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LEEP –Spring Training Update

Overview of LEEP activities and focus on upcoming LEEP products

Monday April 15th, 2019
Hockley Valley, Ontario

Patric Langevin, LEEP Facilitator and Technical Lead
Natural Resources Canada, CanmetENERGY

Canada

LEEP's Purpose

LEEP was developed with the building industry to…

Reduce your time and risk in finding and trying innovations that can help you build higher performance homes better, faster and more affordably.

"LEEP assists with bringing innovation into the market in a well thought out and responsive way."

Canadian Home Builders' Association

Home Energy Performance

NZE - NZE-R

New Code Reqs.
&
Housing Programs

BC 9.36

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2018/19 LEEP Delivery - Overview

- 30 High performance LEEP field trials completed in BC
- Enabled over 1000 industry participants to learn about new technological advances at various LEEP 1 and 2 day events in 7 Provinces.
- 3 LEEP Innovation Exchanges (Prince George, Kelowna, Vancouver – all 1 day events)
  - Presentations on field trials learnings - 27 from builder volunteers on field trial results + 3 energy advisors on integrated design + 3 on high performance envelopes building science + 3 on mechanical sizing and design
- 3 LEEP Technology Forums (Surrey – 2 day, Victoria – 2 day, Nanaimo – 1 day)
  - 8 manufacturer presentations, exterior envelope and mechanical system presentations + HTAP Presentation
  - High builder interest in participating in second round of LEEP field trials
- 4 LEEP for Renovators Project Events (all in London – 2 renovator planning workshops + 2 Technical Forums (Envelope and Mechanicals)
  - Technical presentations on the Why and the How of LEEP deep energy renovation (Whole home, envelope, mechanicals) +
  - 9 Manufacturers developed and presented solutions for deep energy retrofit – 4 on Envelope systems plus 5 on mechanicals systems
  - Brought stakeholders together for a Fanshawe College proposed Deep Energy Retrofit deploying 5 competing approaches.
- 5 LEEP Gas Mechanical Forums (Toronto, Saskatoon, Regina, Edmonton, Calgary)
  - Added new sections and finalized the *Master Planning & Design Guide for Gas Mechanical Systems*
  - Developed an accompanying tool and mechanical systems; 9 cities are using it and providing feedback
  - 5 Manufacturers upgraded offerings and presented solutions.
  - Developed 3 expert local panels and demonstration providers brought up to speed for delivery in these markets
- 4 LEEP Atlantic Canada Builder Planning Workshops (St. Johns, NL, Halifax, NS, Charlottetown, PEI, Fredericton, NB)
  - Updated base case home and materials for Atlantic market and HTAP presentation, and locally selected technologies

  (Technology forums and workshops to follow in 2019/2020)

19 TECHNICAL WORKSHOPS
7 PROVINCES
1000+ CONVERSATIONS

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LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS
INNOVATION EXCHANGE






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LEEP Technology Forums




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LEEP for Renovators London Pilot




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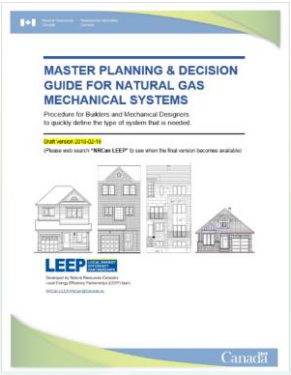
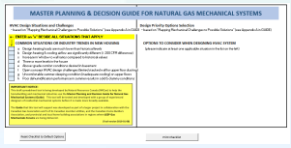
LEEP Gas Mechanicals Forums





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The Big LEEP Takeaways - 2018

1. **Integrated design** rarely happens, but is crucially important in high performance housing. ($10, $100, $1000 rule)
2. **High performance wall systems** are challenging. (inboard/outboard ratios, vapour permeable/vapour closed, vapour retarders, vapour barriers)
3. **Mechanical system sizing** is essential, 3rd party **mechanical design** preferable, coordination essential!
4. **PV System** cost of continues to drop. ($2.50 - $3.00 per watt)

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1 – Integrated Design

1. Integrate the new technologies/systems into the design from the very beginning with the support of your client and designer;
2. Make sure your Team clearly understands the systems and pays attention to the details;
3. Ensure the client and Team are realistic about what the technology outcomes are expected to be;

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LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS

ENERGY EFFICIENT TECHNOLOGY COST OPTIMISATION TOOL

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2 - High Performance Wall Systems

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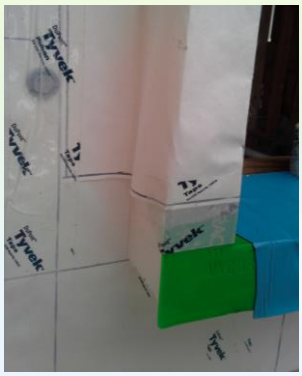

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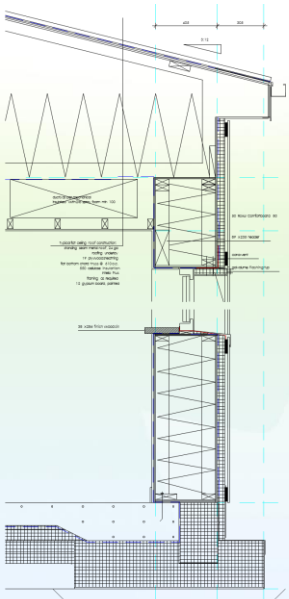

- Double 2x4 wall with blown cellulose, dual air barrier, exterior insulation
- Metric U-value of 0.097 W/m2K (approximately R-59)

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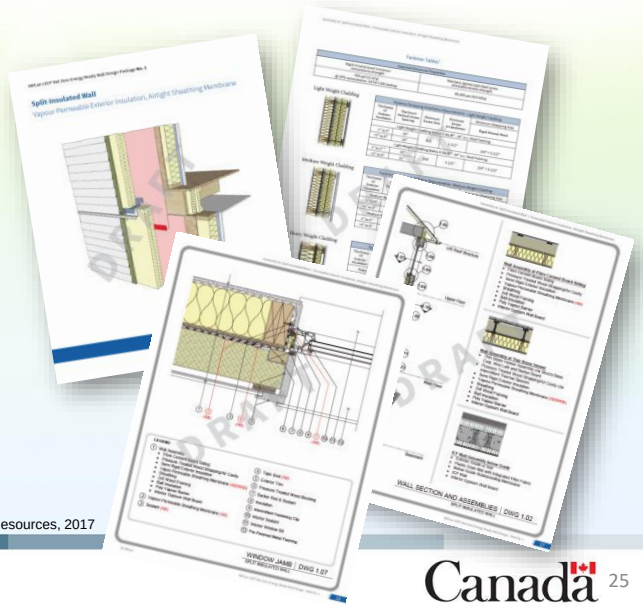
WALL SECTION 3 SCALE 1:10

