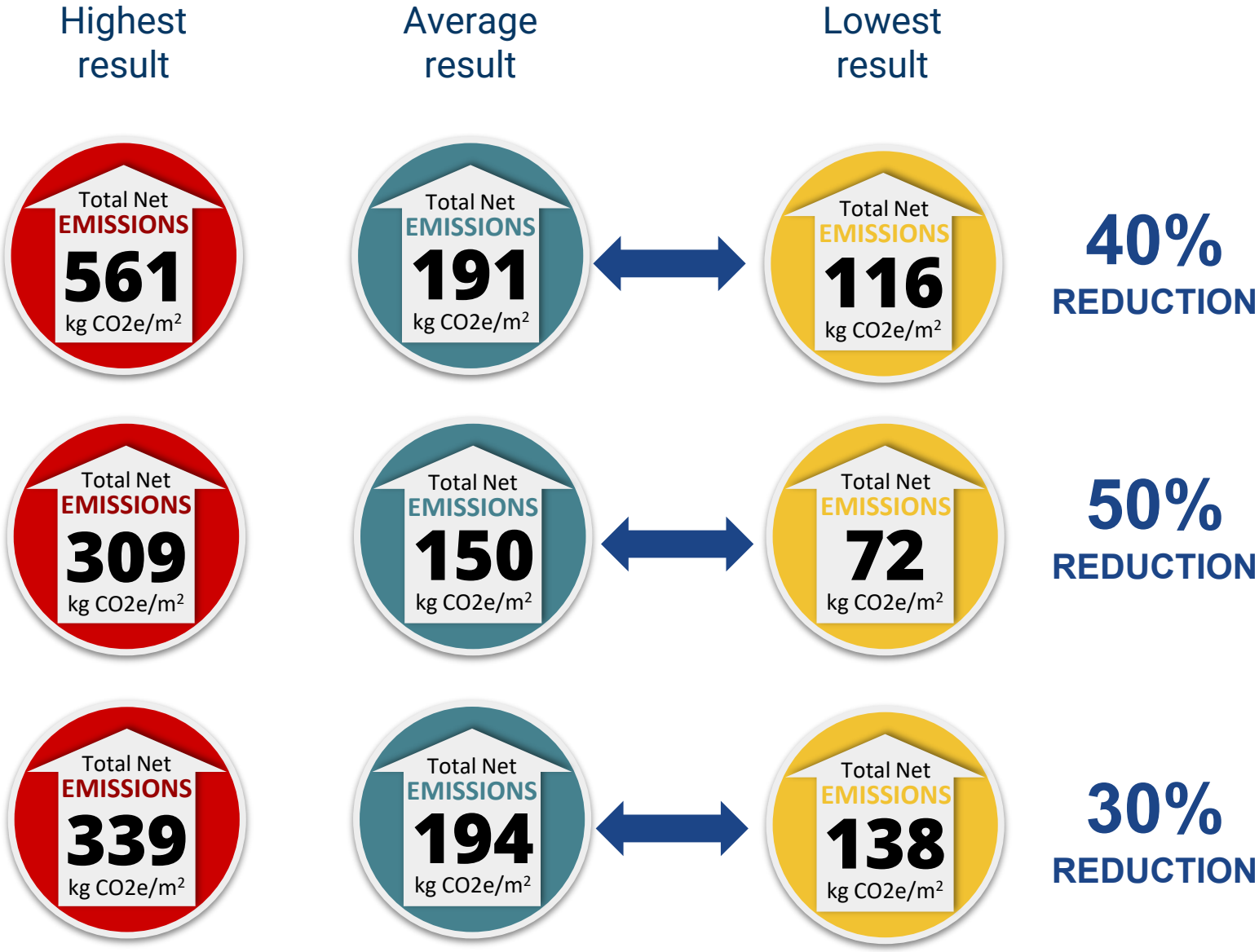
“These results would suggest that material selection and quantity is the leading factor in driving MCI higher or lower, and that it is possible to achieve both high levels of energy efficiency and low MCI.”

– *City of Nelson embodied carbon study, 2021*



How do I reduce embodied carbon?

Study results*



*All results based on A1-A3 analysis of structure, enclosure and partitions.
Area based on heated floor area.

Embodied carbon study

DOUG TARRY HOMES

Rosewood ‘A’ Model Net Zero Ready						
	Ontario Code Minimum Baseline	2021 As-built	2022 minor insulation substitutions	NEAR TERM 1:1 SUBSTITUTIONS	MEDIUM-TERM 2-5 YEARS	FUTURE SCENARIO 5-10 YEARS
Total kg CO2e	48,266	66,087	52,087	22,854	11,309	183
Percent reduction			21%	65%	83%	99.7%

Embodied carbon study

DOUG TARRY HOMES

NEAR TERM 1:1 SUBSTITUTIONS
22,854 kg CO2e
65% reduction

Concrete → High slag (35-50%) concrete mix

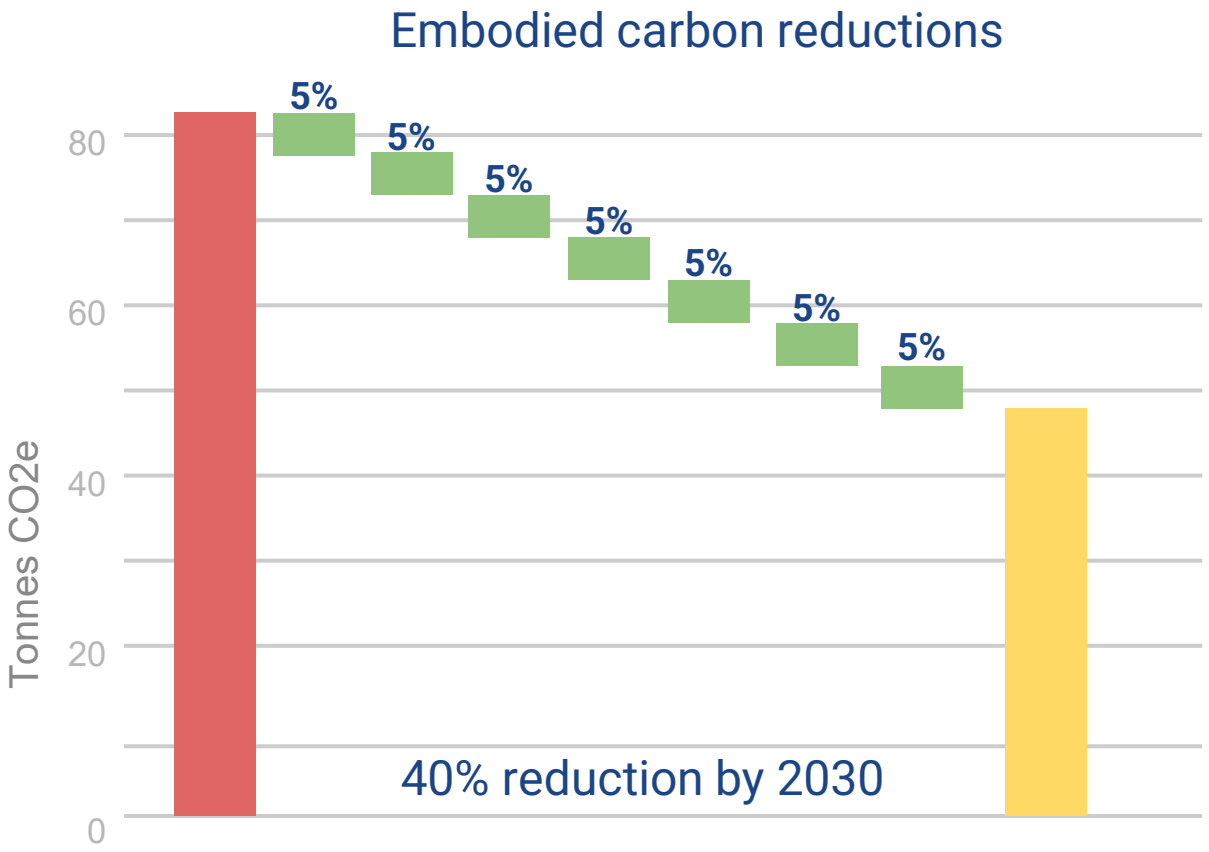
EPS foam board → Replace ccSPF below slab

