BFREEHOMES

Scaling Up Deep Energy Retrofits in Cold Climates

23 Feb 2021

Presented to: 2021 Virtual Duluth Energy Design Conference

Presented By: Shawna Henderson, CEO, Blue House Energy
and Bfreehomes Design Ltd.

Principal
Abri Sustainable Design 1992 – 2008

Key Projects:
2008 The Canadian Solar Home Design Manual: Solar NS
2008 Approaching Net Zero in Existing Housing, CMHC
2006 Low Impact Housing: 24 Case Studies, CMHC
2006 Alternate Energy Ready Homes: Lit. Review, CMHC
2006 Community Energy Systems: Market Opportunities & Business Models: Study, NRCan
2005 Energy Indicators for Urban Environments, NRCan
2004 Renovating for Energy Savings, CMHC
2004 Renewable Energy for Off-Grid in the North, NRCan
2003 In Hot Water: marketing for solar thermal, CanSIA
2003 PV on the Grid, CanSIA

CEO
Bfreehomes Design Ltd. 2008 – present

Key Projects:
2020 WHERE-NS, Panelized Retrofits for Part 9 MURBS, Ecology Action Centre
2019 Clean Net Zero Retrofit Pilot Project (NRCan funding) Clean Foundation
2018 Leadership in Energy Efficiency Partnerships (LEEP), NRCan
2018 Exterior Wall Upgrades in Atlantic Canada, NRCan
2017 Rapidly Deployable Housing for the North, NRCan
2014 Low Energy House Total Cost Index: Industry Survey, NRCan
2014 Solar Ready Initiatives, Guidelines & Legislation: Literature Review, C3
2012 Path to Net Zero in New Construction: Builder Focus Groups, NRCan
2012 Sustainable Features and Technologies: 10 profiles, CMHC
2011 Next Generation EnerGuide Rating System Technical Procedure: NRCan
2011 Benefits of Solar Thermal Combination Systems: Presentation, NRCan
2011 Energy Efficiency Program Evaluation: PEI Office of Energy Efficiency
2011 Payback for Green Building Products: Research Report and Profiles, CMHC
2010 Construction Options beyond the 2010 OBC: Builder Focus Groups, OPA
2010 Deep Energy Retrofits: Baseline models for 11 Consumer booklets, NRCan

Energy Evaluator & Researcher
Sustainable Housing & Education Consultants 1990 – 2002

Key Projects:
Beta Testing Hot2000, NRCan
Evaluating/Inspecting R2000 New Construction, NRCan/OEE
Carrying out field research, CMHC, NRCan and OEE
Piloting EnerGuide for Existing Houses, NRCan and OEE
Training New Evaluators, in house
Managing regional delivery of national energy efficiency programs (Woodstove Changeout, Renovation Demonstration), NRCan, CMHC

TIMELINE

CEO
Blue House Energy Ltd 2012 – Present

Key Projects:
Developing a suite of high quality, cost-effective building science-based online courses for the residential construction and renovation industry.
'Recognized training provider' status with Tarion, (Ontario's New Home Warranty Program), Built Green Canada, BC Housing, Canadian Association of Consulting Energy Advisors.
US continuing education: Building Performance Institute, National Association of Home Builders, North American Technical Excellence.

- Chair, CHBA Working Group on NZE Renovations
- CANMET/NRCAN Industry Working Group on Pre- Engineered Exterior Panels (PEER)
- Chair, Professional Development, CHBA-NS
- Board member, Atlantic Home Building and Renovation Sector Council

Approaching Net Zero in Existing Houses:

- Canada Mortgage & Housing Corp (CMHC)
  - Study completed 2008
- 12 house types
- 6 cities
- Vintages: 1922 – 2000
- How does climate affect NZEEH?
  - Vancouver Bungalow:
    low EE costs and smaller RE option
  - Halifax: best case for GHG reductions

RESEARCH HIGHLIGHT

June 2008 Technical Series 08-104

Approaching Net-Zero Energy in Existing Housing

INTRODUCTION

CMHC defines "net-zero energy housing" as a home that produces as much energy as it consumes annually. This is accomplished by a variety of means, including :

- reducing energy loads through a high-performance building envelope and energy-efficient appliances and lights;
- increased use of passive-solar cooling and heating techniques;
- high-efficiency mechanical systems that match the lower energy requirements of the home;
- space and water heating assisted by commercially available, solar thermal systems and heat pumps;
- electrical use offset by grid-connected, commercially available photovoltaic (PV) systems.

It is easier to build a new home to stringent energy specifications than it is to retrofit an existing house, yet new construction accounts for only two per cent of the housing stock annually. With residential uses accounting for 17 per cent of Canada's energy requirements and 16 per cent of our greenhouse gas (GHG) emissions, cost-effective ways to retrofit the millions of existing houses to meet net-zero energy targets are key elements to energy security and climate change mitigation.

Current energy-efficiency programs for existing homes aim for overall energy reductions of 20 to 30 per cent. Net-zero retrofits would require reductions in overall energy use of between 70 and 90 per cent.

There is a history of practical experience in energy retrofitting in Canada that stretches back to the 1970s. One of the 12 EQuilibrium initiative projects, the Now House™ is exploring the net-zero retrofit concept. This 60-year-old wartime house, in an established neighbourhood in Toronto, represents hundreds of thousands of homes in Canada.

Table 1 Benefits and barriers to net-zero energy retrofits

Why focus on retrofits?

Canada

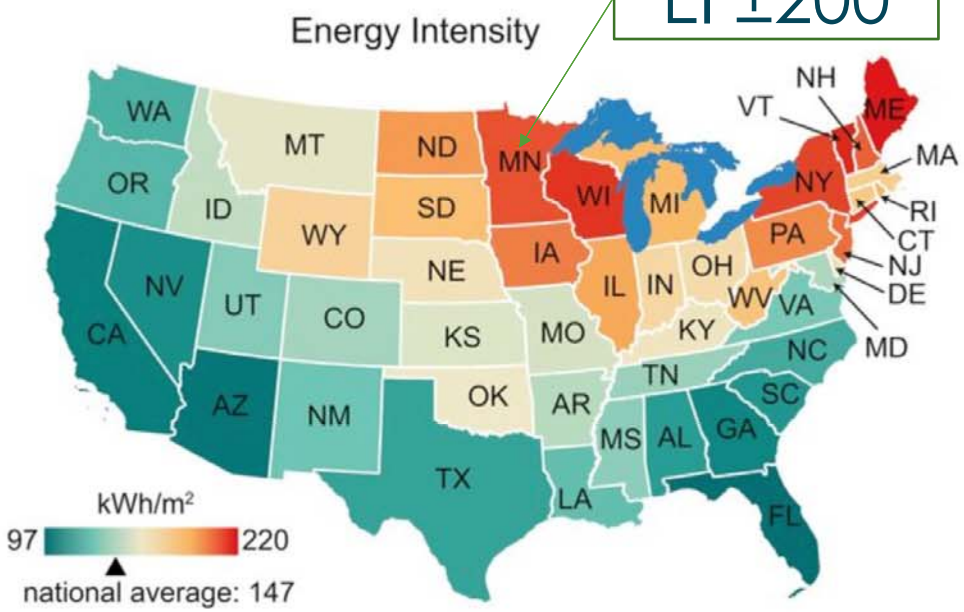
- ± 110,000 new houses built annually
- 14.5 million existing houses
- +14% of all energy use
- +11% of total GHG emissions

USA

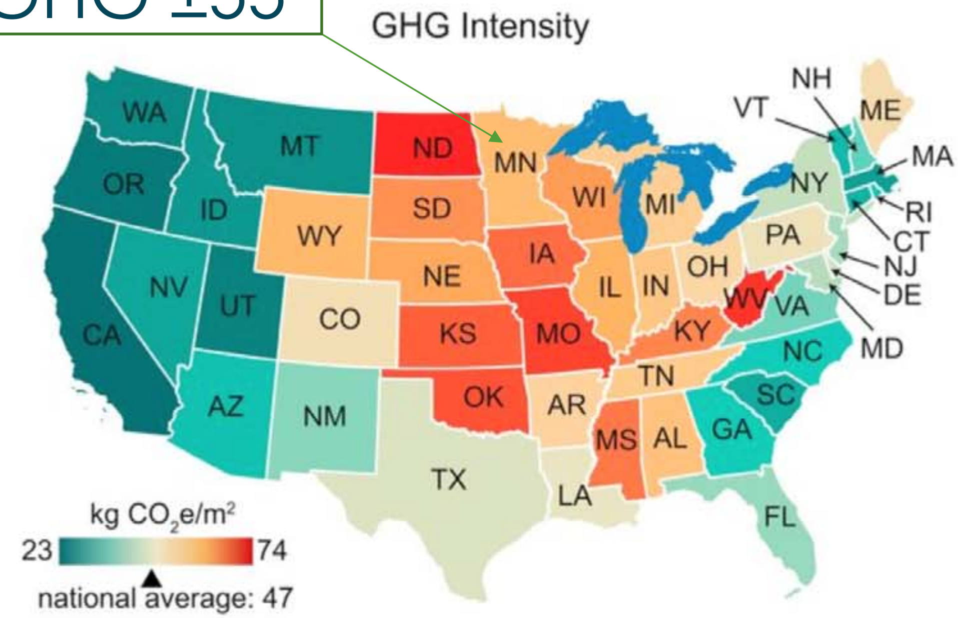
- 700,000-1,000,000 new/annually
  - West: 23%, Midwest: 15%, NE: 8%
- 139 million existing houses
- ± 21% of all energy use
- ±20% of total GHG emissions

Why focus on retrofits?

EI ±200



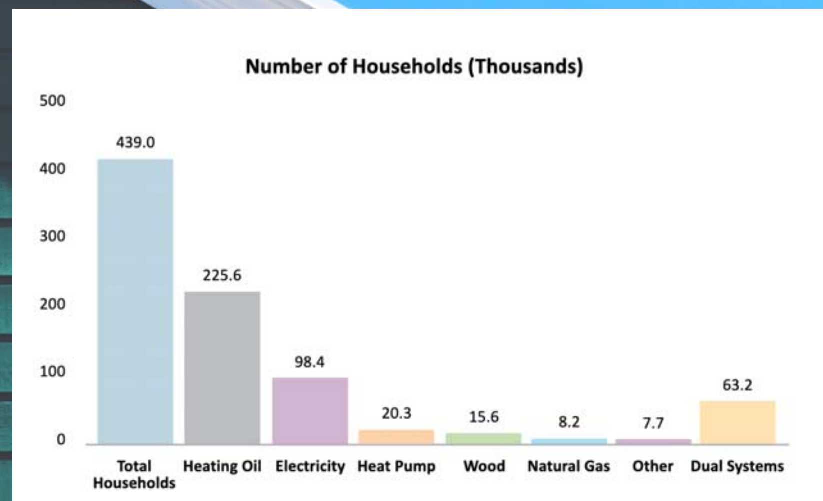
GHG ±55



Why focus on retrofits?

Nova Scotia

- 50% of housing stock pre-1970
- 50% of housing stock heats with oil
- ± 60% electricity is coal-fired
- High energy costs
- High carbon intensity



Why focus on retrofits?