NRCan Net Zero Energy Wall Guidelines

- Series of 4 Building Science Guidelines being developed for 4 common near net zero ready wall systems, R-25 to R-40 range (e.g. 2-6" of exterior insulation on 2x6)
- Covers design & construction considerations
- Provides Effective R-value Tables
- Commentary on building Science guidance (Air, Vapour, Water) for each and rationale
- Includes cladding attachment fastener tables
- costing information
- installation checklists



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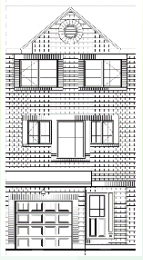
2 – Mechanical System Sizing and Design: Housing is changing



- More energy efficient construction
- Lower design heating loads
- More open concept and tall homes
- More attached homes
- Larger windows
- Greater customer expectations

Mechanical systems need to adapt

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LEEP FIELD TRIALS & F280-12

SONBUILT HOMES

	RULE OF THUMB	F280-12	OVERSIZE
HEATING	64,656 BTU	31,126 BTU	107%
COOLING	43,104 BTU	26,440 BTU	57%

BLACKFISH HOMES

	RULE OF THUMB	F280-12	OVERSIZE
HEATING	71,655 BTU	47,265 BTU	52%
COOLING	47,265 BTU	69,884 BTU	22% undersized

INSIGHTFUL HEALTHY HOMES

	RULE OF THUMB	F280-12	OVERSIZE
HEATING	72,945 BTU	36,691 BTU	98%
COOLING	58,356 BTU	38,045 BTU	53%

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TYPICAL QUOTE DILEMMA

HVAC Contractor #1:

$**45,000** – 100,000 BTU Furnace & HRV with 4 ton A/C

HVAC Contractor #2:

$75,000 – 60,000 BTU Furnace, HRV & 3 ton Heat Pump, 2 zones

HVAC Contractor #3:

$36,000 – Forced Air Furnace & A/C… *Size not Disclosed*

Buddy with Free Advice:

$25,000 – Radiant, with no HRV (just open windows), no A/C needed.

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ecolighten | BC LEEP Technology Forums October 2018

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Business-as-usual practices create “issues” for all stakeholders

Stakeholder	Gas heat + A/C system – example “issues”
Homeowners	Rooms and floors that are too hot or too cold in their NEW home. Lost and unusable space due to box-outs and floor register placements.
Builders	Comfort complaints. After-hours call backs. Hard to fix. Potential damage to reputation. Mechanicals bulkheads, box-outs and venting.
Designers	Design services rarely used. When used, last in and ‘bare-bones’ designs needed ‘yesterday’. Incomplete info. from builder requires assumptions.
Contractors	No specs. Need to ‘wing it’ / use rules-of-thumb. When things go wrong, the contractor is usually blamed. No margin in price to fix.
Manufacturers	Large brands have focussed on retrofit market with double the sales volume and better profit margins.

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New Guide

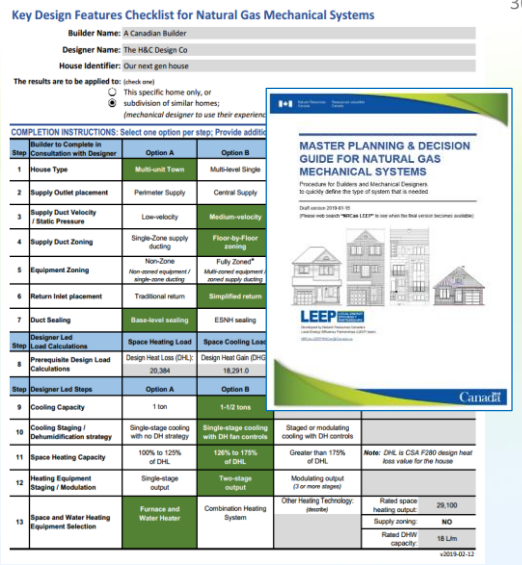
Simplifying decision making for better mechanicals

Offers incremental solutions for all new homes
(13 pre-design decisions plus discussion of issues, 61 pages).

Gives designers / contractors ‘permission’ to proceed with “better-fit” designs.

Can make decisions that apply to an entire subdivision in about 1 hour.

Companion Spreadsheet Tool helps focus attention quickly on design options that will make a difference.



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Canadian Guide Trial

- Eight designers worked with ~40 home builders
- Examples from 5 provinces
- Range of housing types and sizes

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Duct Design Results from Guide Trial

Guide Step:	Option A: (i.e. traditional design default)	Option B:	Option C:
Step 2: Supply Outlet Location	Perimeter Supply	Central Supply	Hybrid Supply
	23%	28%	49%
Step 3: Supply duct velocity /static pressure	Low	Medium	High
	46%	43%	11%
Step 4: Supply Duct Zoning	Single Zone	Floor-by-floor zoning	Other zoning configuration
	43%	49%	8%
Step 6: Return Inlet placement	Traditional	Simplified	n/a
	29%	71%	
Step 7: Duct Sealing	Base-level sealing	ENERGY STAR for New Homes (ESNH) sealing	ESNH sealing with leakage testing
	49%	51%	0%

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Results from Guide Trial – Details (4 of 5)

Step 10: Cooling Staging /DH Strategy	**Single-stage cooling with no DH Strategy**	**Single-stage cooling with DH Controls**	**Staged or modulating cooling with DH controls**
	50%	20%	30%
Step 11: Space heating capacity range	**100 to 125% of DHL**	**126 to 175% of DHL**	**> 175% of DHL**
	32%	61%	7%
Step 12: Heating equipment staging / modulation	**Single-stage output**	**Two-stage output**	**Modulating output**
	46%	28%	26%
Step 5: Equipment Zoning	**Non-zoned**	**Fully Zoned** (zoned equipment)	**Zone-ready** (non-zoned equipment)
	43%	20%	37%
Step 13: Heating equipment type	**Furnace Water Heater**	**Combo Heating System**	**Other (specify)**
	80%	20%	0%

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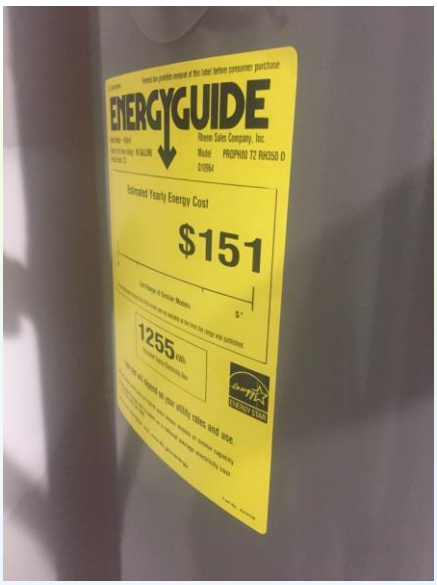

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WHAT DID WE DO IN OUR LEEP HOME?