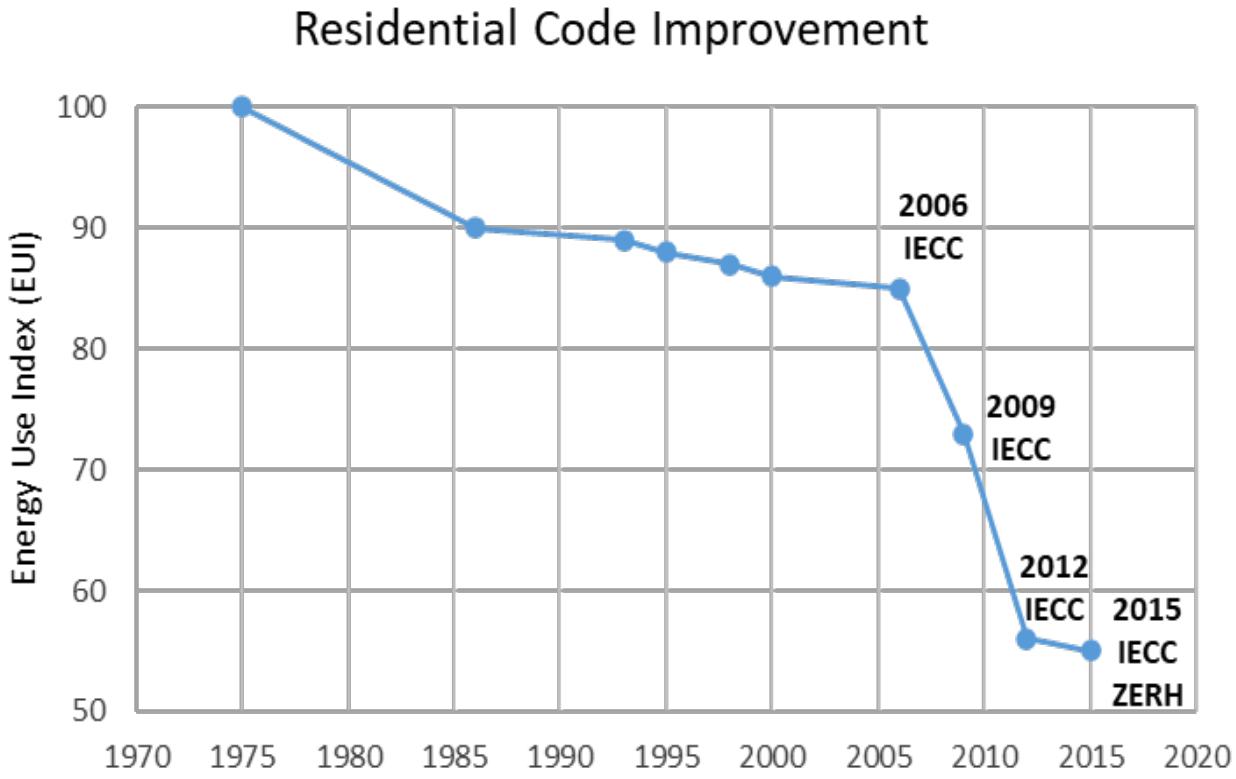
Cellulose insulation → replace other cavity insulation materials

Cork & linoleum flooring → replace carpet and hardwood

Engineered wood cladding → replace brick

We've seen this curve before!





Or, be more ambitious:

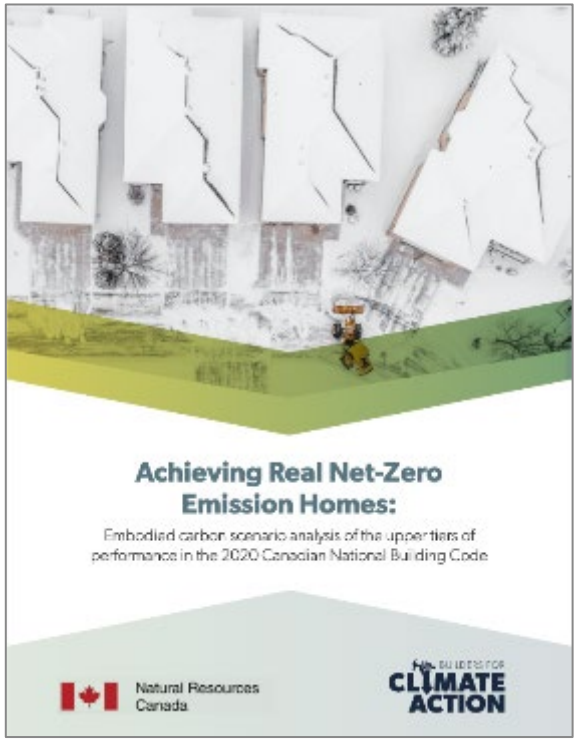
Projects near and below net zero embodied carbon

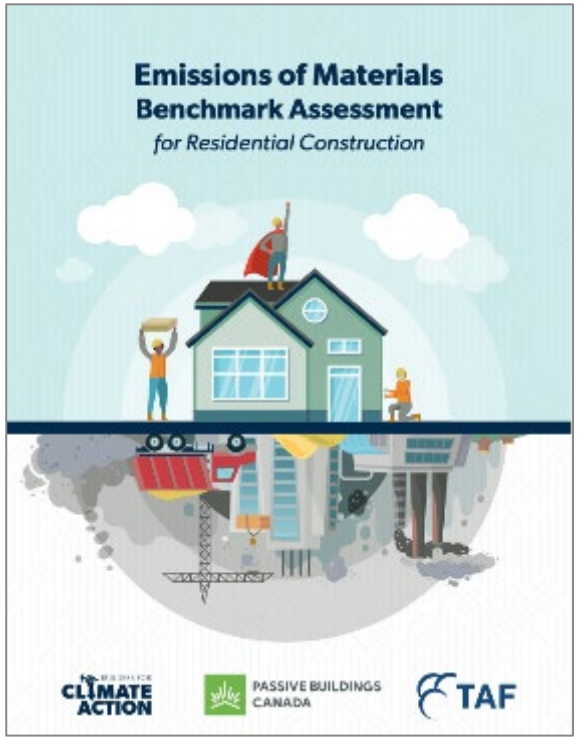
More information:

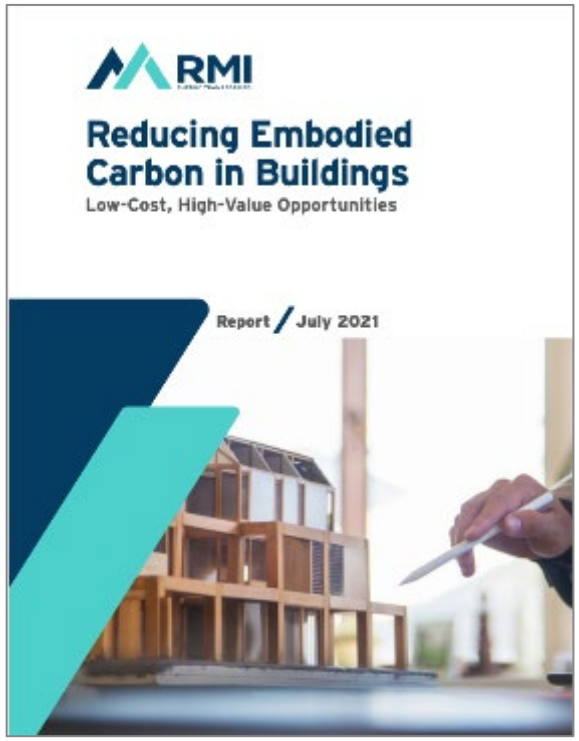
www.buildersforclimateaction.org

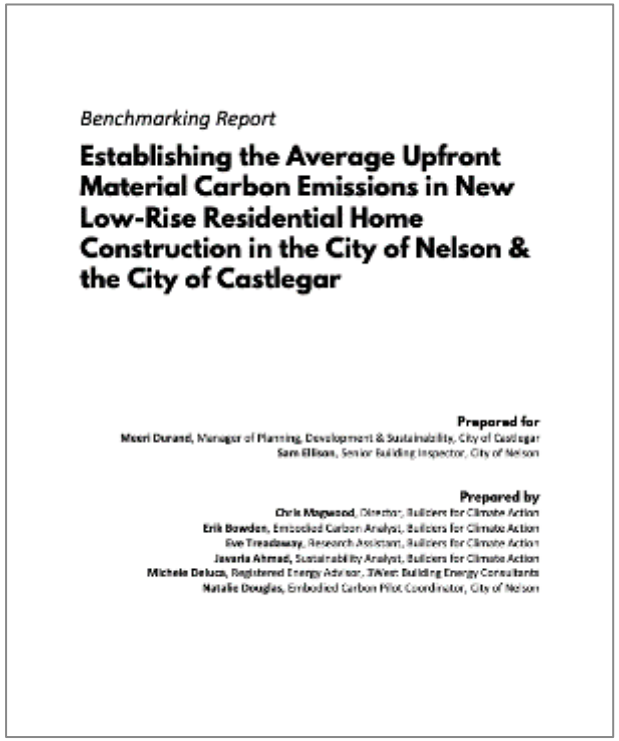
www.rmi.org

RMI
ENERGY. TRANSFORMED.









Paul Springer

AeroBarrier

AEROBARRIER®
Air Sealing Technology from Aeroseal

Air Sealing

Paul Springer
National Director, AeroBarrier

Why is Air Sealing so Important?

Simply put; air sealing arguably has the single greatest impact on any build when it comes to **quality, build cost, indoor air quality (IAQ), occupant comfort**, and **energy conservation**.

- DOE estimates uncontrolled air leakage accounts for as much as 40% of energy use
- Air leakage introduces moisture, mold, pollen, pests, and sound into the living environment
- The negative effects of air leakage reduces the overall durability and longevity of any structure

Benefits of Reduced Air Leakage

Experience dramatic savings on home heating and cooling
See immediate savings of up to one-third on heating and cooling

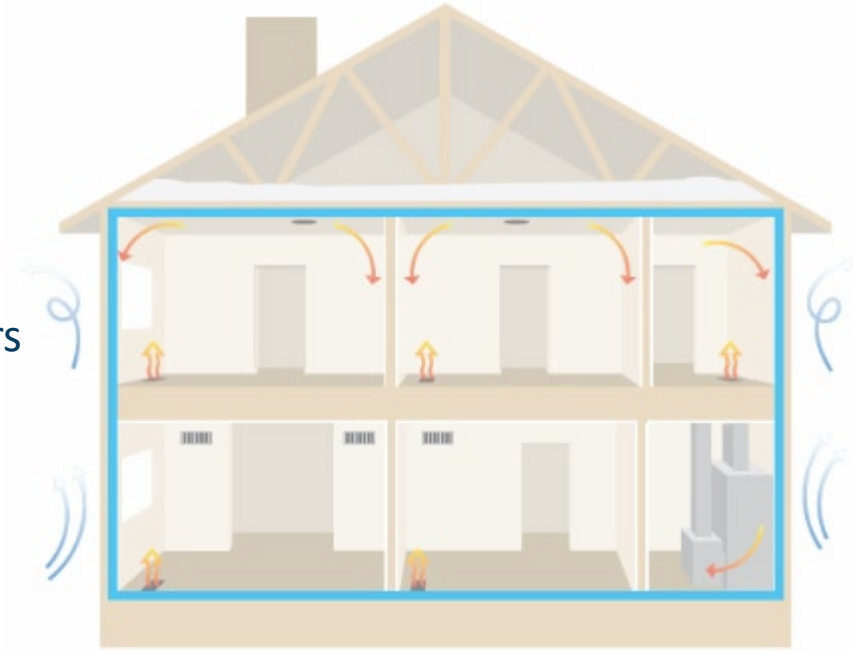
Enjoy a more comfortable home
More consistent room-to-room comfort with fewer drafts. Feel warmer in the winter, cooler in the summer

Help prevent moisture from entering the wall system
Reduce conditions that can lead to mold growth

Diminish outside noise
Up to 40% reduction in outside noise from traffic and neighbors

Defend against insects and pests
Seal gaps and holes to create the first line of defense against critters and pests

Improve indoor air quality
Help seal out pollutants and allergens to create a healthier indoor environment with the inclusion of mechanical ventilation



How Tight is “Tight Enough”?

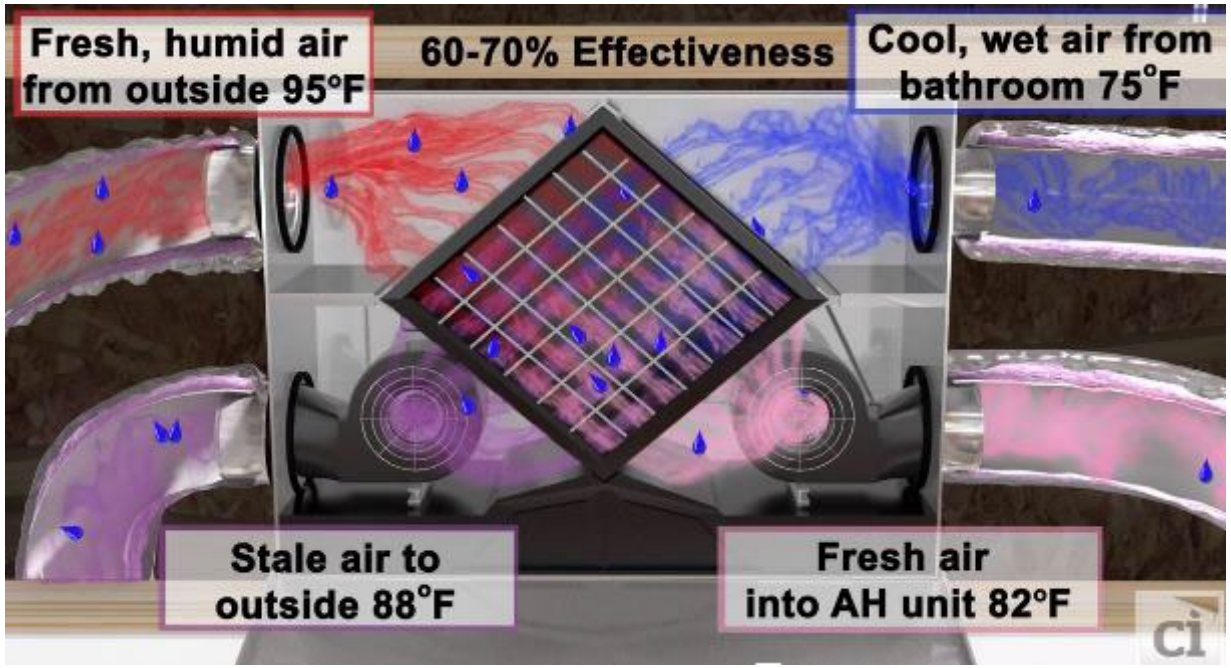
Overall, a house or dwelling unit should be as airtight as possible. This does need to be managed according to the goals of build:

- Compliance Requirements
- Impacts on mechanical equipment
- Building owner’s goal

Can a Building be too Tight?