Minnesota

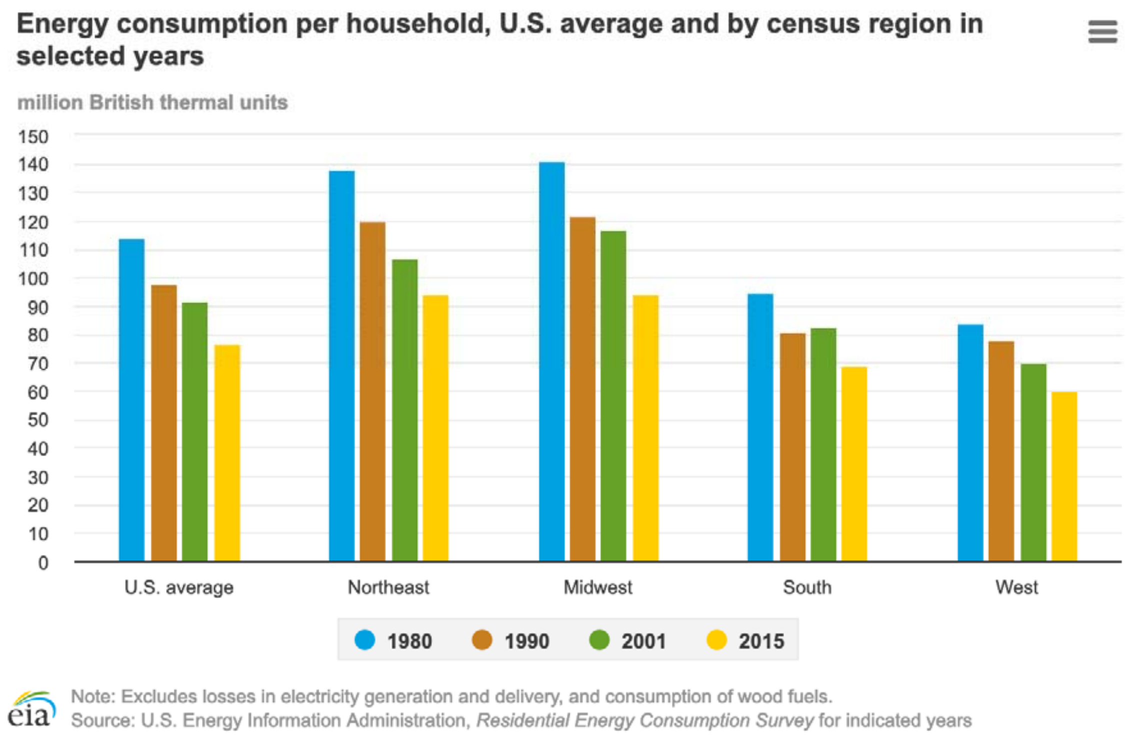
- 32% of housing stock pre-1960
- 66% of housing stock heats with gas
- ± 40% electricity is coal-fired
  - Down from ±60% in 1990

MN= 2, 456,064 houses

- High carbon intensity
- Energy Poverty
  - ± 25% pay more than they can afford for housing

10 Coldest States = 13.7 million houses

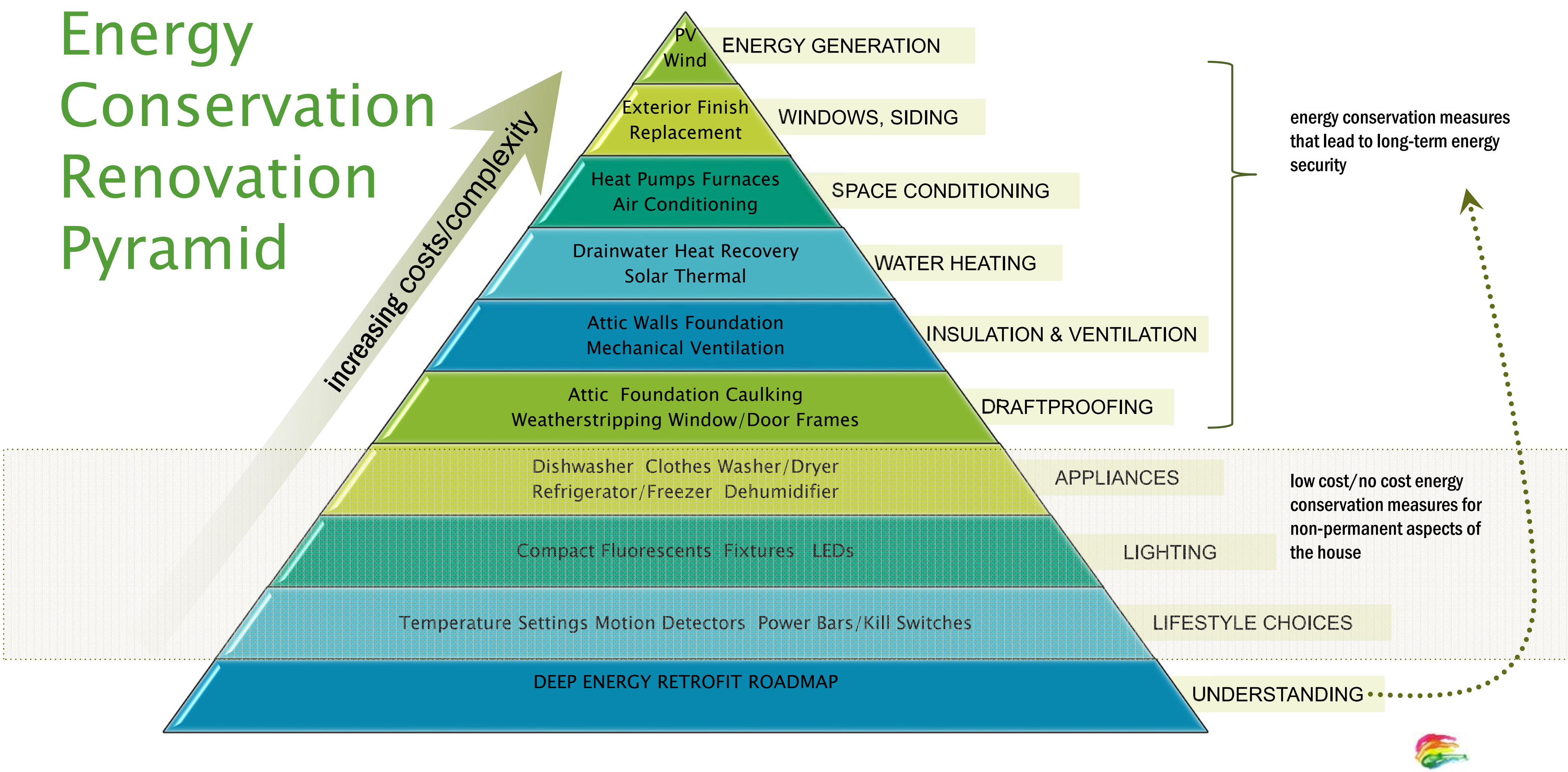
- Alaska
- N Dakota
- Maine
- Minnesota
- Wyoming
- Montana
- Vermont
- Wisconsin
- New Hampshire
- Idaho/Michigan



Non-Energy Benefits…

- Lower financial load on owner or occupant
- Healthier indoor air quality
- Extended lifespan of existing buildings
- Improved value of existing buildings
- Stable tax base/longer rental tenure
- Increased resiliency
- Decreased carbon footprint

HOW to Focus on DERs?

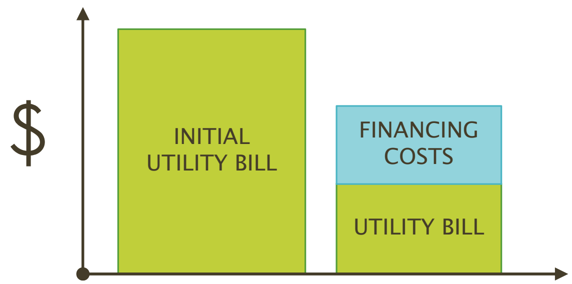

Energy Conservation Renovation Pyramid
increasing costs/complexity
PV Wind
ENERGY GENERATION
Exterior Finish Replacement
WINDOWS, SIDING
Heat Pumps Furnaces Air Conditioning
SPACE CONDITIONING
Drainwater Heat Recovery Solar Thermal
WATER HEATING
Attic Walls Foundation Mechanical Ventilation
INSULATION & VENTILATION
Attic Foundation Caulking Weatherstripping Window/Door Frames
DRAFTPROOFING
energy conservation measures that lead to long-term energy security
Dishwasher Clothes Washer/Dryer Refrigerator/Freezer Dehumidifier
APPLIANCES
Compact Fluorescents Fixtures LEDs
LIGHTING
Temperature Settings Motion Detectors Power Bars/Kill Switches
LIFESTYLE CHOICES
low cost/no cost energy conservation measures for non-permanent aspects of the house
DEEP ENERGY RETROFIT ROADMAP
UNDERSTANDING

← Energy Reduction Continuum →

Energy Efficiency Replacements New or Already Upgraded Houses	Energy Conservation Retrofit ±20% reduction	Deep Energy Retrofit 50-70% reduction	Net Zero Energy NZE-Ready Retrofit 70%+ reduction
Lightbulbs	Air Sealing	Aggressive Air Sealing	Push DER to Limit
Appliances	Attic Insulation	Highest Levels of Attic Insulation	Add Renewable Energy
ECM fans	Blown Insulation Walls	Exterior Wall Insulation	
Cold Climate Heat Pump	High Efficiency Gas Space/Water Heating	Foundation Wall Insulation Upgrade	
New Water Heater	Add Spot Ventilation	Whole House Ventilation	
		Cold Climate Heat Pump	

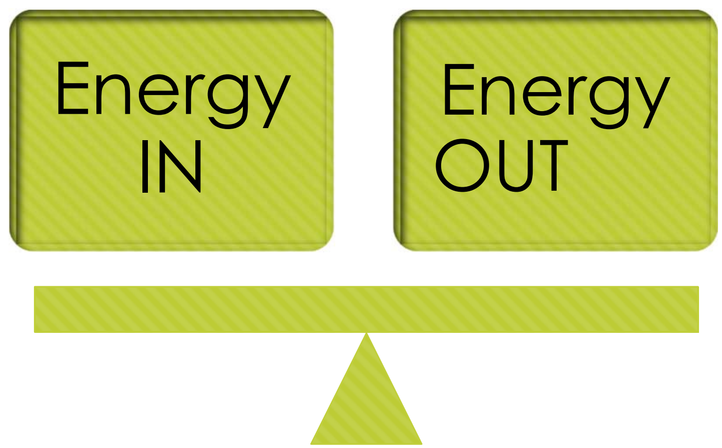
What's in a name?

Deep Energy Retrofit



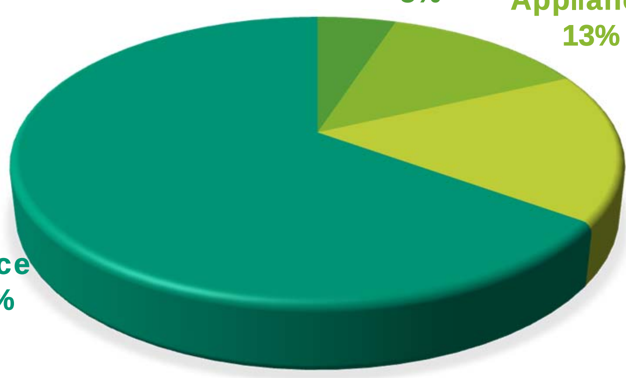
- 50 -90% drop in space & water heating
- Optimize building envelope
- Optimize resiliency/passive survivability
- Minimize mechanical systems
- Barrier free layouts + user friendly details
- Maximize renewables where possible

Net Zero Energy/NZE-r

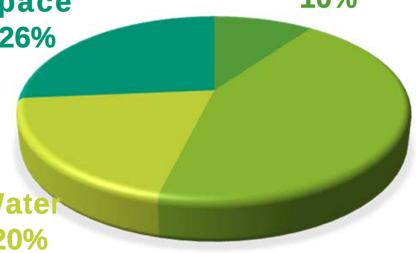


- Install renewables for site-based generation
- The 'r' is for 'ready' = pre-planning for PV