Determined Mechanicals using F280-12 Standard

Smart Duct System & Heat Pump

Thermal Image Scan Prior to Completion

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Key Takeaways on Mechanicals

1. Make sure your Team and mechanical trade clearly understands the technology and pays attention to the details;
2. Make sure you understand your clients goals around thermal comfort, system noise, and intimate relationship between the right sized equipment and the final performance outcomes of the home.
3. Engage with trades that are genuinely keen to participate and benefit from the new technology;
4. Ensure the client and Team are realistic about what the technology outcomes are expected to be;

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Placeholder – Consumer HVAC Guide

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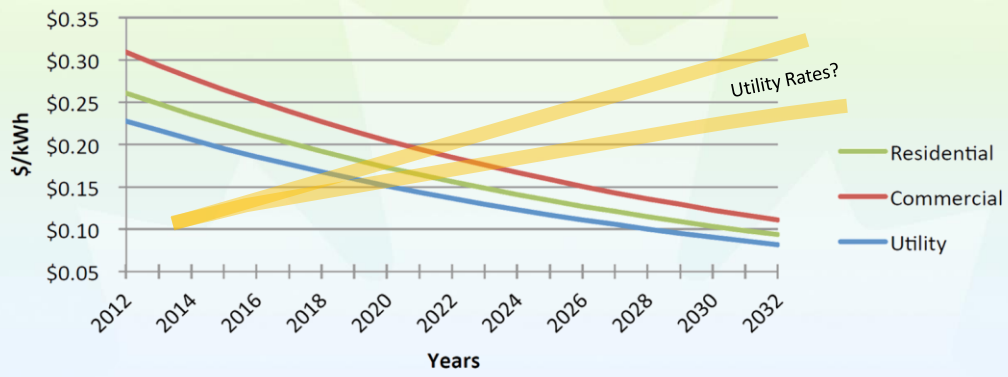
PV Systems are a cost competitive Energy Conservation Measure NOW!



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Selling Solar House vs. Net Zero

SOLARMAX POWER

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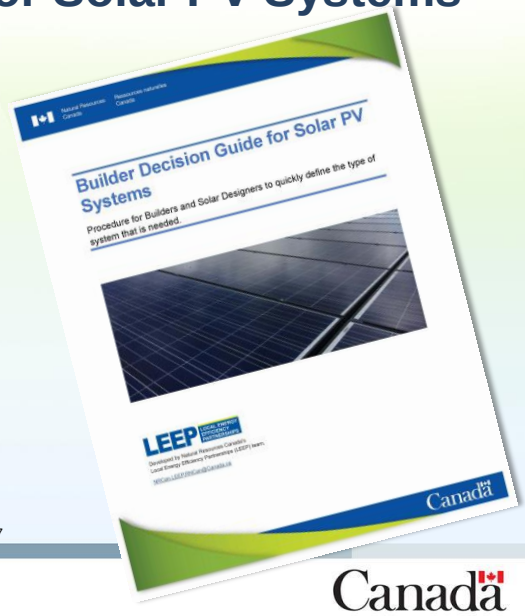
Builder Decision Guide for Solar PV Systems

Offers incremental solutions for all new homes (10 pre-design decisions and considerations plus discussion of issues).

Can make decisions with a solar professional that apply to a home in less than one hour.

Provides background information required to support better builder decisions on why, where and what application of solar PV for your project.



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LEEP LOCAL ENERGY EFFICIENCY PARTNERSHIPS

ENERGY EFFICIENT TECHNOLOGY COST OPTIMISATION TOOL

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#1

Let's look at the input used in our Energy Efficient Technology Cost Optimization Tool

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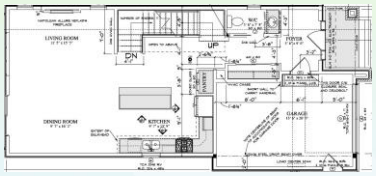

Base Case Home

- Approx 2750 sq ft on three floors, with walk out basement
- **Electric Baseboard heaters & 96% AFUE Natural Gas Furnace**
- Basic HRV 65% heat recovery @ 0 degrees C
- **Electric 40 Gallon HWT & 0.67 EF Natural Gas Tank**
- Main walls: 2x6 @ 16 o.c. R20 batt with 1" EPS sheeting
- Foundation: 8" concrete, 2x4 @ 16 o.c. 2" off foundation, R20 batt
- Interior sealed poly vapor & air barrier
- 1.5 air changes per hour @ 50 pascals
- Double glazed windows with argon gas and low e coating and insulated spacers
- Weather file for energy model: Fredericton, New Brunswick

CRESCO
THE ART OF BUILDING

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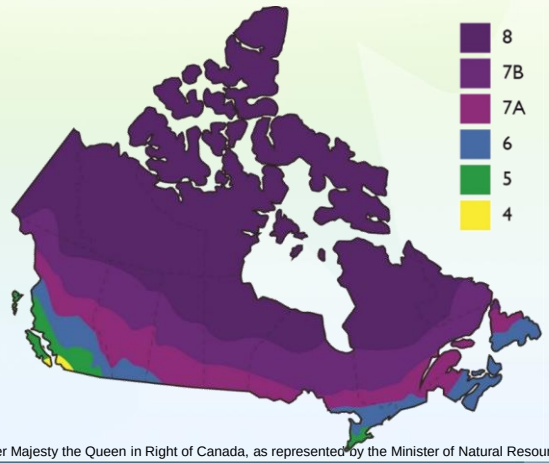
Looking at results in 3 climate zones with updated regional costs



Climate Zone 4 (Vancouver 2850 HDD)

Climate Zone 5 (Toronto 3520 HDD)

Climate Zone 6 (Halifax 4000 HDD)

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#2

What will it cost to build?

Estimating the cost of reaching various performance targets using different technology pathways (clusters of technologies)

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STEP 3: BUILDER COSTS & SPECIFICATIONS