All buildings need ventilation for proper indoor air quality, comfort, and for the building to perform as a system. As buildings get tighter air recovery units become a necessity.

- **Heat Recovery Ventilation (HRV)** is a system that uses the heat in stale exhaust air to preheat incoming fresh air. This reduces the energy required to bring outside air up to ambient room temperature so saves money on heating bills.
- **Energy Recovery Ventilation (ERV)** goes a little further than the HRV units, as this type of system also captures some of the humidity in the air to keep it on the same side of the thermal envelope that it came from.



Building Science – 4 Control Layers

1. Bulk Moisture Control
2. Air Flow Control
3. Thermal Control
4. Moisture/Vapor Control

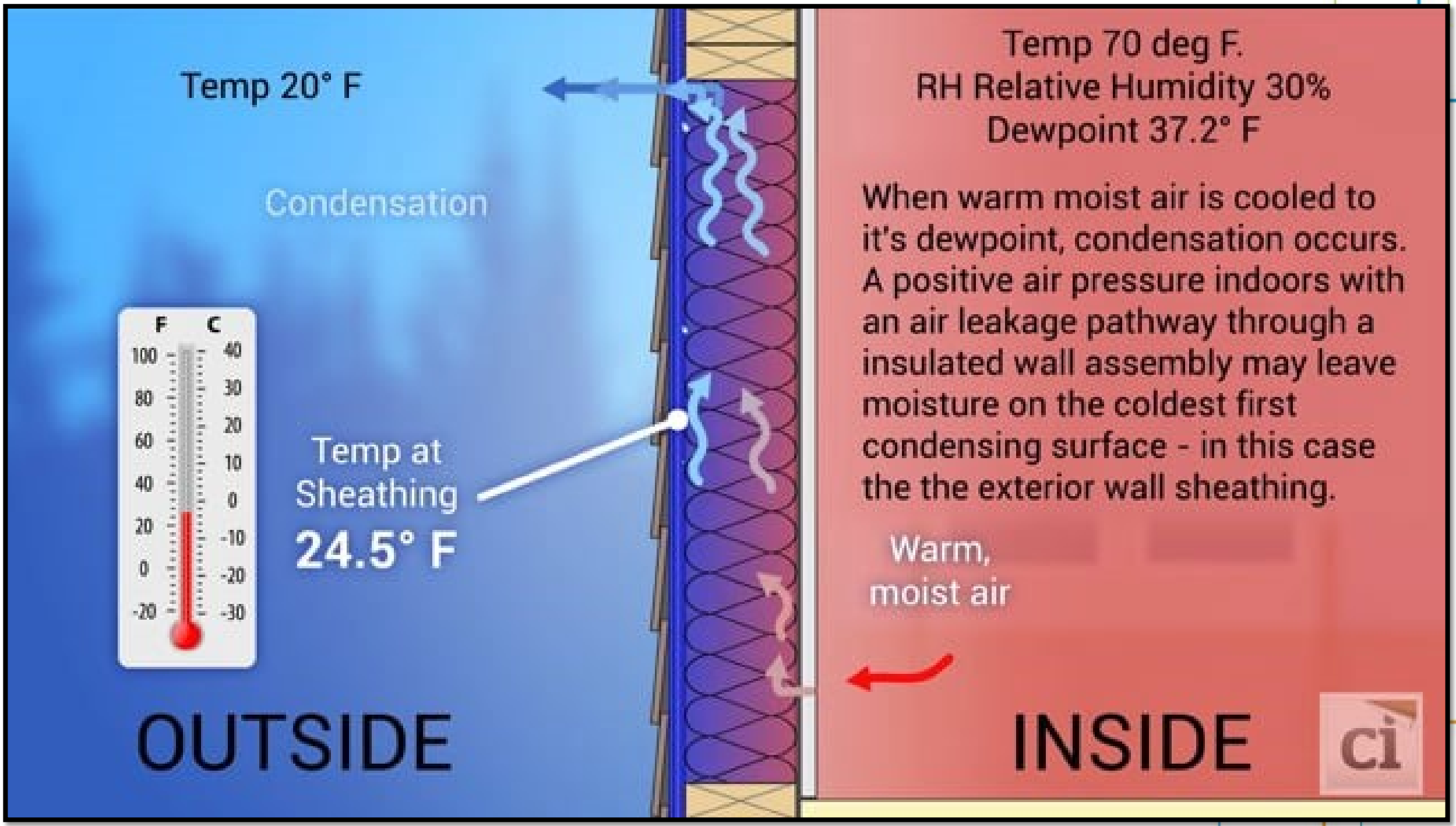
Risk Management

Airtightness is Tied to Insulation Levels

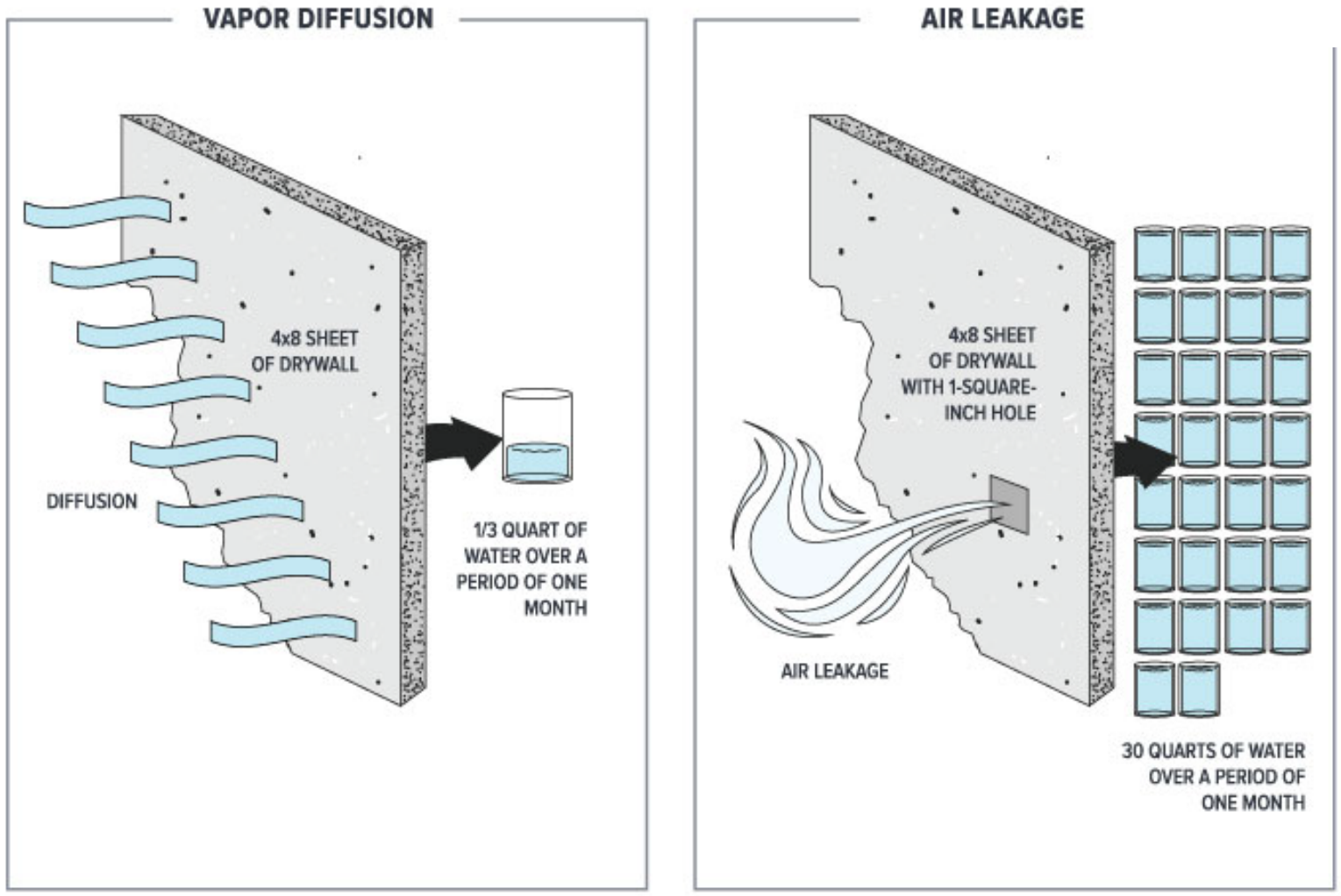
AEROBARRIER
Air Sealing Technology from Aeroseal