Lower Energy Use, Patterns Change



AS-IS EXISTING HOUSE

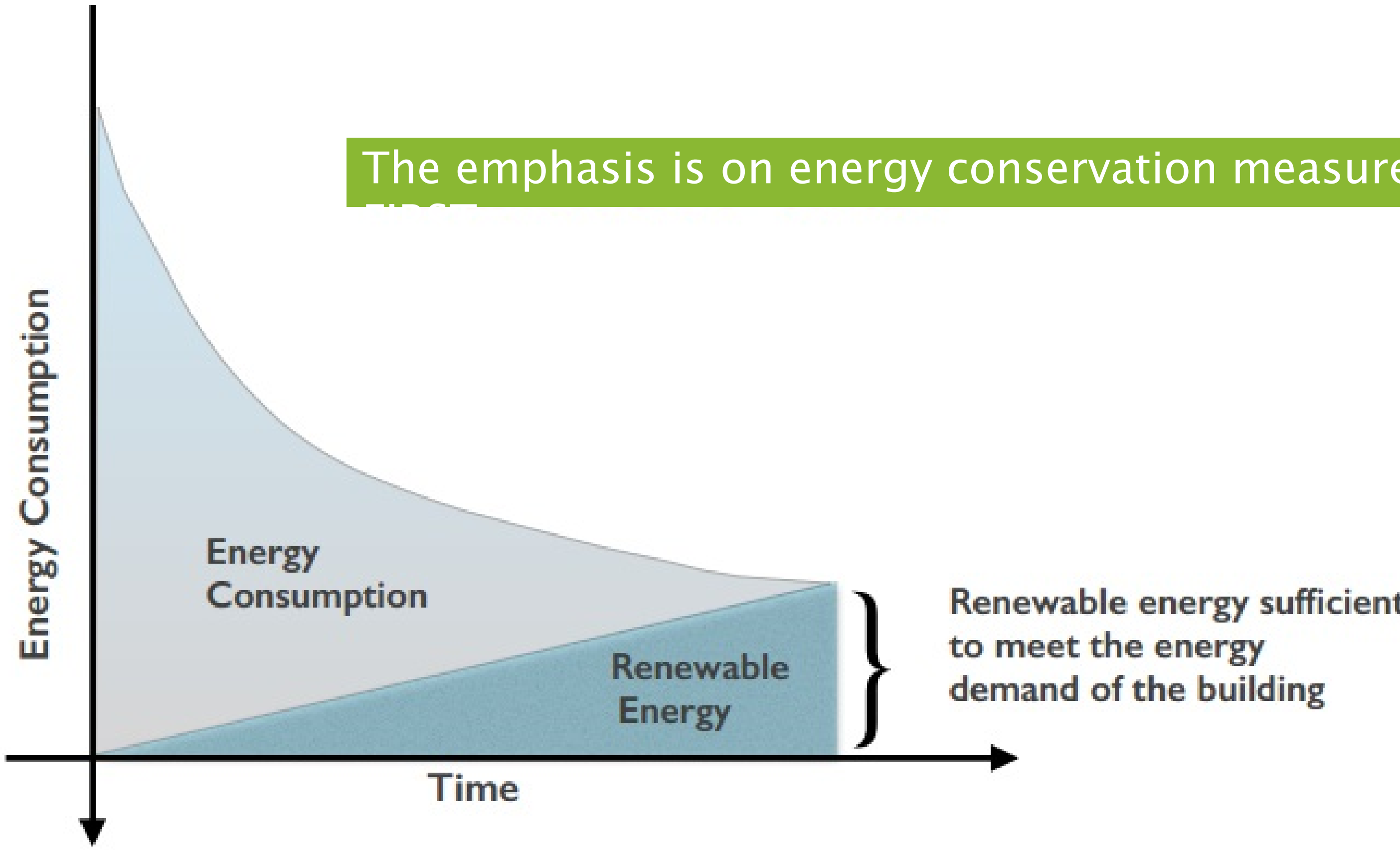


DEEP ENERGY RETROFIT

IMPACTS SPACE & WATER HEATING STRATEGY, OPTIMIZES RENEWABLE ENERGY NEEDS

Reduce energy loads, add renewables

The emphasis is on energy conservation measures



Deep Energy Retrofits Two Ways

'Gut Rehab': Retrofit from Interior

'Gut Rehab': Retrofit from Interior

Exterior Retrofit

Exterior Retrofit

Gut Rehab vs. Exterior Retrofit

- Gut Rehab:
  - Significant disruption for occupants
  - Replace/refurbish all surfaces
  - Challenges with control layers
  - Not a significant number of houses
  - Custom/bespoke process
- Exterior Retrofit
  - Minimal disruption for occupants
  - Interior surfaces upgraded separately
  - Better execution of control layers
  - Many houses upgraded cost effectively
  - Can be scaled easily

PROBLEM: Incremental Retrofits

- More difficult, more expensive to reach goals
- Constantly reinventing the wheel
- Poor practices = unintended consequences
- Lock in emissions for generations
- Timeframe unmanageable: stop 2°C over 10/12/16 years?

We will never make it

UNLESS

We move into bulk, aggregated retrofits

SOLUTION: Bulk/Aggregated Retrofits

INSPIRED: EnergieSprong (Netherlands)

- NZE retrofit
- Prefabricated façades
- Insulated rooftops + solar panels
- Smart heating/ventilation/cooling
- 40 year performance warranty

Photo: Energiesprong on Youtube

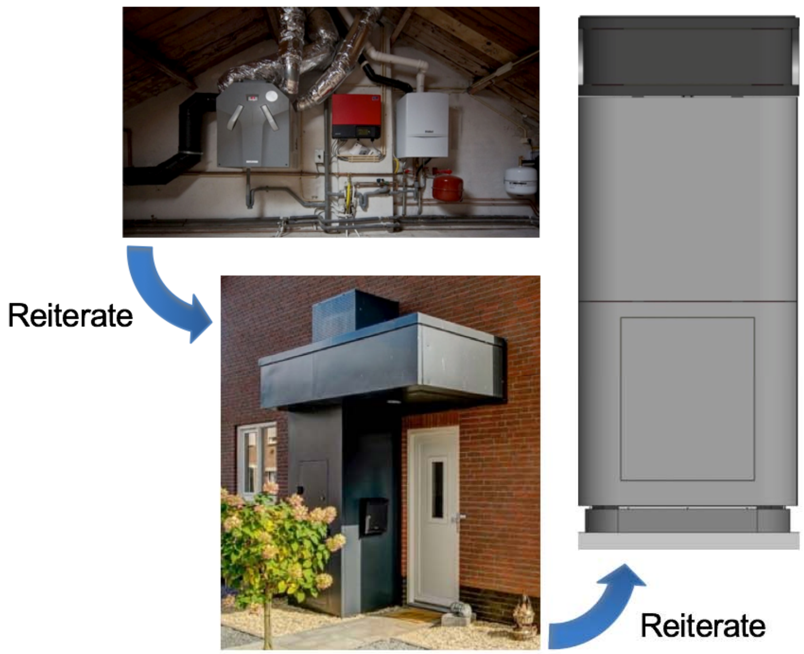
ADVANTAGE: Panelization at Scale

Industrialization of construction to scale up to production-line roll-out

Images: Energiesprong

PEMBINA institute

ITERATIONS: become an agent of change



Images: Energiesprong, Factory Zero and Realize by Rocky Mountain Institute

PEMBINA institute

Advantages of Panelized DERs

- Less expensive than component by component replacement
- Higher quality control/quality assurance
- Faster, less disruptive to occupants
- Easier to manage
- Better total solution
- Can be done, now – no waiting on technology

Why it works in the Netherlands/EU

- Large social housing network
- Few archetypes, many copies
- LEGISLATION
- Social Enterprise
- Centralized manufacturing
  - Tight geographical areas
  - High density

What’s Different in North America?

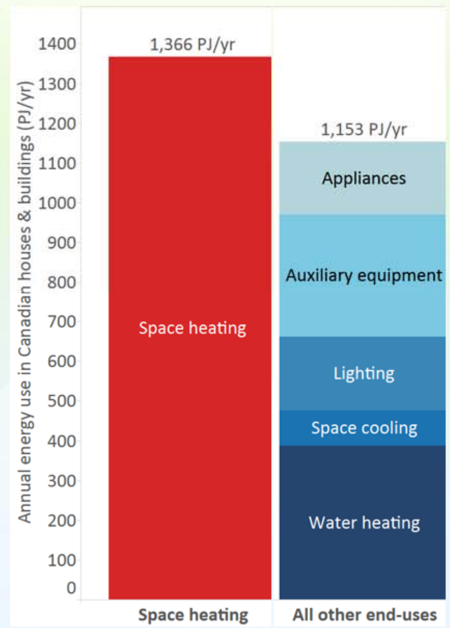
- Many archetypes, fewer copies
- Geographically diverse and dispersed
  - US bigger high density areas
- Social housing not the norm
- Abbreviated history of social enterprise
- Limited central manufacturing options
  - See bullet #2

Those who disrupt their industries change consumer behavior, alter economics, and transform lives.

Heather Simmons, former CMO for Dell Canada

PEER Project (2016-2021)

- Goal: prefabricated building envelope retrofit solutions to achieve Net-Zero Ready heating demand
- Main research question:
  - Can factory-built, super-insulated, airtight panels be installed directly over existing finishes? Could this be a cheaper and more effective way to do deep retrofit?
- 3 primary research areas:
  1. Building capture: rapid, accurate measurement
  2. Panel prototypes, fabrication and installation
  3. Building science: minimizing risks of failure



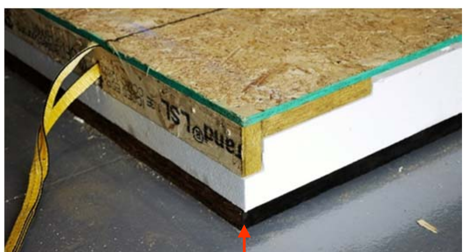
Photos: CanmetENERGY, NRCan

PEER: Pre Engineered Exterior Retrofit

Exploration of a Canadian approach to panelized aggregated exterior retrofits

Panel #1:
Rigid Foam Nail Base (SIP)

Integrated lifting straps



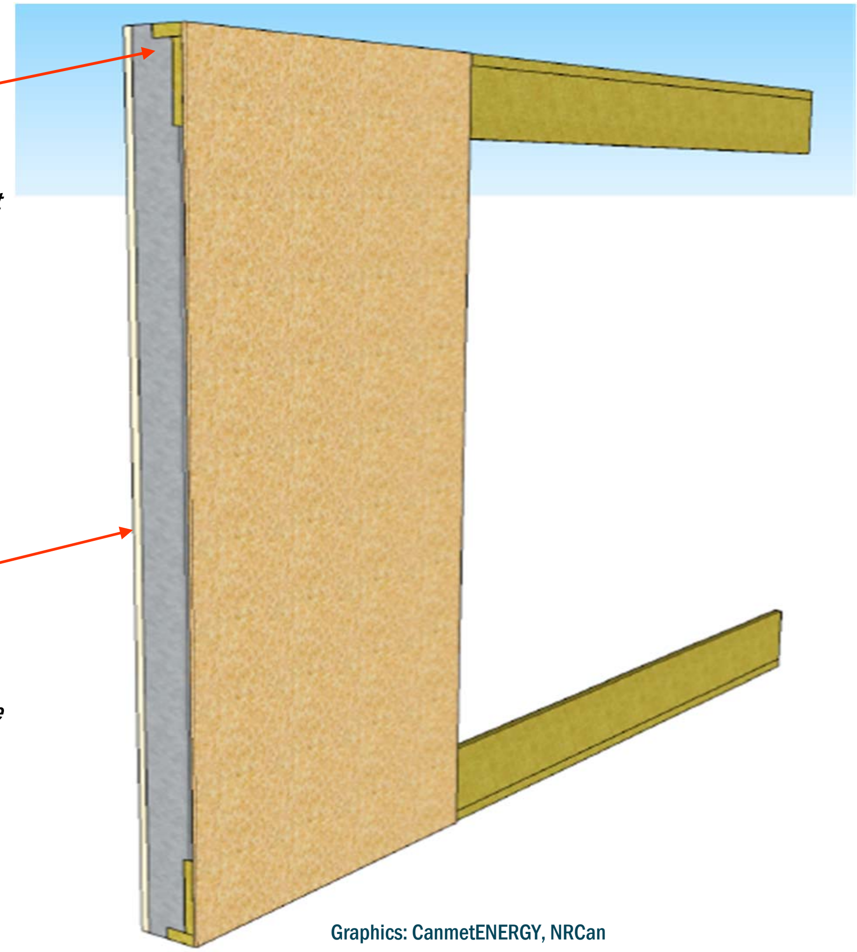
Squishy
Layer

Let-in structure

Ties sub-panels into superpanel
Stiffens superpanel and enables it to be lift into place

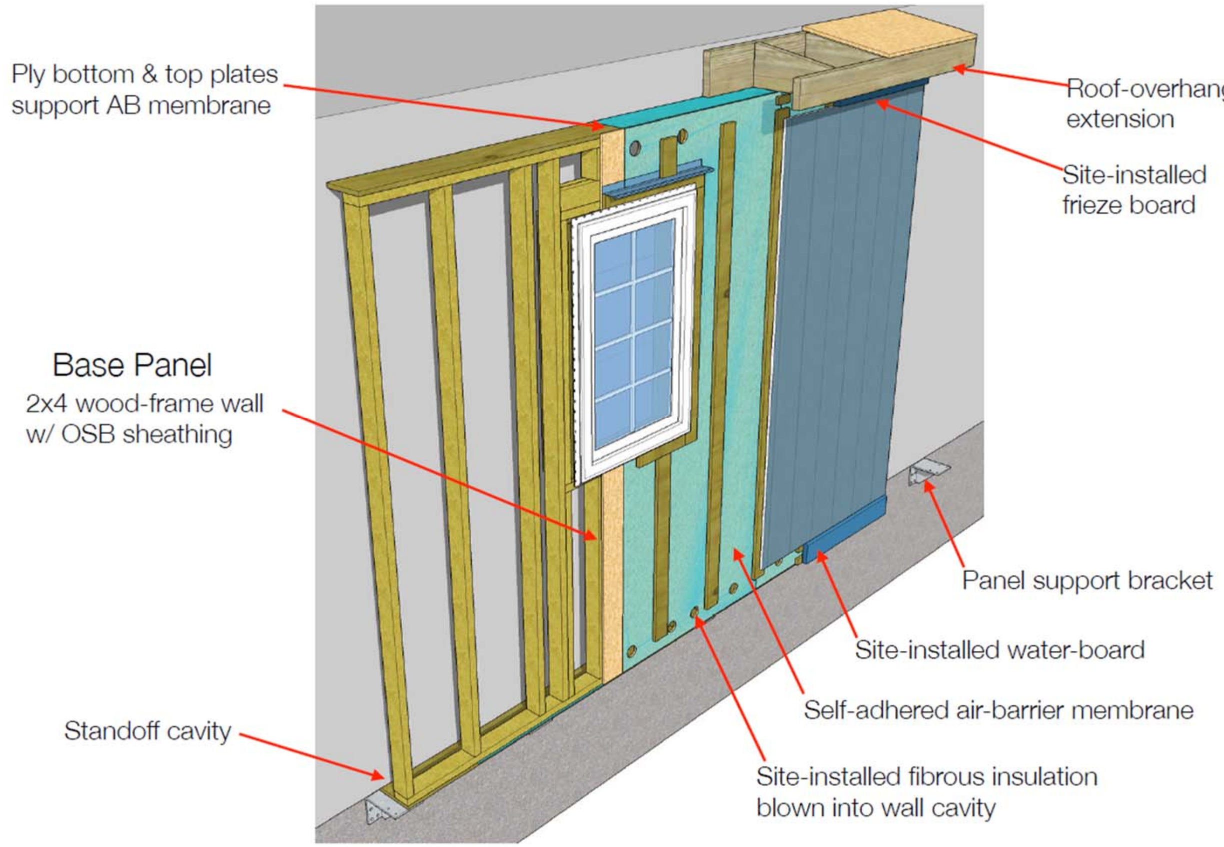
Squishy Layer

Helps with plumb/square
Absorbs surface irregularities
Provides dimensional tolerance
Vapour open