SPECIFICATION	UNITS	MAT'L. & EQUIP. COST PER UNIT ($)	LABOUR COST PER UNIT ($)	TOTAL COST ($)
FRAMING				
Framing, conventional, 38x184mm (2"x8") @ 406mm (16") o.c.	sf wall	0.87	0.60	1.47
Framing, conventional, 38x140mm (2"x6") @ 406mm (16") o.c.	sf wall	0.70	0.60	1.30
Framing, conventional, 38x89mm (2"x4") @ 406mm (16") o.c.	sf wall	0.46	0.53	0.99
Framing, advanced, 38x140mm (2"x6") @ 482mm (19") o.c	sf wall	0.63	0.57	1.20
Framing, advanced, 38x140mm (2"x6") @ 610mm (24") o.c	sf wall	0.60	0.39	0.99
Framing, double stud wall, 305mm (10 or 12") (expand footprint)	sf wall	0.80	0.90	1.70
Framing, double stud wall, 305mm (10 or 12") (Maintain existing footprint)	sf wall	0.64	0.90	1.54
Framing, interior basement, 38x89mm (2"x4") @ 610mm (24") o.c.	sf wall	0.24	0.51	0.75
Framing, interior basement, 38x140mm (2"x6") @ 610mm (24") o.c.	sf wall	0.36	0.51	0.87
Strapping, 1x4 @ 16" o.c.	sf wall	0.19	0.42	0.61
Strapping, 1x4 @ 16" o.c. on 2" of insulation	sf wall	0.34	0.67	1.01
Strapping, 1x4 @ 16" o.c. on 4" of insulation	sf wall	0.34	1.12	1.46
DRYWALL				
1/2" Gypsum board	sf wall	0.35	0.41	0.76
SHEATHING				
Oriented Strand Board (OSB), 12mm (7/16")	sf applied	0.26	0.36	0.62
Plywood, 13mm (1/2")	sf applied	0.57	0.36	0.93
WATER, VAPOUR AND AIR CONTROL LAYERS				
Water Resistant Barrier (WRB) (includes taping seams)	sf applied	0.14	0.28	0.42
Water Resistant Barrier (WRB) self sealing vapour permeable	sf applied	1.32	0.30	1.62
Vapour barrier, 6 mil polyethylene	sf wall	0.10	0.28	0.38
Selective vapor retarder, membrane material	sf wall	0.25	0.29	0.54
ACHIEVING ACH TARGETS				
2.5 ACH	total	150.00	600.00	750.00
1.5 ACH	total	500.00	750.00	1,250.00
1.0 ACH	total	750.00	1,000.00	1,750.00
0.6 ACH	total	1,500.00	1,250.00	2,750.00
INSULATION				
Insulation, R14 batt (fiberglass)	sf applied	0.35	0.28	0.63
Insulation, R20 batt (fiberglass)	sf applied	0.57	0.39	0.96
Insulation, R22 batt (fiberglass)	sf applied	0.84	0.39	1.23
Insulation, R24 batt (fiberglass)	sf applied	1.38	0.39	1.77

RESULTS | STEP 3 BUILDER COSTS | STEP 4 UPGRADE COMPARISON | ROOF INSULATION | ABOVE GRAD

Builders define the costs…

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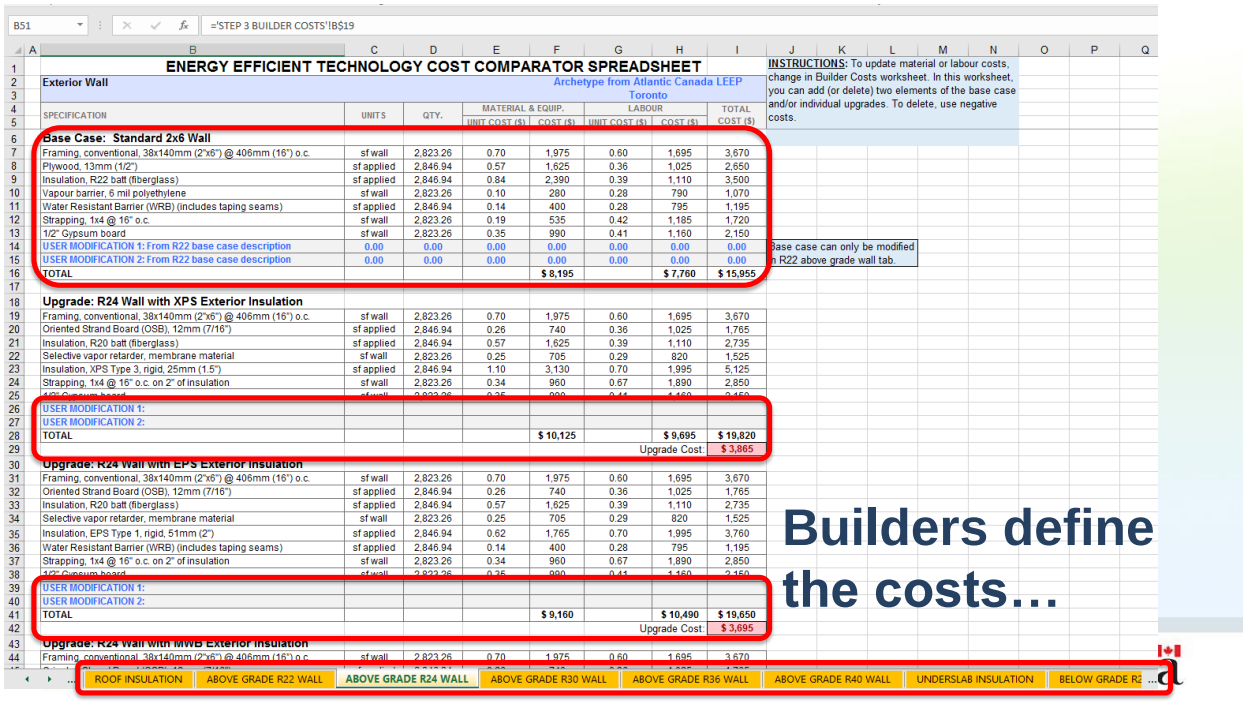


B51 ='STEP 3 BUILDER COSTS'!B$19

ENERGY EFFICIENT TECHNOLOGY COST COMPARATOR SPREADSHEET

Exterior Wall — Archetype from Atlantic Canada LEEP Toronto

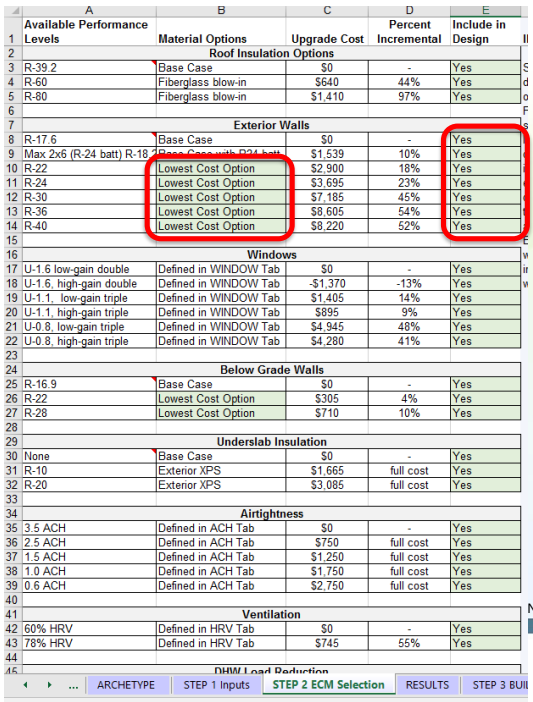
INSTRUCTIONS: To update material or labour costs, change in Builder Costs worksheet. In this worksheet, you can add (or delete) two elements of the base case and/or individual upgrades. To delete, use negative costs.