More insulation =

- less drying potential
- colder surfaces


Temp 20° F
Condensation
F C
100 40
80 30
60 20
40 10
20 0
0 -10
-20 -20
-30
Temp at Sheathing
24.5° F
OUTSIDE
Temp 70 deg F.
RH Relative Humidity 30%
Dewpoint 37.2° F
When warm moist air is cooled to it's dewpoint, condensation occurs. A positive air pressure indoors with an air leakage pathway through a insulated wall assembly may leave moisture on the coldest first condensing surface - in this case the the exterior wall sheathing.
Warm, moist air
INSIDE
ci

Moisture Control - Diffusion v. Air Leakage



Source: Building Science Corporation

Efficiency Demands Are Higher

Air-sealing requirements for new construction is becoming increasingly more difficult. States throughout the US have already adopted the 2018 International Energy Conservation Code (IECC) requirement of 3 ACH_{50} and more states and municipalities will follow. **You need to prepare now.**

Air sealing with AeroBarrier can help you meet or exceed the 2018 IECC requirements every time, guaranteed

2009 IECC Requirements = 7 ACH_{50}
Equivalent to 15” x 15”hole in home

2015 IECC Requirements = 5 ACH_{50}
Equivalent to 13” x 13” hole in the home

2018 IECC Requirements = 3 ACH_{50}
Equivalent to 10” x 10” hole in the home

Challenges with Air Sealing

Many Trades Involved

- Framer, HVAC, plumber, insulator, electrician, etc…
- Superintendent is often left to manage the outcome

Many Materials Involved

- Caulks, foams, tapes, gaskets, membranes, etc…
- What is the right combination?

Must Know Where to Seal

- Houses are getting more complex which means so is the building envelope
- Trades need to be well trained on where to seal and what products go where

Unpredictable Results

- Leakage results aren't typically available until later in the construction process
- Failing a requirement causes additional cost and last-minute scrambling to remediate the problem

Getting it Right Matters

- Getting the envelope sealed properly is key to meeting code and/or other certification goals
- Failing to meet code or desired leakage can result in $1,000's to fix

Air Sealing – The Human Factor

"To make mistakes is human, but to blame it on someone else, that's even more human"

– Anonymous

What is the Solution?

The demand for tighter building envelopes is growing every year through code changes and customer expectations while the design and construction remains challenging.

- Define a goal in the design phase and communicate this across all parties.
- Develop an air sealing detail with accountability.
- Educate the trades and let them educate you.
- Rely on manufacturers for new product capabilities and updates.

A Sea Change in Air Sealing:

Automated Air Sealing

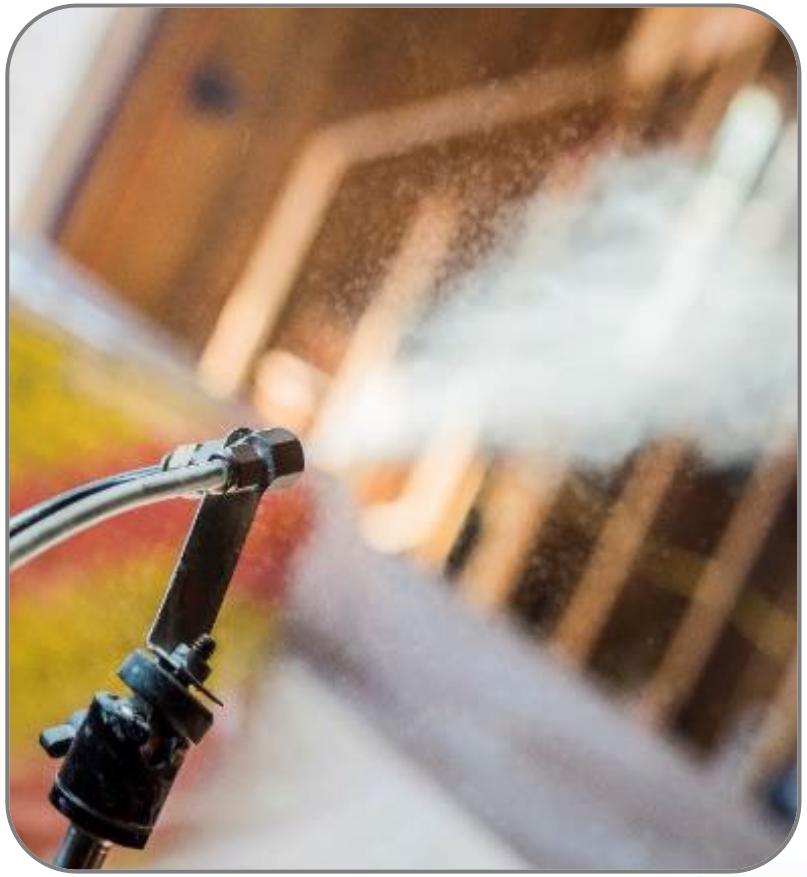
A Game Changing Solution

AEROBARRIER
Air Sealing Technology from Aeroseal

AeroBarrier is an automated, single step solution that seals air leaks in the building envelope, guaranteeing that a builder will meet their target air infiltration goal and saving them time and money.

Changing the Way Homes are Built with:

- Consistently tighter building envelopes
- Verified and documented results
- Eliminates/reduces manual air sealing
- Less time and money spent air sealing
- Shorter build time



How AeroBarrier Works

- Like a building being sealed with AeroBarrier, there is air inside a balloon that is at higher pressure than the air outside the balloon
- If there are leaks in the balloon, the air inside will find the holes and flow through these leaks to the outside
- AeroBarrier's atomized sealant does the same thing – it follows the air currents that are escaping through the leaks in the building envelope, thus finding and sealing those leaks

The AeroBarrier Process

STEP 1:

Prepare the house/unit for sealing. Cover all large openings (drains, bathroom vents, etc.) and horizonal surfaces, set up sealing equipment, and pressurize the home/unit.