Graphics: CanmetENERGY, NRCan

Panel # 2:
Wood-frame Standoff Panel



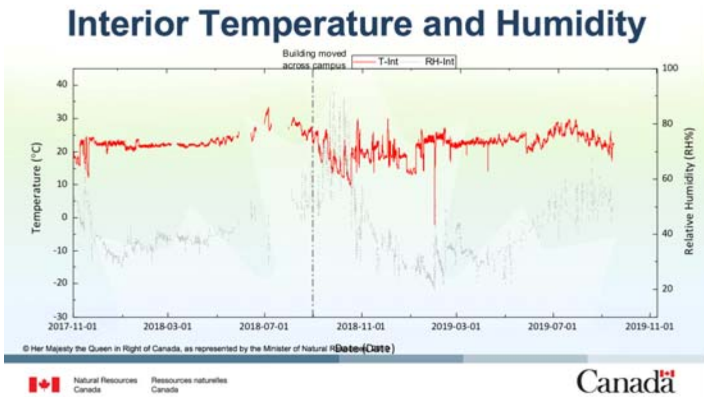
Graphics: CanmetENERGY, NRCan

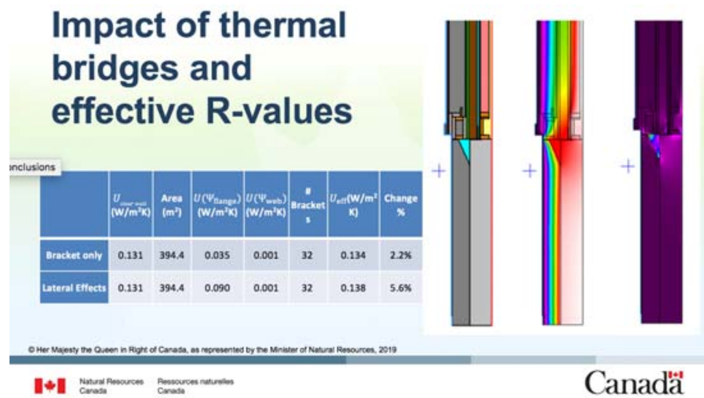
2017 Proof of Concept Pilot

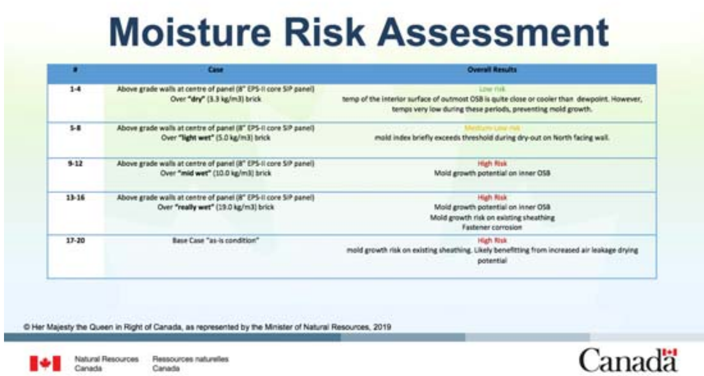
Performance Metric	Baseline	Retrofit	% Improved
Tested Airtightness (ACH@50Pa)	7.62	0.82	89%
Normalized Leakage Area @ 10 Pa (cm2/m2)	1.84	0.20	89%
Simulated Heat loss – Walls (GJ)	15.2	4.7	69%
Peak thermal demand (@-25°C) (W)	5760	2540	56%
Thermal Energy Demand Intensity (kWh/m2a)	230.3	64.7	72%

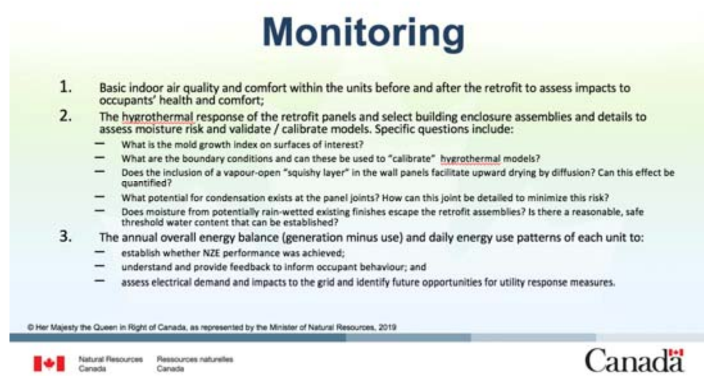
Graphics: CanmetENERGY, NRCan

PEER Project Ongoing through 2021









Graphics: CanmetENERGY, NRCan

NOT JUST WALLS:

PEER looking at wall assemblies

Real-world must look at whole building

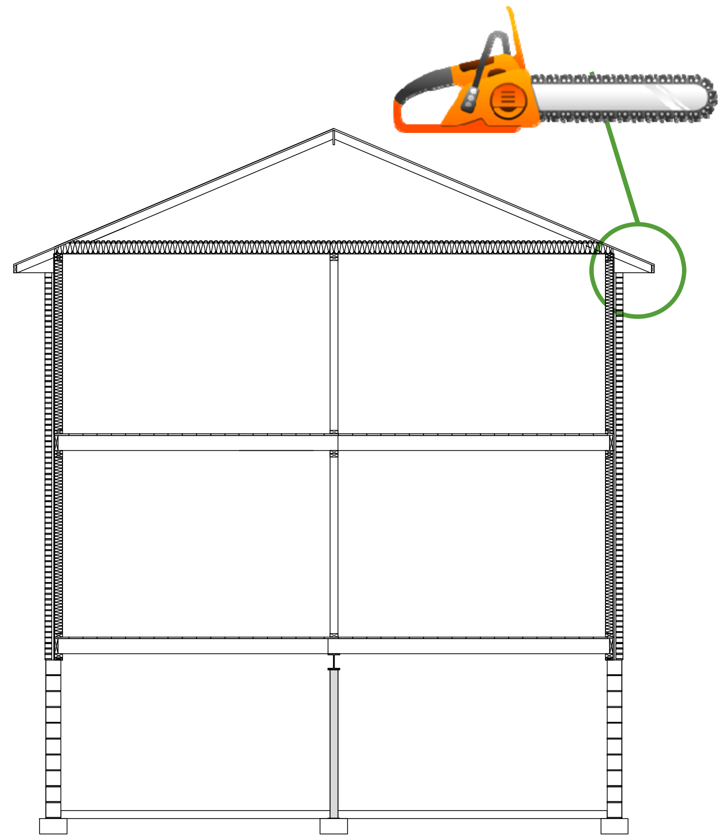
Hydrovac at foundation

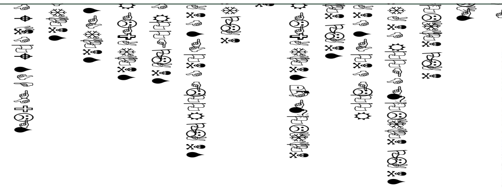
Perimeter/geometry challenges

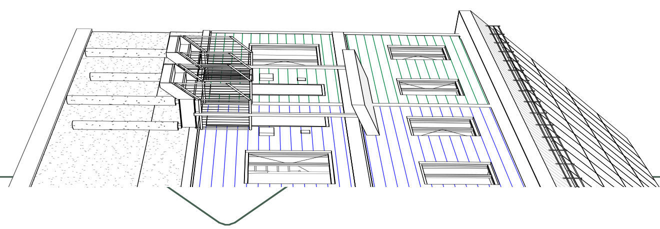
Chainsaw retrofit at roof

Change out mechanicals

Fuel switching/Electrification





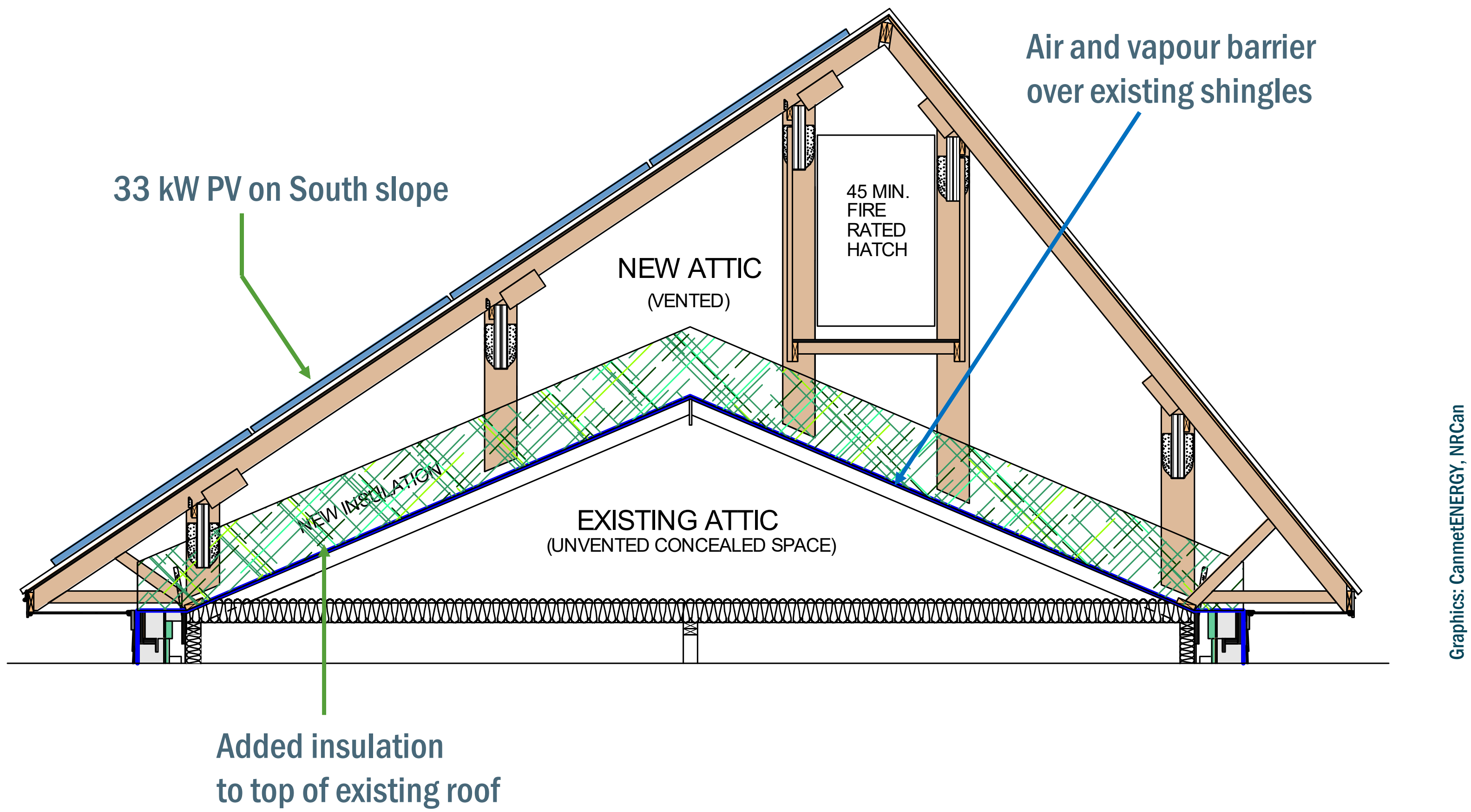


Graphics: CanmetENERGY, NRCan

PEER Demo: Ottawa Community Housing Pilot

Nail Base Panel, New Roof, Net Zero Project – Hundreds of Buildings in Portfolio

New PV Roof


33 kW PV on South slope
Air and vapour barrier over existing shingles
45 MIN. FIRE RATED HATCH
NEW ATTIC
(VENTED)
NEW INSULATION
EXISTING ATTIC
(UNVENTED CONCEALED SPACE)
Added insulation to top of existing roof
Graphics: CanmetENERGY, NRCan