SPECIFICATION	UNITS	QTY.	MATERIAL & EQUIP. UNIT COST ($)	MATERIAL & EQUIP. COST ($)	LABOUR UNIT COST ($)	LABOUR COST ($)	TOTAL COST ($)
Base Case: Standard 2x6 Wall							
Framing, conventional, 38x140mm (2"x6") @ 406mm (16") o.c.	sf wall	2,823.26	0.70	1,975	0.60	1,695	3,670
Plywood, 13mm (1/2")	sf applied	2,846.94	0.57	1,625	0.36	1,025	2,650
Insulation, R22 batt (fiberglass)	sf applied	2,846.94	0.84	2,390	0.39	1,110	3,500
Vapour barrier, 6 mil polyethylene	sf wall	2,823.26	0.10	280	0.28	790	1,070
Water Resistant Barrier (WRB) (includes taping seams)	sf applied	2,846.94	0.14	400	0.28	795	1,195
Strapping, 1x4 @ 16" o.c.	sf wall	2,823.26	0.19	535	0.42	1,185	1,720
1/2" Gypsum board	sf wall	2,823.26	0.35	990	0.41	1,160	2,150
USER MODIFICATION 1: From R22 base case description		0.00	0.00	0.00	0.00	0.00	0.00
USER MODIFICATION 2: From R22 base case description		0.00	0.00	0.00	0.00	0.00	0.00
TOTAL				$ 8,195		$ 7,760	$ 15,955
Upgrade: R24 Wall with XPS Exterior Insulation							
Framing, conventional, 38x140mm (2"x6") @ 406mm (16") o.c.	sf wall	2,823.26	0.70	1,975	0.60	1,695	3,670
Oriented Strand Board (OSB), 12mm (7/16")	sf applied	2,846.94	0.26	740	0.36	1,025	1,765
Insulation, R20 batt (fiberglass)	sf applied	2,846.94	0.57	1,625	0.39	1,110	2,735
Selective vapor retarder, membrane material	sf wall	2,823.26	0.25	705	0.29	820	1,525
Insulation, XPS Type 3, rigid, 25mm (1.5")	sf applied	2,846.94	1.10	3,130	0.70	1,995	5,125
Strapping, 1x4 @ 16" o.c. on 2" of insulation	sf wall	2,823.26	0.34	960	0.67	1,890	2,850
1/2" Gypsum board	sf wall	2,823.26	0.35	990	0.41	1,160	2,150
USER MODIFICATION 1:							
USER MODIFICATION 2:							
TOTAL				$ 10,125		$ 9,695	$ 19,820
						Upgrade Cost:	$ 3,865
Upgrade: R24 Wall with EPS Exterior Insulation							
Framing, conventional, 38x140mm (2"x6") @ 406mm (16") o.c.	sf wall	2,823.26	0.70	1,975	0.60	1,695	3,670
Oriented Strand Board (OSB), 12mm (7/16")	sf applied	2,846.94	0.26	740	0.36	1,025	1,765
Insulation, R20 batt (fiberglass)	sf applied	2,846.94	0.57	1,625	0.39	1,110	2,735
Selective vapor retarder, membrane material	sf wall	2,823.26	0.25	705	0.29	820	1,525
Insulation, EPS Type 1, rigid, 51mm (2")	sf applied	2,846.94	0.62	1,765	0.70	1,995	3,760
Water Resistant Barrier (WRB) (includes taping seams)	sf applied	2,846.94	0.14	400	0.28	795	1,195
Strapping, 1x4 @ 16" o.c. on 2" of insulation	sf wall	2,823.26	0.34	960	0.67	1,890	2,850
1/2" Gypsum board	sf wall	2,823.26	0.35	990	0.41	1,160	2,150
USER MODIFICATION 1:							
USER MODIFICATION 2:							
TOTAL				$ 9,160		$ 10,490	$ 19,650
						Upgrade Cost:	$ 3,695
Upgrade: R24 Wall with MWB Exterior Insulation							
Framing, conventional, 38x140mm (2"x6") @ 406mm (16") o.c.	sf wall	2,823.26	0.70	1,975	0.60	1,695	3,670

Base case can only be modified in R22 above grade wall tab.

ROOF INSULATION | ABOVE GRADE R22 WALL | ABOVE GRADE R24 WALL | ABOVE GRADE R30 WALL | ABOVE GRADE R36 WALL | ABOVE GRADE R40 WALL | UNDERSLAB INSULATION | BELOW GRADE R...

Builders define the costs…



Available Performance Levels	Material Options	Upgrade Cost	Percent Incremental	Include in Design
Roof Insulation Options				
R-39.2	Base Case	$0	-	Yes
R-60	Fiberglass blow-in	$640	44%	Yes
R-80	Fiberglass blow-in	$1,410	97%	Yes
Exterior Walls				
R-17.6	Base Case	$0	-	Yes
Max 2x6 (R-24 batt) R-18.2	Base Case with R24 batt	$1,539	10%	Yes
R-22	Lowest Cost Option	$2,900	18%	Yes
R-24	Lowest Cost Option	$3,695	23%	Yes
R-30	Lowest Cost Option	$7,185	45%	Yes
R-36	Lowest Cost Option	$8,605	54%	Yes
R-40	Lowest Cost Option	$8,220	52%	Yes
Windows				
U-1.6 low-gain double	Defined in WINDOW Tab	$0	-	Yes
U-1.6, high-gain double	Defined in WINDOW Tab	-$1,370	-13%	Yes
U-1.1, low-gain triple	Defined in WINDOW Tab	$1,405	14%	Yes
U-1.1, high-gain triple	Defined in WINDOW Tab	$895	9%	Yes
U-0.8, low-gain triple	Defined in WINDOW Tab	$4,945	48%	Yes
U-0.8, high-gain triple	Defined in WINDOW Tab	$4,280	41%	Yes
Below Grade Walls				
R-16.9	Base Case	$0	-	Yes
R-22	Lowest Cost Option	$305	4%	Yes
R-28	Lowest Cost Option	$710	10%	Yes
Underslab Insulation				
None	Base Case	$0	-	Yes
R-10	Exterior XPS	$1,665	full cost	Yes
R-20	Exterior XPS	$3,085	full cost	Yes
Airtightness				
3.5 ACH	Defined in ACH Tab	$0	-	Yes
2.5 ACH	Defined in ACH Tab	$750	full cost	Yes
1.5 ACH	Defined in ACH Tab	$1,250	full cost	Yes
1.0 ACH	Defined in ACH Tab	$1,750	full cost	Yes
0.6 ACH	Defined in ACH Tab	$2,750	full cost	Yes
Ventilation				
60% HRV	Defined in HRV Tab	$0	-	Yes
78% HRV	Defined in HRV Tab	$745	55%	Yes
DHW Load Reduction				

ARCHETYPE | STEP 1 Inputs | STEP 2 ECM Selection | RESULTS | STEP 3 BUI...

Decide which technologies you want to include

- Builder/EA can toggle either yes or no for each technology option.
- Or, can specify discreet assembly to include (i.e. EPS, XPS, MWB, double stud)

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Canada

#3

What will it cost to own?