The AeroBarrier Process

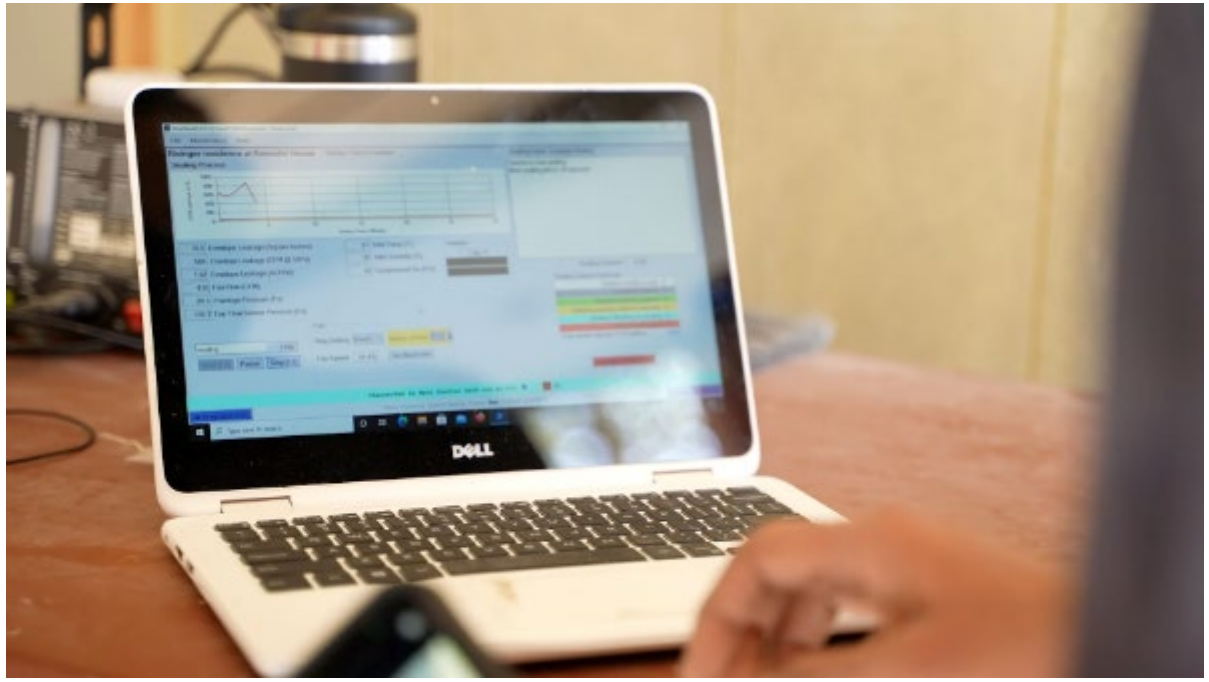
STEP 2:

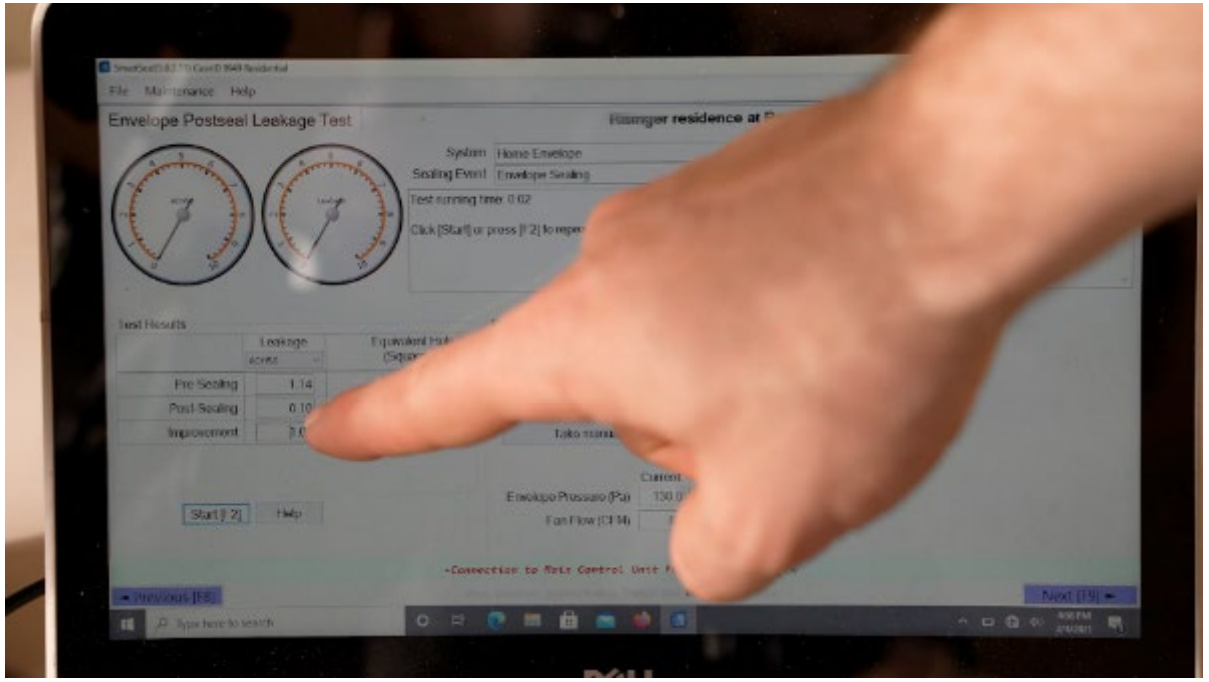
After the baseline leakage is determined, the sealing process begins by atomizing the sealant into a “fog”. Since the unit is pressurized, air takes the path of least resistance and escapes through intrusions, carrying the sealant, and sealing in the process.

The AeroBarrier Process

STEP 3:

The software regulates the entire process; controlling all parameters, monitoring the sealing, recording all data, and verifying air-tightness target is achieved.