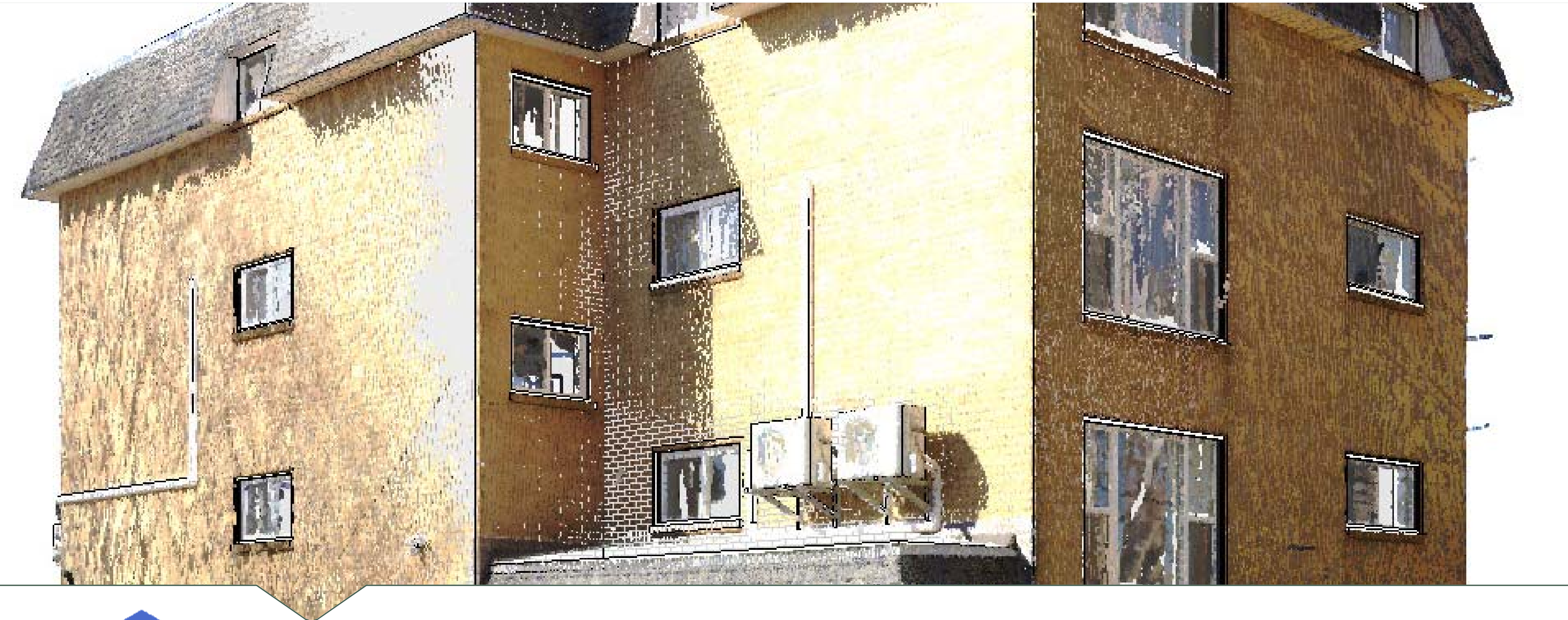
Sundance Housing Co-op Phase 1 Pilot

Wood-frame Standoff Panel

Challenges with Building Geometry…

Challenges with Established Sites…

Pilot Completed!



QUEST Canada, RSI Projects, Habit Studio


The ReCover Team (so far)
Lorrie Rand
Habit Studio
Co-Manager
Andrea Doncaster
Doncaster Engineering
Structural Engineering
William Marshall
Equilibrium Engineering
WuFi Analysis
Nick Rudnicki
RSI Projects
Co-Manager
Aaron Smith
M & R Engineering
Energy Modeling
Greg Hanlon
Smarter Spaces
LIDAR & CAD
Emma Norton
QUEST
Supervisor
Liam Kidson
M & R Engineering
Electrical and Mechanical Engineering
Jim Nosted
SEEFAR
Cost of Building Ownership

The Next Five Years

2020

First Pilot Project
$139,500 invested

At least one building has been panelled and is being monitored.

2021

6 More Pilots Completed
$600,000 invested
40 tons of carbon saved

Catalogue of archetypes determined, and one exemplar per archetype implemented.

Begin Development of automated scan to panel algorithm.

2022

50 More Households Complete
$2,100,000 invested
370 tons of carbon saved

Lowest hanging fruit buildings rolled out in force.

Use of scan to panel algorithm begins.

Panels take 2 days to make.

2023

250 More Households Complete
$4,600,000 invested
2080 tons of carbon saved

As efficiencies of assembly ramp up, so does capacity to execute.

Scan to panel algorithm perfected.

Panels take 1 day to make.

2024

1000 More Households Complete
$5,000,000 invested
9034 tons of carbon saved

Solution is being rolled out to include all studied archetypes.

Panels take 8 hours to make.

Install takes 3 days on average.

2025

2500 More Households Complete
$5,500,000 invested
28,000 ton of carbon saved

Multiple assembly facilities operating throughout the province and the maritimes.

Panels being produced around the clock.

30 install crews running full time

Whole Housing Energy Retrofit Envelope (WHERE-NS)

The Business Case: Exterior Retrofits for Affordable Housing

Ecology Action Centre

Project Lead

Partners

- Pembina Institute
- Efficiency Nova Scotia – Affordable Housing Program
- Cape Breton Regional Municipality

- Funding: Low Carbon Community Grant
  Nova Scotia Dept. of Energy & Mines

Stakeholders

- Housing Nova Scotia
- Nova Scotia Community College
- Mainland Building Trades
- Canadian Home Builders' Association of Nova Scotia
- Investment Property Owners' Association of Nova Scotia
- Affordable Housing Nova Scotia

What are your questions?

Characteristics of a Good Candidate for DER

House Vintage

Was it built before insulation was sexy?

Might it be due for some maintenance or replacement?

House Shape

Complex or Simple?

Tricksy corners

Exterior Condition

Is it ready for a renewal or replacement? Oh, goodie!

Roof Geometry

Simple or complex?

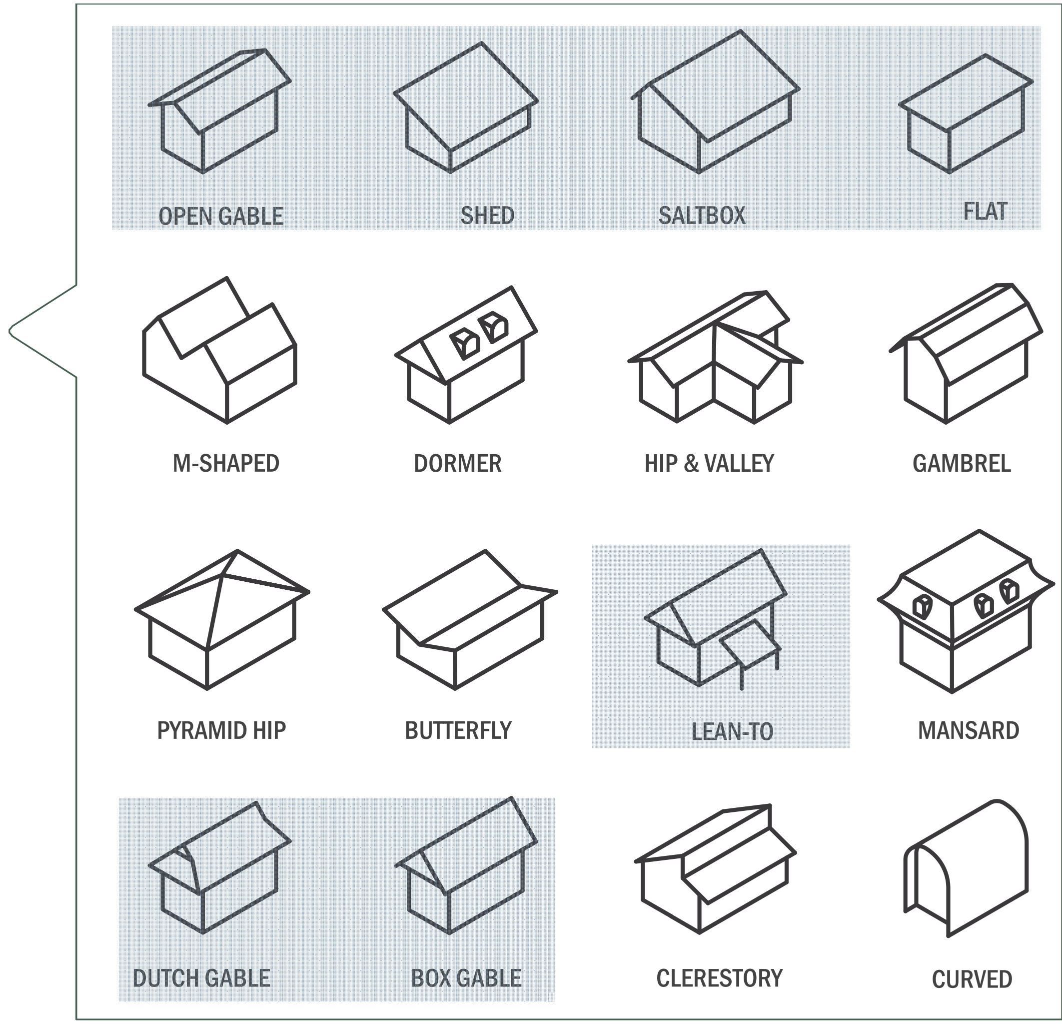
What about those overhangs?

Does roofline cause shading?

Does complexity mean there's very little 'clear' area?

Obstructions = shading

- Avoid South-facing dormers
- Avoid hips and valleys
- Avoid pitch changes



Good Solar Aspect

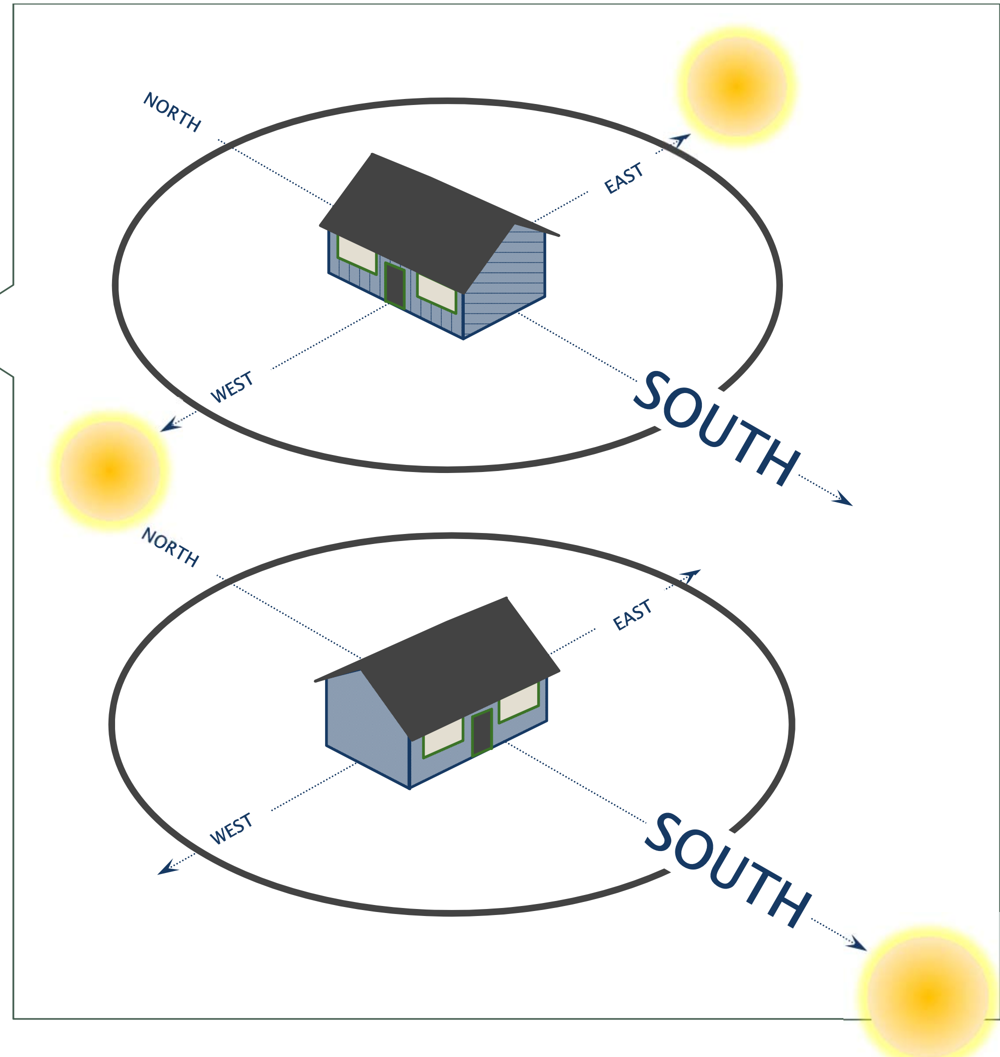
To make the most of renewables, the roof has to see the sun:

100% potential solar gain

on south roof face

85% potential solar gain

on west AND east roof face



Room to Work?