Total Costs = **Energy Costs** + **Payments on interest and principle for upgrades (4%, 25 yrs)**

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Canada

	A	B	C	D
1		USER INPUT	UNITS	DESCRIPTION
1		USER INPUT	UNITS	DESCRIPTION
2		**Performance Target**		
3	Net-Zero Approach	Yes 1		Is the target net-zero, or net-zero ready?
4	Acutal NZ target	Net-Zero Ready		Specify if it is net-zero, net-zero ready, or not-applicable.
5	Energy Efficiency Target	CHBA NZ-NZR		Chose energy efficiency target.
8				
9		**Utility Costs**		
10	Natural Gas Base Cost	$14 2	/month	Monthly charges regardless of consumption
11	Natural Gas Costs	$0.20	/m³ (26.853 m³/GJ)	Average consumption charges, not considering any tiers.
12	Electricity Base Cost	$6	/month	Monthly charges regardless of consumption
13	Electricity Costs	$0.14	/kWh (277.8 kWh/GJ)	Average consumption charges, not considering any tiers.
14	PV Electric Feed-in Tariff	$0.10	/kWh	Rate paid by utility for PV electricity produced that is above yearly electricity consumption.
15				
16		**Local GHG Emission Intensity**		
17	Natural Gas	1.879	kg CO2 per m³	Enter local fuel emission factor.
18	Electricity	0.100	kg CO2 per kWh	Enter local fuel emission factor.
19				
20		**Homebuyer Finances**		
21	Owner Down Payment	10%	% of total upgrade cost	
22	Amortization period	25 3	ears	
23	Interest rate	4%	% per year	
24				
25		**Other Additional Costs**		
26	Energy evaluator	$1,000 4	otal Cost	
27	Administration costs	$500	otal Cost	
28	Contingency (%)	10%		Percent additional cost above calculated incremental capital costs.
29				
30				
31				
32				
33				
34				
35				
36				
37				

ARCHETYPE | STEP 1 Inputs | STEP 2 ECM Selection | RESULTS | STEP 3 BUILDER COSTS | STEP 4 UPGRADE C

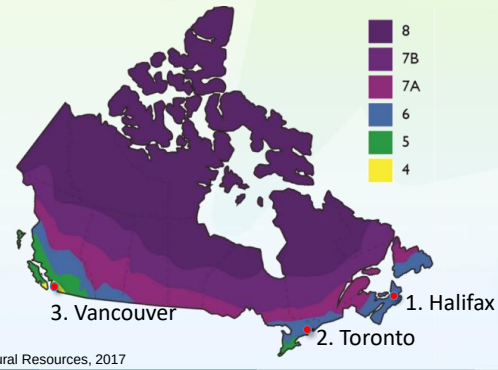
Set performance target, local energy cost, and financing costs

1. Select performance target from the list
2. Enter cost of NG and Electricity
3. Define financing costs
4. Additional soft costs

Canada

#4

Some examples of technology pathways that reach NZE and NZE Ready



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LEEP Costing Comparisons to Base

1. Halifax (Climate Zone 6, 4000 HDD)

LEVEL

1. NET ZERO
2. NET ZERO READY
3. 20% <CODE

SCENARIOS

A = Lowest Cost Default

B = User Limited Options

Step 5 = BC Energy Step Code

Step 3 = BC Energy Step Code

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Scenario B: User Limited Options NZ & NZr

- 1.0 ACH or less
- Ceiling: R-60
- Walls: R-24 XPS or R-40 double stud (lowest cost)
- Below Grade: R-28 walls (stand-off w/EPS)
- U-value Windows: 1.1 or better

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NZ/NZr Optimization & TEDI

- CHBA Net Zero
  - 33% reduction in thermal energy demand
- TEDI: Thermal Energy Demand Intensity
  - Annual heat loss (envelope & ventilation)
- BC Step Code
  - TEDI target = compliance for heat loss

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Halifax Base

	Base
TEDI	75.2
Electricity	$4560
Annual H/OCost	$4560

NET ZERO Lesser of 10 Options

A	B	Step 5	
49.6	25	24.9	TEDI
$130	$130	$130	Electricity
$3,021	$3,146	$3,144	Annual H/O Cost
$50,713	$52,901	$52,880	Upgrade Cost
13.8	11.3	11.3	PV Size

ACH:	3.5	ACH:	1	1	0.6
Ceiling:	R-49.2	Ceiling:		R-60	
Walls:	R-17.6	Walls:		R-40	R-40
BGWalls:	R-16.9	BGWalls:	R-22	R-28	R-28
Subslab:	None	Subslab:		R-10	
U-value:	1.6	U-value:	1.1	1.1	1.1
SHGC:	0.25	SHGC:	0.45	0.45	0.45
HRV:	60%	HRV			78%
DWHR:	No	DWHR			
DHW:	Elec. Tank	DHW	HPHW	HPHW	HPHW
Space:	Elec BB	Space	ASHP	ASHP	ASHP

Available rebate: $7000

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Halifax Base

	Base
TEDI	75.2
Electricity	$4560
Annual H/OCost	$4560

NZ-Ready Lesser of 10 Options

A	B	Step 5	
29.3	27	24.9	TEDI
$1,985	$1,948	$1,912	Electricity
$3,097	$3,160	$3,159	Annual H/O Cost
$19,507	$21,126	$22,169	Upgrade Cost
11.8	11.6	11.3	PV Size (future)

ACH:	3.5	ACH:	1	1	0.6
Ceiling:	R-49.2	Ceiling:		R-60	
Walls:	R-17.6	Walls:	R-40	R-40	R-40
BGWalls:	R-16.9	BGWalls:	R-22	R-28	R-28
Subslab:	None	Subslab:		R-10	
U-value:	1.6	U-value:	1.1	1.1	1.1
SHGC:	0.25	SHGC:	0.45	0.45	0.45
HRV:	60%	HRV			78%
DWHR:	No	DWHR			
DHW:	Elec. Tank	DHW	HPHW	HPHW	HPHW
Space:	Elec BB	Space	ASHP	ASHP	ASHP

Available rebate: $7000

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Halifax Base

	Base
TEDI	75.2
Electricity	$4560
Annual H/OCost	$4560

20%<Code Lesser of 10 Options

A	B	Step 3	
47.1	47.2	46	TEDI
$3,631	$3,631	$3,504	Electricity
$3,916	$4,013	$3,761	Annual H/O Cost
$5,004	$6,692	$4,454	Upgrade Cost
108 to 86 GJ	108 TO 86	108 to 88.3	Energy Reduction

ACH:	3.5	ACH:	1	**2.5** 1.5
Ceiling:	R-49.2	Ceiling:		R-60
Walls:	R-17.6	Walls:		
BGWalls:	R-16.9	BGWalls:	R-28	R-28 R-28
Subslab:	None	Subslab:		
U-value:	1.6	U-value:		
SHGC:	0.25	SHGC:	0.5	0.45 0.5
HRV:	60%	HRV		
DWHR:	No	DWHR		
DHW:	Elec. Tank	DHW		
Space:	Elec BB	Space		