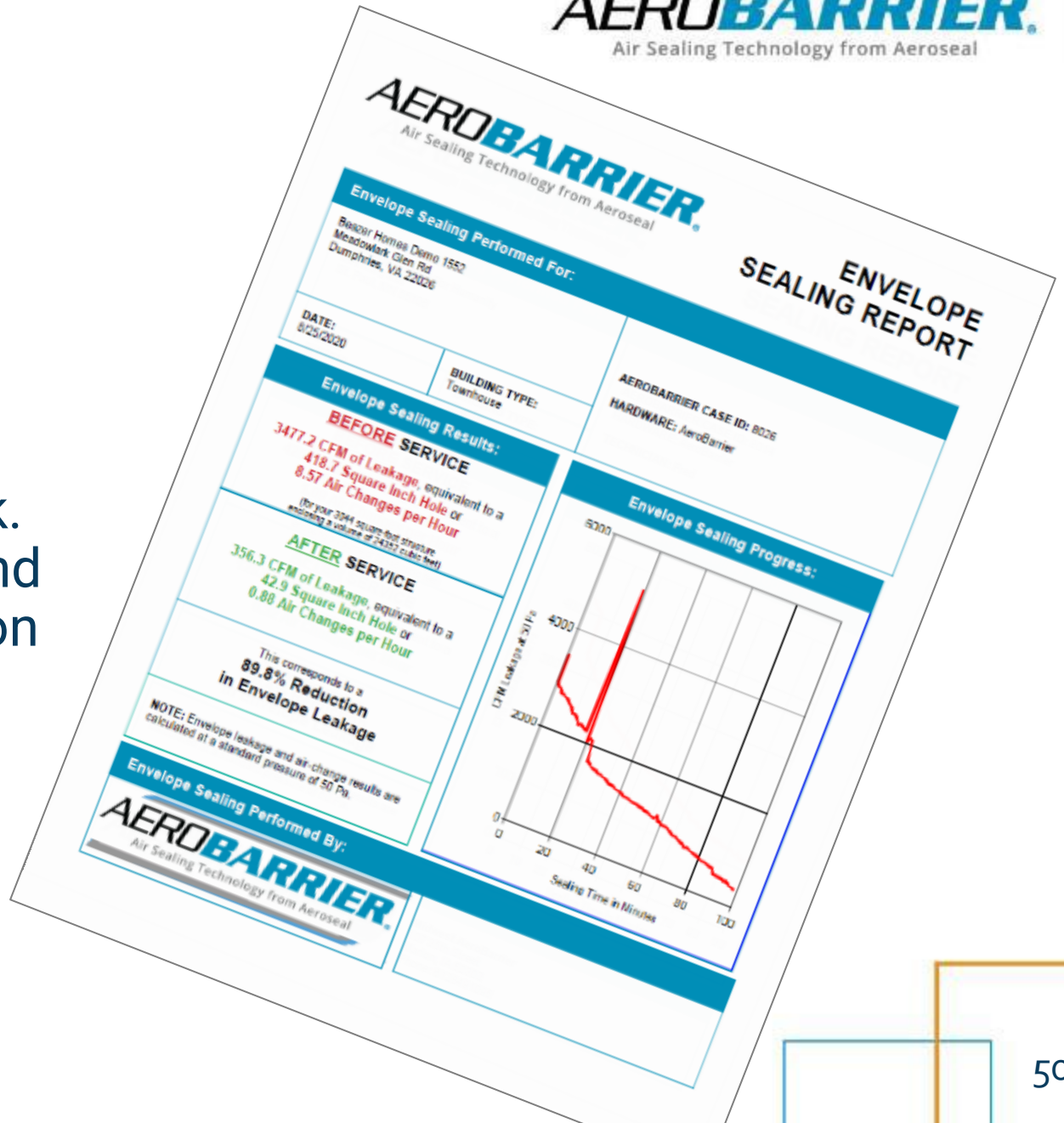




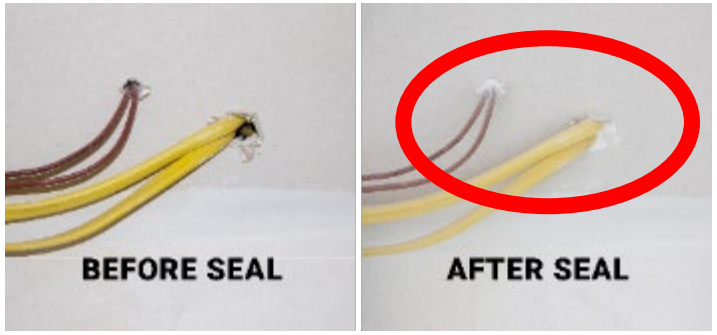
The AeroBarrier Process

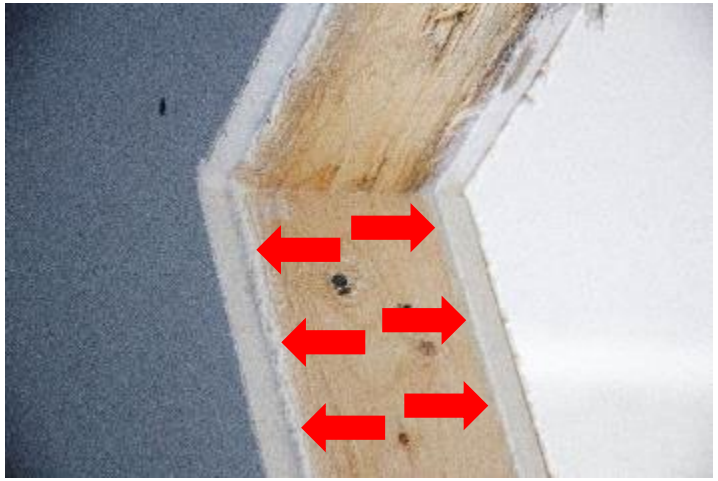
Verified Results!

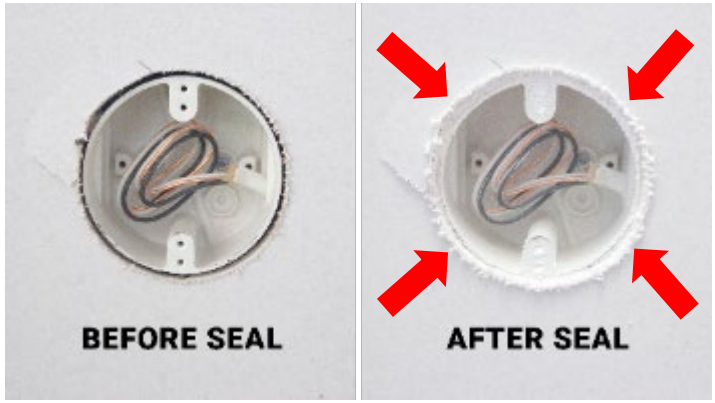
Every seal provides a certificate of completion outlining the sealing work. Pre- and post-leakage are captured, and the seal duration and leakage reduction are all displayed on the graph

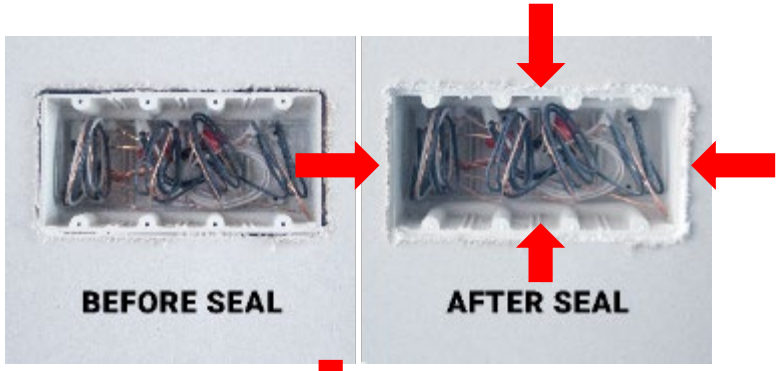


Seal Results









The Sealant

AeroBarrier X1 is an **inert sealant** based on permeable waterborne acrylic

- GreenGuard Gold Certified
- National Green Built Standard Certified Product
- Ultra-Low VOC / No Off-Gasing

Meets:

- ASTM 2178 - Air Sealing Material
- ASTM E84 - Flame Spread
- ASTM E84 - Smoke Development
- ASTM C719 - Sealant Durability
- ASTM D543 - Chemical Compatibility
- NFPA 285 – Fire Evaluated Wall Assemblies
- ASTM E2357 – Air Leakage in Assemblies

Average of 82% reduction in leakage

6 units done in 1 day

Thank You!

Paul Springer

paul.springer@aeroseal.com

Tommy Gibbons

Hempitecture

hempitecture®

Truly Sustainable Materials

Hempitecture Business Summary

Summer 2022

We’re an **AgTech Startup** bridging the gap between **agriculture** and **sustainable construction**.

Hempitecture **manufactures** and **distributes** the *most sustainable* insulation **on the planet.**

We are a for-profit Public Benefit Corporation disrupting the building industry with healthy, high performing, easy-to-use products made from ag fiber with the potential to reverse climate change.

Problem:

Insulation is in every building, but...

- It can be **toxic**
- Has a large **carbon footprint**

Buildings rely on insulation to save energy, but...

- Conventional insulation like **fiberglass** is underperforming - it deteriorates over time
- The installation can be expensive and require specialized labor

Solution

Healthy, plant based insulation that absorbs **carbon dioxide**, and immediately makes homes more **energy efficient.**

Our material feedstock offsets an estimated **9.8 tons of CO2 / acre**

Healthier home, **happier** people,
more **sustainable planet.**

HempWool®

Our newest product offering: **Natural Fiber Insulation**

1-to-1 replacement for traditional
Insulation. We own the trademark.

$950k sold since Q3 2019
550 customers & growing

Now: Importing from manufacturing partner
Soon: Manufacture in Southern Idaho

Manufacturing technology meets agricultural fiber:

Phase 1: Build market, grow customer base, develop IP generate revenue.

HERE / NOW

Phase 2: USA Manufacturing Facility.

Hempitecture has proprietary process and IP.