Can you get scaffolding and a crew around the whole building?

Is the house built to property lines?

What are local setback requirements?

Will a fat wall require a variance?

Observable Upgrades Completed?

Dang. Bad timing.

Level of Deferred Maintenance/Hazards

Interior AND exterior – moisture/mold issues, hazardous materials, IAQ, combustion spillage.

What needs to be replaced or dealt with immediately?

Window Characteristics Matrix

	LAWFUL	NEUTRAL	CHAOTIC
GOOD	Windows in panels **No flange/brickmold** Removeable cladding	Windows in panels Flange/brickmold Removeable cladding	***Existing Windows*** Flange/brickmold Removeable cladding
NEUTRAL	Windows in panels **No flange/brickmold** **Masonry cladding**	Windows in panels Flange/brickmold **Masonry cladding**	***Existing Windows*** Flange/brickmold **Masonry cladding**
EVIL	Windows in panels **No flange/brickmold** **Wood/Mas cladding**	Windows in panels Flange/brickmold **Wood/Mas cladding**	***Existing Windows*** Flange/brickmold **Wood/Mas cladding**

Best Candidate Checklist

- No recent energy conservation measures
- Building in need of major capital upgrades
- No historical/heritage qualities
- Roof geometry lends itself to PV
- Simple elevations
- Façade in need of updating

30 Point Checklist for MURBS

- Owner/Portfolio
- Site
- Building Geometry
- Building Condition (Interior)
- Building Condition (Exterior)
- Space Conditioning Equipment and Distribution
- Mechanical Ventilation Equipment and Distribution
- DHW Equipment

WHERE-NS CASE STUDIES

Bringing Energy Efficiency to Affordable Housing

The Impact on NS Social Housing

DER for 9,015 Social Housing Units over 12 years:

$7.8 billion full time employment

$15.25 million in family savings

- Increase uptake of NZE/r retrofits
- Inspire and connect stakeholders
- Made-in-NS business case strategy and roadmap
- Capacity building plan

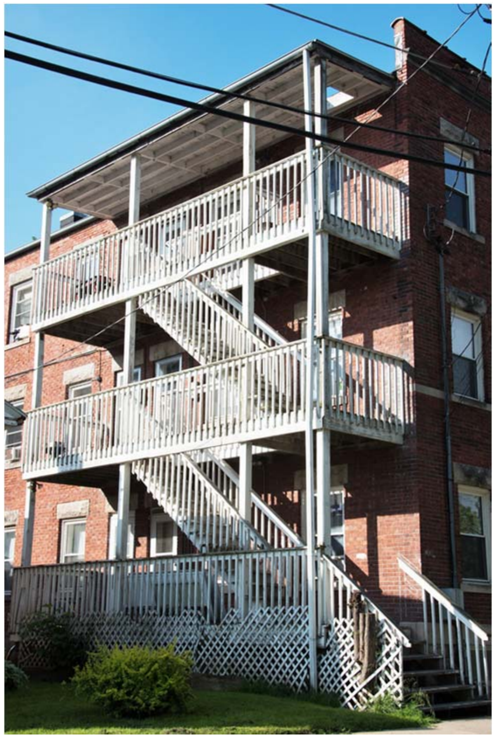
Project Parameters

- Assess sites, model baseline and upgrade
- Assess financing options
- Develop workshops
- Identify who can carry out work
- Research supply chain
- Test/monitor 2 panelized wall systems (n/a due to COVID)

GOAL:
Two Distinct Investment Property Building Archetypes

- Pre-1980 construction
  No recent energy conservation measures
- Building in need of major capital upgrades
- No historical/heritage qualities
- Roof geometry lends itself to PV
- Simple elevations
- Façade in need of updating

Purpose Built:
3-storey
Flat Roof, Brick Façade



Converted
2-3 storey
Gable Roof Removable Siding

The Case Studies

Heating Reduction Target

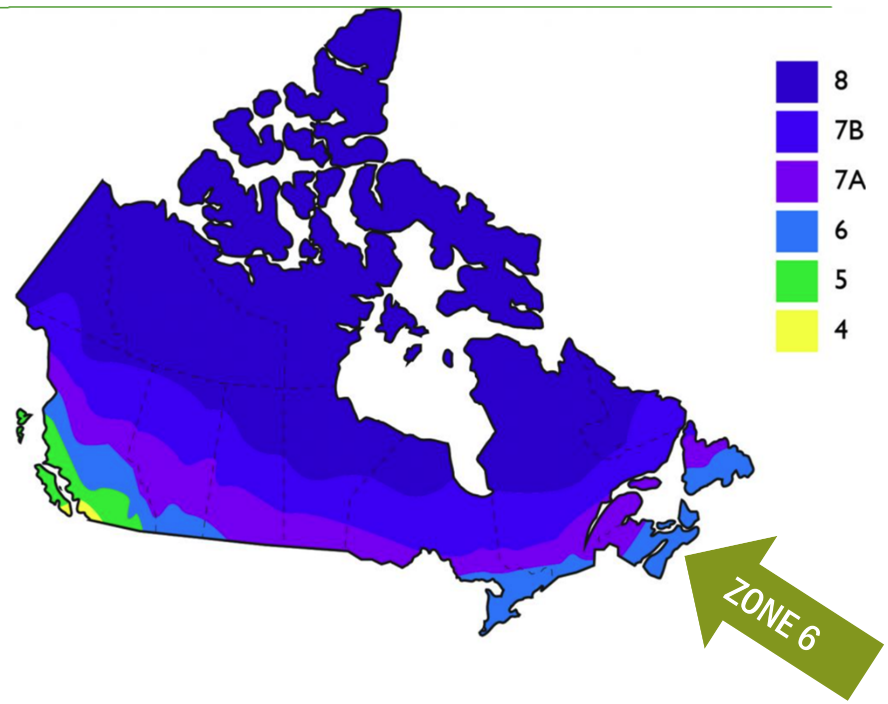
BC Energy Step Code 2018

Step 5 (NZE new build)

TEDI: Total Energy Density Intensity

(building envelope & ventilation)

TEDI for Zone 6:≤ 25kWh/m^2



Why focus on retrofits?

Nova Scotia's Perfect Storm

- Old housing stock
- High energy consumption
- High energy prices
- High GHG emissions
- Low median income
- High median income tax
- Growing fixed-income population
- Poor energy security
- Incidence of energy poverty
- Extreme weather events
- Lack of resiliency in housing

THE UPSIDE:

SMALL MARKET
LOW 'TIPPING POINT'
INDUSTRY CAPACITY

MN & NS: HISTORY OF
ENERGY CONSERVATION

Two buildings in HRM

- Built early/mid-1960s
- Purpose built
- Flat roof
  - 1 stick frame w/wood
  - 1 stick frame w/wood and brick
- Oil-fired boiler & slant fin rads

54 Jackson Road, Dartmouth

Mixed bag o' windows:
2 fixed, single, wood
25 fix/slid, double, alum
5 fixed, double, vinyl
14 fix/slid, double, low-e, vinyl

33 Brule Street, Dartmouth

- 2x4 construction on poured concrete foundation(s)
- Footprint: 2,639 s.f. (91x29)
- Total Heated Area: 5,278 s.f.
- Oil-fired boiler (83%)
- 8 Electric DHW storage tanks

Building As Usual v. Proposed Upgrades

Replacement

Roof re-surfaced and insulated to R30

Cladding, Windows & Doors Replaced

Foundation: dirt floor covered

Space Heating:

- 1x oil boiler
- 2x electric boiler (after 2050)

DHW: storage tanks replaced

Ventilation: bath fans replaced

Net Zero Energy Retrofit

Roof re-surfaced and insulated to R50

Exterior Wall Retrofit: R30 outboard of R10 wall, Cladding, Windows & Doors

Foundation: dirt floor covered, concrete walls insulated to R12 min. w/med. density sprayfoam

Air leakage reduction

Space Heating:

- **Air to Water heat pump** back up oil boiler
- Replace oil boiler w/electric boiler 2x

DHW: integrated into heat pump

Ventilation: through the wall HRVs, bath fans replaced

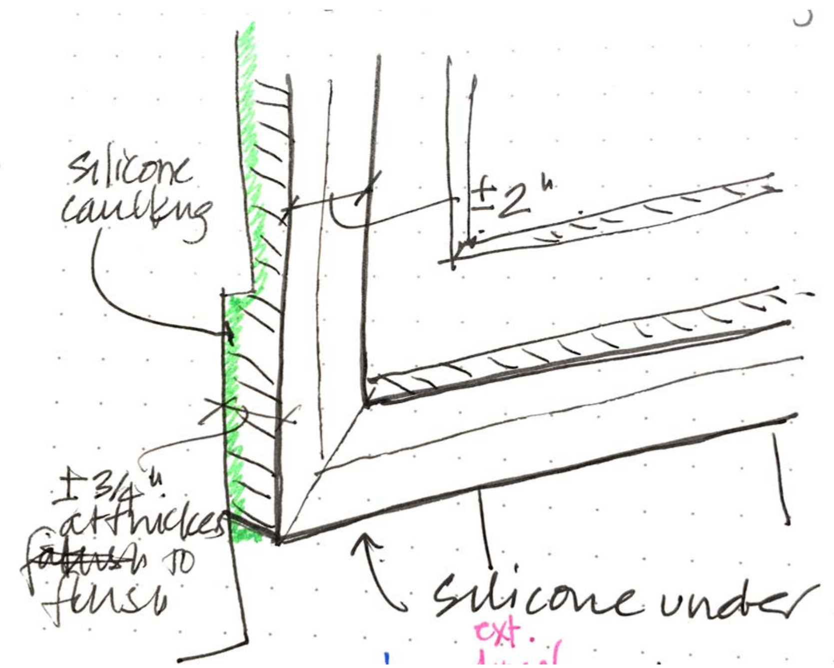
33 Brule Street

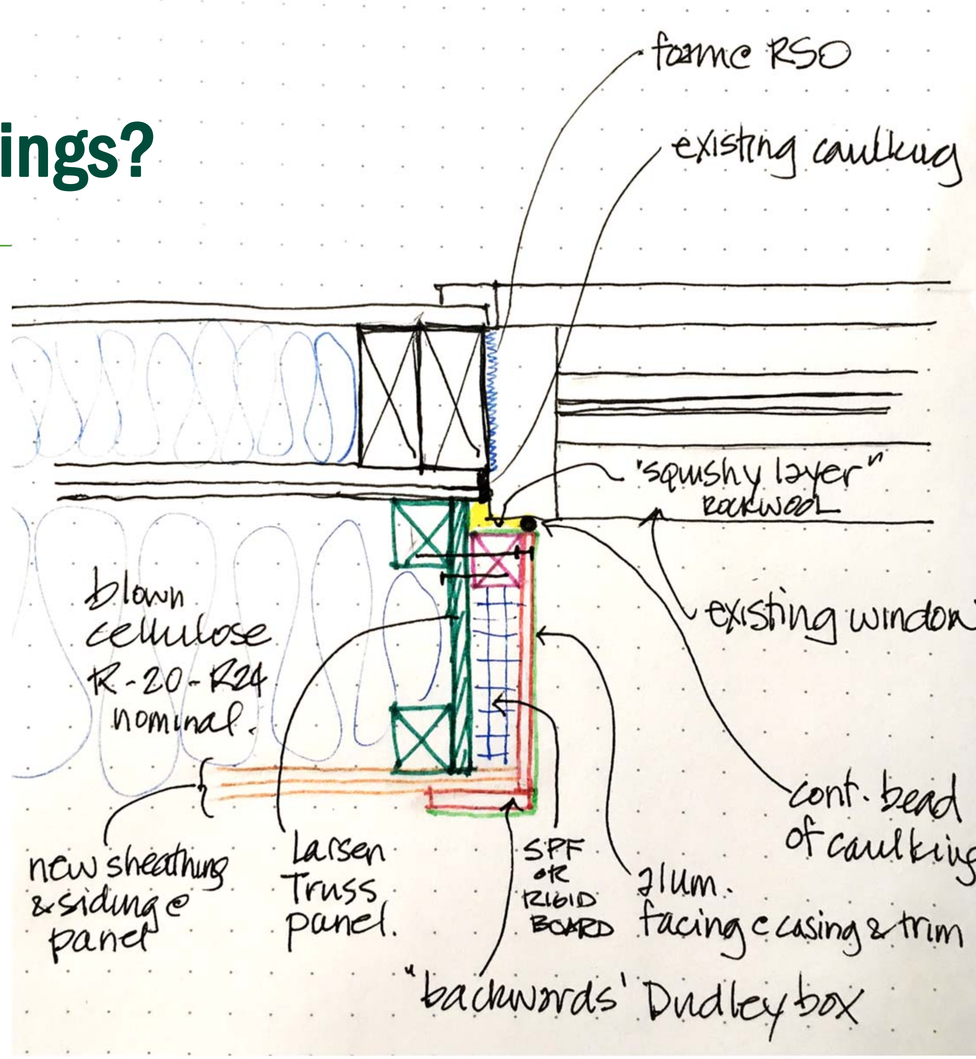
2 pane horizontal sliders low-e, vinyl. (2018)

Window Characteristics Matrix

33 Brule Street 54 Jackson Road	LAWFUL	NEUTRAL	CHAOTIC
GOOD	Windows in panels No flange/brickmold Removeable cladding	Windows in panels Flange/brickmold Removeable cladding	Existing Windows Flange/brickmold Removeable cladding
NEUTRAL	Windows in panels No flange/brickmold Masonry cladding	Windows in panels Flange/brickmold Masonry cladding	Existing Windows Flange/brickmold Masonry cladding
EVIL	Windows in panels No flange/brickmold Wood/Mas cladding	Windows in panels Flange/brickmold Wood/Mas cladding	Existing Windows Flange/brickmold Wood/Mas cladding

Fit to Openings?