Available rebate: $2000

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Halifax Base

	Base
TEDI	75.2
Electricity	$4560
Annual H/OCost	$4560

R20+2”XPS 1.0 ACH/Lowest TEDI

NZ	NZr	50% red	
36.2	33.1	34.3	TEDI
$130	$2,038	$2,335	Electricity
$3,287	$3,307	$3,342	Annual H/O Cost
$55,385	$22,219	$17,665	Upgrade Cost
12.6	12.2	not targetted	PV Size

ACH:	3.5	ACH:	0.6	1.0	1.0
Ceiling:	R-49.2	Ceiling:		R-60	R-60
Walls:	R-17.6	Walls:	R-24	R-24	R-24
BGWalls:	R-16.9	BGWalls:	R-28	R-28	R-28
Subslab:	None	Subslab:			
U-value:	1.6	U-value:	1.1	1.1	1.1
SHGC:	0.25	SHGC:	0.45	0.45	0.45
HRV:	60%	HRV			
DWHR:	No	DWHR			
DHW:	Elec. Tank	DHW	HPHW	HPHW	HPHW
Space:	Elec BB	Space	ASHP	ASHP	ASHP

Available rebate:
NZ/NZr = $7000
50%<Code = $5000

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LEEP Costing Comparisons to Base

2. South Western Ontario (Climate Zone 5, 3520 HDD)

LEVEL

1. NET ZERO
2. NET ZERO READY
3. 50% Savings

SCENARIOS

A = Lowest Cost Default

B = User Limited Options

C = 50% Savings (w/ User Limits)

Bonus Fun = 20% Savings

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NZ/NZr Optimization & TEDI

- CHBA Net Zero
  - 33% reduction in thermal energy demand
- Keeping in Mind Roof area of 800 Ft2
- Residential PV Threshold 10 KW System
- TEDI: Thermal Energy Demand Intensity
  - Annual heat loss (envelope & ventilation)

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B: User Limited Options NZ & NZr

- 1.5 ACH or lower
- Ceiling: Unchecked R80
- Walls Above Grade: Choose from following Types
  R22+1” XPS / R20+1.5” XPS / R20+3” XPS
- Walls Below Grade: Choose from following Types
  R20+2”MWB / R22+3”MWB
- U-value Windows: 1.1 or better
- Under slab- R10 or Higher
- 10 KW PV (Res. Threshold)
- Primary Space Heating: Unchecked the following
  Geo-thermal, Combo Heating, Nat. Gas Furnace
- Assumed Water Heaters are rentals.

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Toronto Base

	Base
TEDI	67.3
Electricity Natural Gas Total Energy	$1252 $595 110 GJ
Annual H/OCost	$1847

ACH:	3.5
Ceiling:	R-39.2
Walls:	R-17.6
BGWalls:	R-16.9
Subslab:	0
U-value:	1.6
SHGC:	0.25
HRV:	60%
DWHR:	No
DHW:	NG. 0.67EF
Space:	96% ECM Furnace

NET ZERO (NZE) Scenario

A	B	50 % Savings	
39.9	37.6	35.8	TEDI
$72 $0 44.4GJ	$72 $0 43.7 GJ	$2071 $0 51.4 GJ	Electricity Gas Total Energy GJ
$2,858	$2,914	$3,101	Annual H/O Cost
$48,880	$49,845	$18,066	Upgrade Cost
11.2	11	---	PV Size

ACH:	1	1	1.5
Ceiling:	R39.2	R-39.2	39.2
Walls:	R20+1.5” EPS	R-20+1.5” XPS	R-20+1.5” XPS
BGWalls:	R22+2” EPS	R-20+2” MWB	R-20+3” MWB
Subslab:	R10	R-10	R20
U-value:	1.1	1.1	1.1
SHGC:	0.45	0.45	0.45
HRV	60%	60%	60%
DWHR	None	None	60”
DHW	HPHW	HPHW	HPHW +DWHR
Space	Cold-Climate ASHP	Cold-Climate ASHP	ASHP

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Toronto Base

	Base
TEDI	67.3
Electricity Natural Gas Total Energy	$1252 $595 110 GJ
Annual H/OCost	$1847

NZ-Ready Scenario (NZR)

A	B	50 % Savings	
29.2	29.2	35.8	TEDI
$1641 $56 46.4GJ	$1641 $56 46.4 GJ	$2071 $0 51.4 GJ	Electricity Gas Total Energy GJ
$2,913	$2,948	$3,101	Annual H/O Cost
$21,333	$21,949	$18,066	Upgrade Cost
11.7	11.7	---	PV Size (future)

ACH:	3.5	0.6	1.5
Ceiling:	R-39.2	R60	39.2
Walls:	R-17.6	R-20+1.5"XPS	R-20+1.5" XPS
BGWalls:	R-16.9	R-20+3.5 EPS	R-20+3" MWB
Subslab:	None	R10	R20
U-value:	1.6	1.1	1.1
SHGC:	0.25	0.45	0.45
HRV:	60%	60%	60%
DWHR:	No	None	60"
DHW:	NG. 0.67EF	Cond. Tank	HPHW +DWHR
Space:	96% ECM Furnace	0.95EF CCASHP	ASHP

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Toronto Base

	Base
TEDI	67.3
Electricity Natural Gas Total Energy	$1252 $595 110 GJ
Annual H/OCost	$1847

Energy Star / Net Zero

	20 % Savings	50 % Savings	
	67.3	35.8	TEDI
	$1471 $26 81.6 GJ	$2071 $0 51.4 GJ	Electricity Gas Total Energy GJ
	$2,474	$3,101	Annual H/O Cost
	$12,885	$18,066	Upgrade Cost
	n/a	---	PV Size

ACH:	3.5	2.5	1.5
Ceiling:	R-39.2	R60	39.2
Walls:	R-17.6	R-22+1"XPS	R-20+1.5" XPS
BGWalls:	R-16.9	R-20+1.5" XPS	R-20+3" MWB
Subslab:	None	0	R20
U-value:	1.6	1.1	1.1
SHGC:	0.25	0.45	0.45
HRV:	60%	78%	60%
DWHR:	No	No	60"
DHW:	NG. 0.67EF	Cond. Tank .95EF	HPHW +DWHR
Space:	96% ECM Furnace	96% ECM-Furnace	ASHP

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Just Don't Forget Energy Star Required 1.9 BOP Points

LEEP Costing Comparisons to Base

3. BC Lower Mainland (Climate Zone 4, 2850 HDD)

LEVELS OF PERFORMANCE:

1. NET ZERO
2. NET ZERO READY
3. BC Energy Step Code Level 3

SCENARIOS:

Lowest Cost Default
User Limited Options
BC Energy Step Code Level 3

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User Limited Options NZ & NZr

- 1.0 ACH or less
- Ceiling: R-60
- Walls: R-24 XPS or R-40 double stud (lowest cost)
- Below Grade: R-28 walls (stand-off w/EPS)
- U-value Windows: 1.1 or better