Equipment is landed at 30k sqft Jerome, Idaho facility

Manufacturing location identified.
Feedstock **supply chain** partners in place.
Regional reach to major **urban centers.**

Already selling in the target market.
Key distributor **partnerships** in place,
Waiting for **US Manufacturing.**

Distribution Roster

IDI DISTRIBUTORS

475 HIGH PERFORMANCE BUILDING SUPPLY

GREEN HOME SOLUTIONS

Since 1974 TRI-COUNTY INSULATION & Acoustical Contractors

Insulation Market Size

Assumes market penetration of 5%

North America Insulation Market in 2020

Fiberglass competitor market share

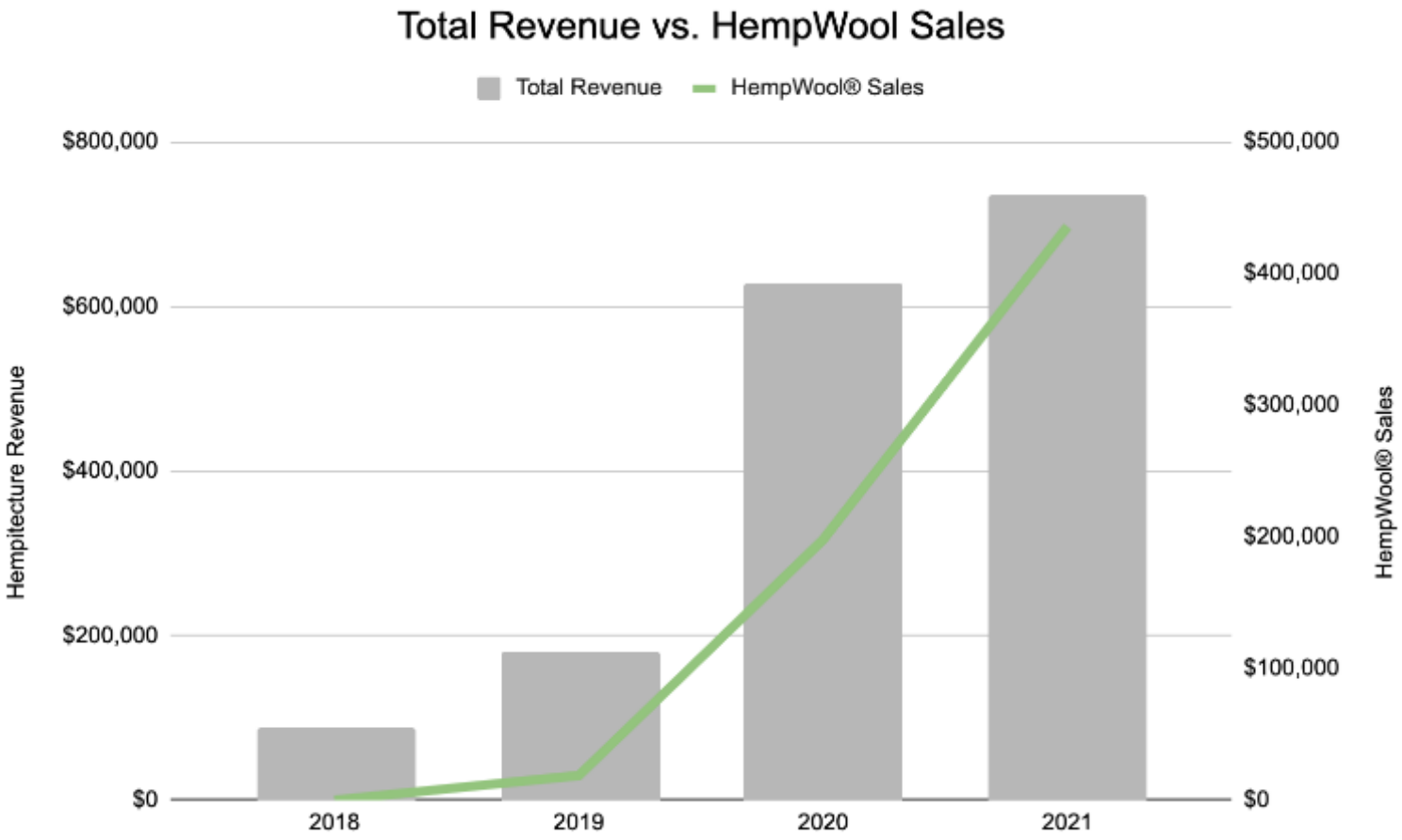
(~15% of fiberglass market is “eco”, 10% of German insulation market is “natural fiber”)

Hempitecture market share

(projected 5yrs post-investment)

*https://www.prnewswire.com/news-releases/us-insulation-market-to-hit-104-billion-in-2019---global-insulation-industry-2020-forecasts-in-new-research-reports-529799171.html

Company Financials



Manufacturing Facility Cost: $3.5m
Break Even: 2 to 3 years

- Yr1 @ $750k sales
- Yr2 @ $1.5m sales
- Yr3 @ $4.5m sales

Imported HempWool margin: 30%
Domestic HempWool margin: 50%

2018
$90k gross revenue

2019
$190k gross revenue

2020
$630k gross revenue

2021
$730k gross revenue

Forecasting 50% YoY growth for 2022

- HempWool® Sales: $25k in 2019 ⇨ $190k in 2020 ⇨ $430k in 2021
- 4 years of breakeven financials
- Company is 100% founder, employee, and advisor owned

Completion of our seed Community Round on WeFunder!

We are using capital to secure our US manufacturing location, and purchase & set up manufacturing equipment, and grow the awareness of our products.

Hempitecture has secured over $4.5mm in funding across 2k+ investors using Regulation Crowdfunding on Wefunder.

The Hempitecture Team

Mattie Mead
Founder & CEO

Tommy Gibbons
Co-founder & CIO

Tommy and Mattie have been friends for 15+ years.

At Hempitecture, they have been partners for 3+ years.

Tommy studied Public Policy at Princeton. Mattie studied Architecture and Entrepreneurship at Hobart College.

Advisors

- Aimee Christensen - Christensen Global Strategies
- Dr. Brian George - Thomas Jefferson University
- Belinda Carr - Building Scientist
- Eric Stonehill - Manufacturing Advisor

As seen on:

The New York Times

The Seattle Times

Forbes 30 UNDER 30

Employees

- Jonnie Pedersen - Growth Operations Associate
- Max Sagdahl - Sales Technician
- Dashawn Hutchinson - Manufacturing Technician

Thank you.

hempitecture®

Mattie Mead - Founder & CEO
mattie@hempitecture.com
973-727-7902

Tommy Gibbons - Founder & CIO
tommy@hempitecture.com
973-943-9239

www.hempitecture.com

Explore the Residential Program Guide

Resources to help improve your program and reach energy efficiency targets:

- Handbooks - explain *why* and *how* to implement specific stages of a program.
- Quick Answers - provide answers and resources for common questions.
- Proven Practices posts - include lessons learned, examples, and helpful tips from successful programs.
- Technology Solutions NEW! - present resources on advanced technologies, **HVAC** & **Heat Pump Water Heaters**, including installation guidance, marketing strategies, & potential savings.
- Health + Home Performance Infographic NEW! – spark homeowner conversations.

https://rpsc.energy.gov

Health + Home Performance Infographic

DOE's new Health + Home Performance Infographic reveals the link between efficiency and health – something everyone cares about. Efficiency programs and contractors can use the question-and-answer format to discover a homeowner's needs.

The infographic is ideal for the "kitchen table" conversations where people decide what to do – and who they want to do it. It also has links for homeowners to find a qualified contractor if they do not already have one.

Download this infographic from DOE's Better Buildings Residential Network.

Thank You!

Follow us to plug into the latest Better Buildings news and updates!

Better Buildings Twitter with #BBResNet

Better Buildings LinkedIn

Office of Energy Efficiency and Renewable Energy Facebook

Please send any follow-up questions or future call topic ideas to:
bbresidentialnetwork@ee.doe.gov