Change Panel Type?
100% Recycled Plastic SIP

R-30, no thermal breaks, ASTM certified

Recycled PET bottles

Lightweight

Strong

ArmaForm

1 new build = 600,000 bottles

Water-shedding

Self-finish or Cladded

Nova Scotian Start-Up!

Mechanical Systems Challenge

- Oil-fired boilers
- Slant fin radiators (baseboard convectors)
- High delivery temps
- On-site tank issues w/insurance
- How to fuel switch?
- Air Source Heat Pumps ≠ HVAC infrastructure

Cascading Hydronic Heat Pump

2009 - present:
400 residential low temp hydronic heat pump installations

2015:
1st commercial models
Q-Lofts
(72 unit condo, Halifax)
9 large MURB installs

2018:
Developed modular hydronic cascade approach

Space and DHW Heating System

Air to water HP in/out units
Cascading Water Source HP
2 buffer tanks
1 indirect tank for DHW
Electric Boiler
Balance of system

Space heating COP: 2.06
DHW COP: 2.3

$72,250 installed

How Much Will it Cost?

Envelope Costs

Replacement: $141,600

NZE: $265,770

Increase in capital cost: 88%

Mechanical Costs

Replacement: $125,550

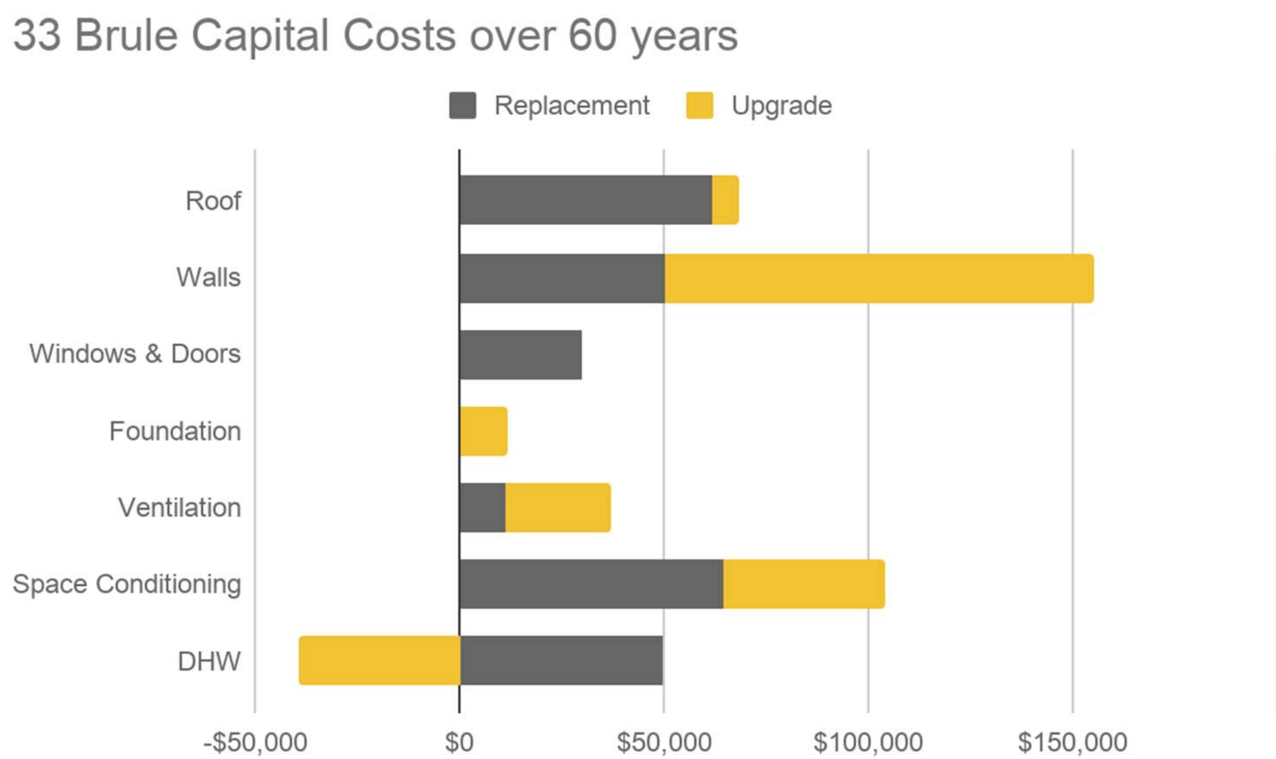
NZE: $152,130

Increase in capital cost: 21%

Total cost

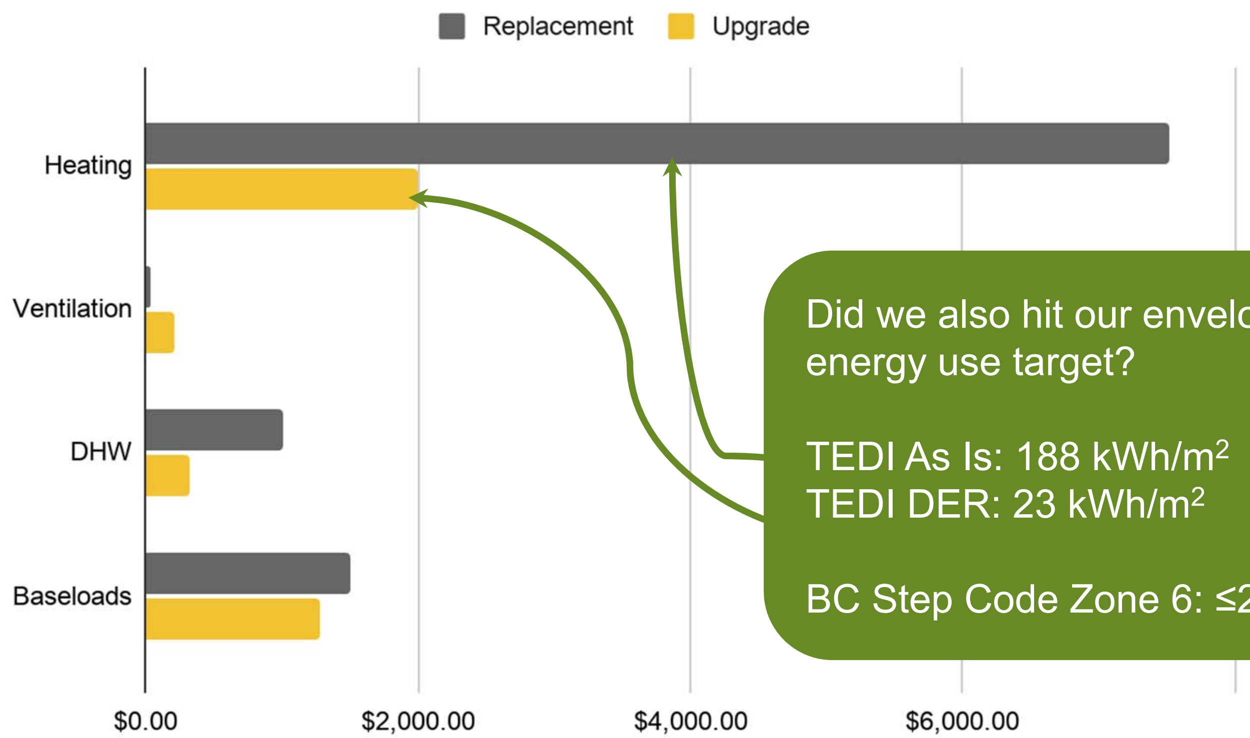
Replacement: $267,150
NZE: $417,900

Increase in capital costs: 56%



How Much Will it Save?

± 70% reduction in annual energy costs



Did we also hit our envelope energy use target?

TEDI As Is: 188 kWh/m^2
TEDI DER: 23 kWh/m^2

BC Step Code Zone 6: ≤25kWh/m^2

Getting to Net Zero

22,800 kWh load

21 kW capacity

70 panels, 1255 s.f.

$62,750 installed

$0 energy costs

Photo: www.hespv.ca

Rough Comparison of Upgrade Options

Business as usual cost: $270,000

$900 financing + $700 energy = $1,600/month ongoing

NZE Retrofit cost: $480,000

$1,800 financing + $0 energy = $1,800/month for 25 yr

Insurer-driven Gut Rehab cost: $670,000

$3,000 financing + $700 energy = $3,700/month ongoing

NZE Financial results

Value of property

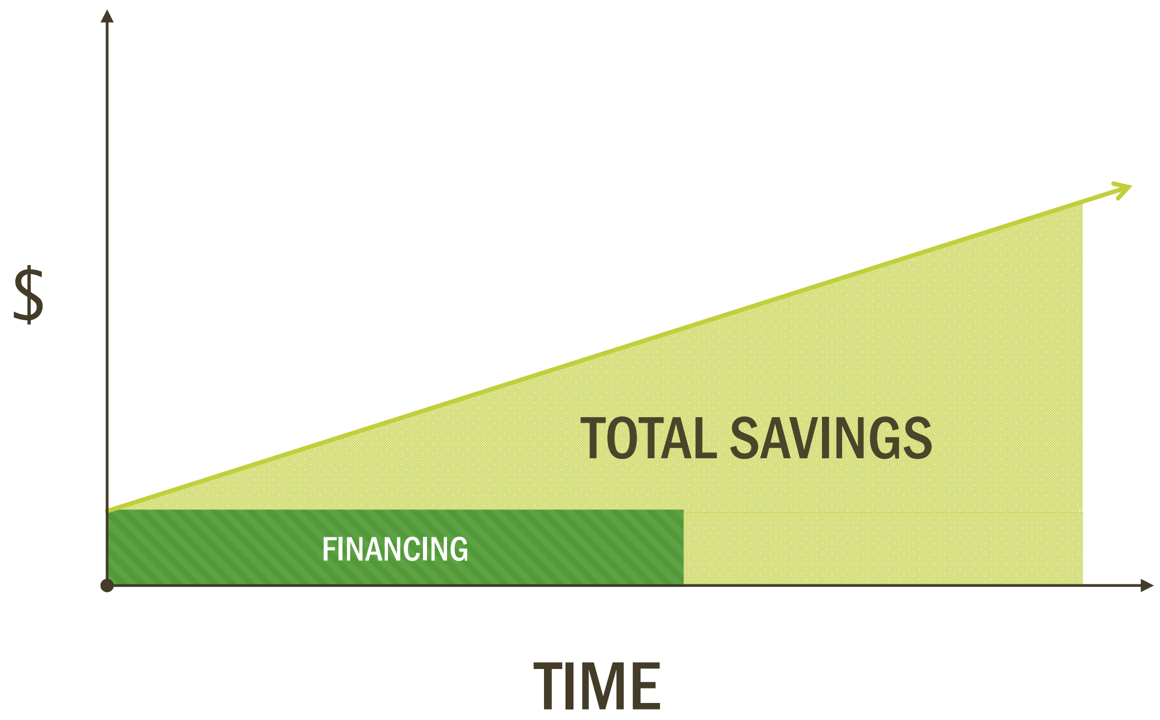
$730,000 >>> $870,000

immediately

Value of company goes up too!

What are your questions?

Business Case: Long-Term Feasibility



Total Cost of Building Ownership

Data has no ego and makes an excellent co-pilot.

Jay Samit

TL;DR: don't make choices blindly, integrate TCBO in decision making

Total Cost of Ownership

Life cycle cost analysis of the building based on all major building operating, age-related renewal and maintenance costs.

Takes into account:

Energy Efficiency

GHG Reduction

Embodied Carbon

Durability

Life-Cycle Performance

Occupant Comfort

60 year time frame:

- Capital cost
- Energy consumption
- GHG emissions
- Useful life
- Current age
- Annual maintenance cost
- Replacement cost escalation
- Improvement in energy efficiency at replacement

- Cost of capital

Why is TCBO so important?

- 90% of costs occur after construction
- $1 million build = $9,000,000 own & operate
- Design costs ± 1% of TCBO
- NEW HIGH PERFORMANCE BLDGS
  - 3-10% more to build
  - TCBO 30-40% lower than standard construction

Defining and Refining the TCBO

- Up front costs = premium on deferred maintenance
- Expected changes in energy costs
- Expected horizon for your investment
- What's the future valuation?
- Impact on current value & property tax rates

TCBO Summary: 33 Brule Street

SEEFAR BUILDING ANALYTICS INC. *Monetizing Building Sustainability*

35 to 38% savings in TCBO over existing building
Scenario E saves $1650/month (ave) over 60 years

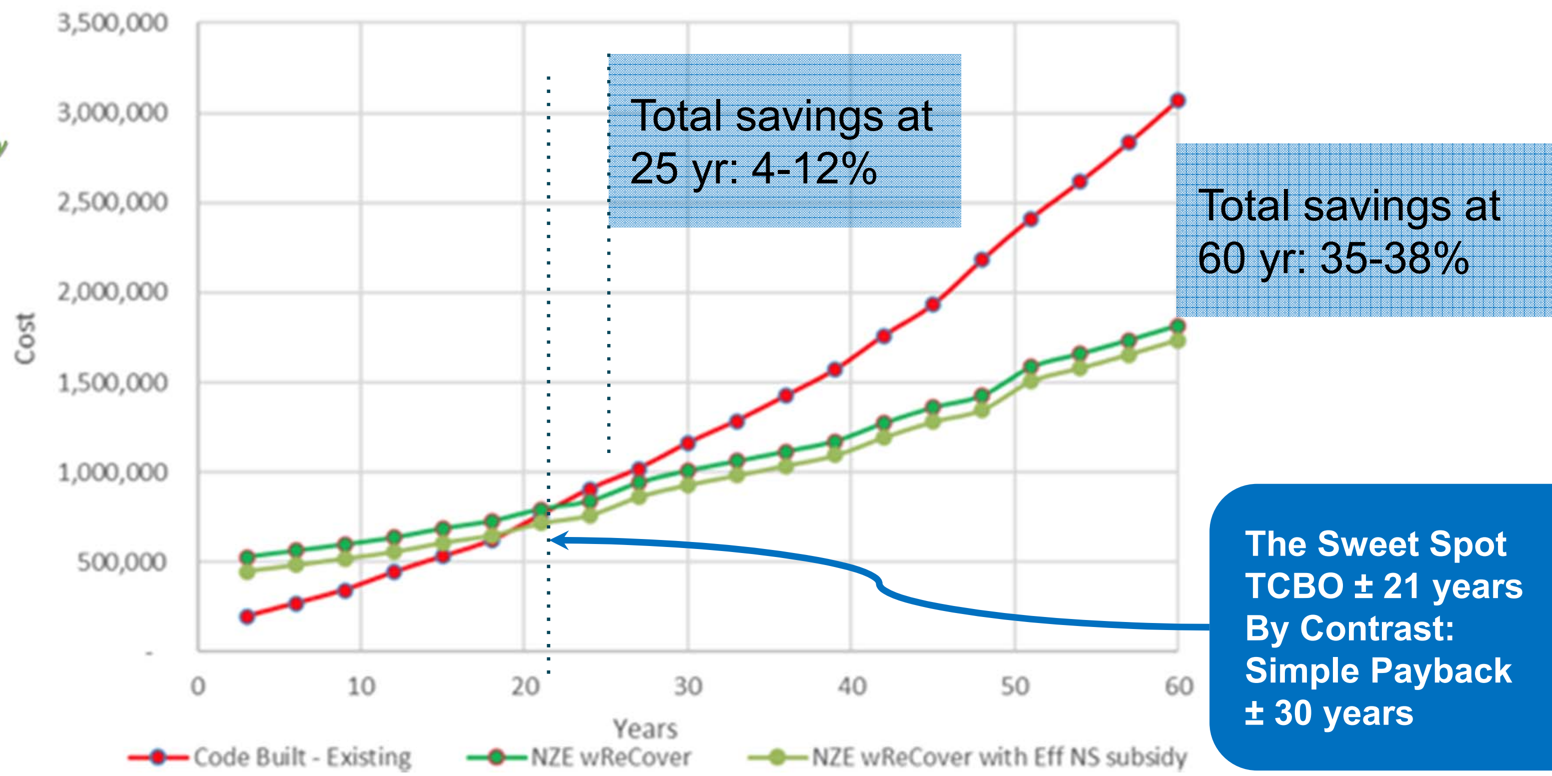
Table 4		A	B	C	D	E
Row	Total Cost of Building Ownership (TCBO)	Existing Building	NZE ReCover, with ASHP	NZE ReCover with ASHP & Eff NS subsidy	NZE ReCover with GSHP	NZE ReCover with GSHP Eff NS subsidy
1	TCBO at 60 years	$3,144,000	$2,031,000	$2,013,000	$1,987,000	$1,957,000
2	Average Monthly Cost of Ownership over 60 years	$4,370	$2,820	$2,800	$2,760	$2,720
3	TCBO/Year/m2	$106	$68	$68	$67	$66
4	60-Year TCBO/m2	$6,345	$4,009	$4,062	$4,010	$3,949

Coming Iterations: keep existing windows, use JD Composite SIPs
(100% recycled plastic bottles)

TCBO Over Time: 33 Brule Street

SEEFAR
BUILDING ANALYTICS INC.

Monetizing Building Sustainability



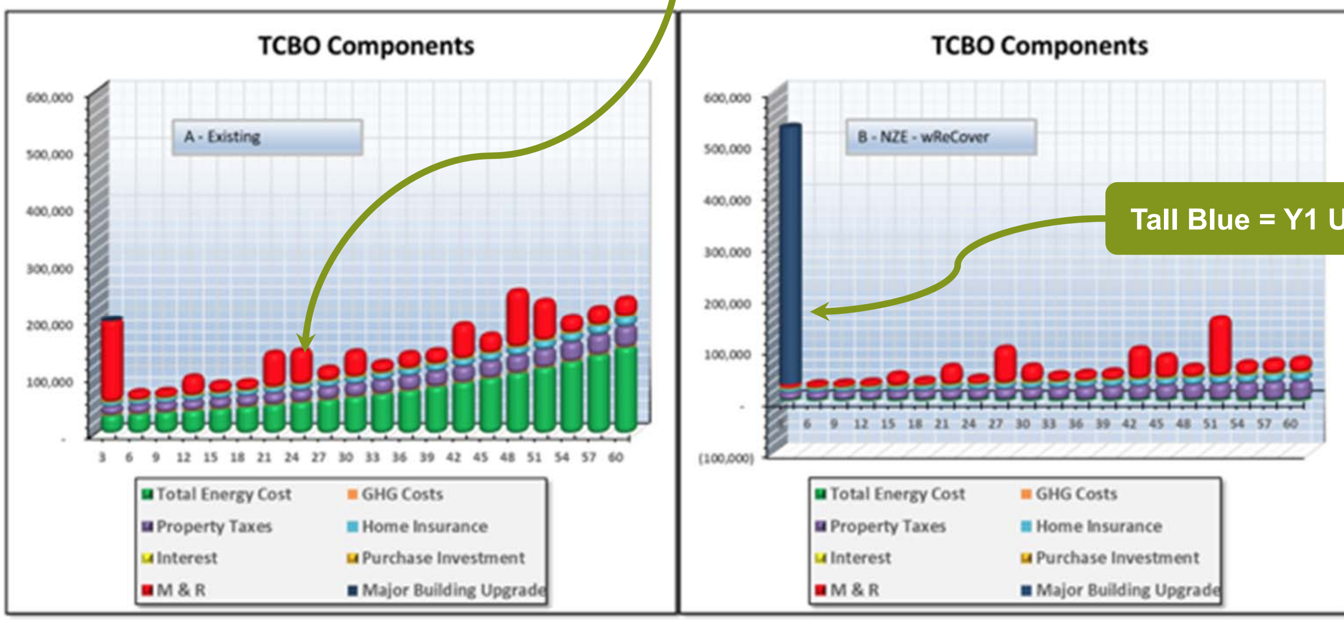
The Sweet Spot TCBO ± 21 years
By Contrast: Simple Payback ± 30 years

Breakdown by Component

SEEFAR
BUILDING ANALYTICS INC.

Monetizing Building Sustainability

Tall Red = replacement of components



Tall Blue = Y1 Upgrades to NZE

TCBO improves w/practice

In 5 years, Netherlands:

EnergieSprong Retrofit 5,000 units

Cut price tag in half

Cut site time to less than 1 week*

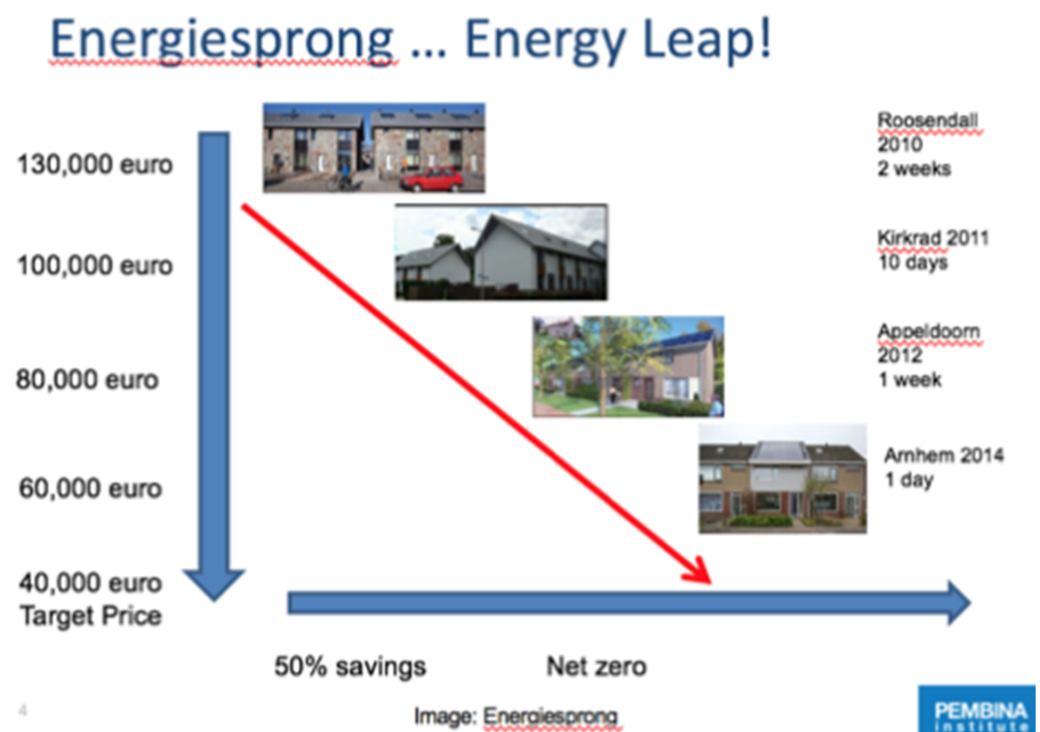
Added PV & mechanicals

Found efficiencies

Trades in-house

10,000 in process

NE PLAN: 110,000 retrofits



Consulting Costs:
$41,000

WuFi (moisture modelling) - $5,000

Electrical, Mechanical and Energy modelling - $13,000

Structural - $5,000

TCBO analysis - $3,000

Carbon analysis$ $1,500

Project Management $7,500

Architectural Design $6,000

TCBO improves w/volume

Possible consulting cost reductions:

Research funded for the first 100
(inc. monitoring for energy and moisture)?

Some reduction as 'packages' and/or calculators emerge for building types and HVAC configs

Specific to each building

Possible calculator?

Calculators being published 2021

Specific to each building

Specific to each building

TCBO improves w/insurance

FUTURE IS NOT THAT FAR AWAY!

Better coverage/rates for:

Gut rehab of buildings pre-1940

Updates w/in 25 years:

Plumbing

Wiring (+ 60A service min)

Roof

Electric over oil for heating

REFERENCE POINT:

NS MURBs: 50% pre-1970

Gut Rehab: $100-$200 s.f.
(wiring/plumbing, not HVAC)
Minor improvement to code-compliant energy measures

NZE (incl HVAC, panel upgrade, not wiring/plumbing): $90 s.f.

PLUS zero energy costs

TCBO improves w/market

Clean economy - will oil be available/affordable?

Carbon tax + NZE helps clean up the grid

Compete w/new high performance buildings

- Improve exterior, boost curb appeal
- Upgrade interiors between tenants
- No renovictions = continuous rent income

Contact Information

Ecology Action Centre, Ben Greider: bengrieder@ecologyaction.ca

Bfreehomes Design Ltd. Shawna Henderson: shawna@bfreehomes.com

ReCover Initiative, Nick Rudnicki: nick.rudnicki@gmail.com

SEEFAR Building Analytics, Jim Nostedt, P.Eng: jim@seefar-value.com

ThermAtlantic Energy Products, Benoit Maneckjee: bmaneckjee@nl.rogers.com

JD Composites, David Saulnier: jdcomposites2@gmail.com

Thank you!

What are your questions?