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Vancouver Base

Base Case (natural gas)	
EnerGuide (GJ)	87
TEDI	44
Electricity/Gas	$1019/$686
Annual H/O Cost	$1705

NET ZERO Lesser of 10 Options

Lowest Cost	User Limits	Step 3	
54	54	54	EnerGuide (GJ)
29	15	29	TEDI
$-272/$289	$-272/$289	$-272/$289	Electricity/Gas
$4,435	$4,610	$4,435	Annual H/O Cost
$77,500	$80,500	$77,500	Upgrade Cost
17.1	16.8	17.1	PV Size (kW)

ACH:	3.5	ACH:	1	1	1
Ceiling:	R-39.2	Ceiling:	R-39	R-60	R-39
Walls:	R-17.6	Walls:	R-17.6	R-24	R-17.6
BGWalls:	R-16.5	BGWalls:	R-28	R-28	R-28
Subslab:	None	Subslab:	R-0	R-0	R-0
U-value:	1.6	U-value:	1.6	1.1	1.6
SHGC:	0.25	SHGC:	0.50	0.45	0.50
HRV:	60%	HRV	60%	60%	60%
DWHR:	No	DWHR	60”	None	60”
DHW:	NG tank 0.67EF	DHW	NG tank	NG tank	NG tank
Space:	NG furnace 96% AFUE	Space	ASHP	Elec baseboard	ASHP

Available rebate from FortisBC: $2000 for Step 3 IF Natural Gas heating and DHW. $4000 for Step 4, $8000 for Step 5.

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Vancouver Base

Base Case (natural gas)	
EnerGuide (GJ)	87
TEDI	44
Electricity/Gas	$1019/$686
Annual H/O Cost	$1705

NZ-Ready Lesser of 10 Options

Lowest Cost	User Limits	Step 3	
54	54	54	EnerGuide (GJ)
30	15	29	TEDI
$1,433/$289	$1,407/289	$1,433/$289	Electricity/Gas
$2,712	$2,913	$2,712	Annual H/O Cost
$17,373	$21,350	$17,373	Upgrade Cost
17.1	16.8	17.1	PV Size (kW)

ACH:	3.5	ACH:	1	1	1
Ceiling:	R-39.2	Ceiling:	R-40	R-60	R-40
Walls:	R-17.5	Walls:	R-16.5	R-24	R-16.5
BGWalls:	R-16.9	BGWalls:	R-28	R-28	R-28
Subslab:	None	Subslab:	R-0	R-0	R-0
U-value:	1.6	U-value:	1.6	1.1	1.6
SHGC:	0.25	SHGC:	0.50	0.45	0.50
HRV:	60%	HRV	60%	60%	60%
DWHR:	No	DWHR	60”	None	60”
DHW:	NG tank 0.67EF	DHW	NG tank	NG tank	NG tank
Space:	NG furnace 96% AFUE	Space	ASHP	Electric baseboard-needs cooling	ASHP

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Vancouver Base

Base Case (natural gas)	
EnerGuide (GJ)	87
TEDI	44
Electricity/Gas	$1019/$686
Annual H/O Cost	$1705

Step Code Level 3 Lesser of 10 Options

Lowest Cost	User Limits	
79	66	EnerGuide (GJ)
24	13	TEDI
$1,129/$602	$1,653/$334	Electricity/Gas
$2,754	$3,260	Annual H/O Cost
$17,900	$22,339	Upgrade Cost
-	-	PV Size (kW)

ACH:	3.5	ACH:	1	1
Ceiling:	R-49.2	Ceiling:	R-80	R-60
Walls:	R-17.6	Walls:	R-16.5	R-24
BGWalls:	R-16.9	BGWalls:	R-28	R-28
Subslab:	None	Subslab:	R-0	R-0
U-value:	1.6	U-value:	1.6	1.1
SHGC:	0.25	SHGC:	0.5	0.45
HRV:	60%	HRV	60%	60%
DWHR:	No	DWHR	60”	60”
DHW:	Elec. Tank	DHW	NG tank	NG tank
Space:	Elec BB	Space	NG furnace, 96% AFUE	Electric base board

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NET ZERO ENERGY – LOWEST COSTS ATLANTIC, ONT, BC

ATLANTIC BASE	ATLANTIC UPGRADE	ONTARIO BASE	ONTARIO UPGRADE	BC BASE	BC UPGRADE	
75.2	49.6	67.3	24.5	44	29	TEDI
$4560	$130	$1252 $595 110 GJ	$72 $0 39.6 GJ	$1,705 87 GJ	$17 54 GJ	Electricity/NG
$4560	$3,021	$1847	$2,944	$1705	$4,435	Annual H/O Cost
N/A	$50,713	N/A	$50,377	N/A	$77,500	Upgrade Cost
N/A	13.8	N/A	10.1	N/A	17	PV Size

ACH:	3.5	1	3.5	1	3.5	1
Ceiling:	R-49.2	R-49.2	R-39.2	R39.2	R-39.2	R-39.2
Walls:	R-17.6	R-17.6	R-17.6	R20+1.5” EPS	R-17.6	R-17.6
BGWalls:	R-16.9	R-22	R-16.9	R22+2” EPS	R-16.9	R-28
Subslab:	None	None	None	R10	None	None
U-value:	1.6	1.1	1.6	1.1	1.6	1.6
SHGC:	0.25	0.45	0.25	0.45	0.25	0.50
HRV:	60%	60%	60%	60%	60%	60%
DWHR:	No	No	No	None	No	60”
DHW:	Elec. Tank	HPHW	NG. 0.67EF	HPHW	NG. 0.67EF	NG 0.67 EF
Space:	Elec BB	ASHP	96% Furnace	CCASHP	96% Furnace	ASHP

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NZ-Ready ENERGY – LOWEST COSTS ATLANTIC, ONT, BC

	ATLANTIC BASE	ATLANTIC UPGRADE	ONTARIO BASE	ONTARIO UPGRADE	BC BASE	BC UPGRADE	
	75.2	29.3	67.3	36	54	29	TEDI
	$4560	$1,985	$1252 $595 110 GJ	$1832 $56 51.3GJ	$1,705 87 GJ	$1,722	Electricity/NG
	$4560	$3,097	$1847	$2,683	$1705	$2,712	Annual H/O Cost
	N/A	$19,507	N/A	$13,958	N/A	$17,373	Upgrade Cost
	N/A	11.8	N/A	13	N/A	17.1	PV Size (future)
ACH:	3.5	1	3.5	1	3.5	1	
Ceiling:	R-49.2	R-49.2	R-39.2	R39.2	R-39.2	R-39	
Walls:	R-17.6	R-40	R-17.6	R-22+1"XPS	R-17.6	R-17.6	
BGWalls:	R-16.9	R-22	R-16.9	R-22+1"XPS	R-16.9	R-28	
Subslab:	None	None	None	R0	None	R-0	
U-value:	1.6	1.1	1.6	1.1	1.6	1.6	
SHGC:	0.25	0.45	0.25	0.45	0.25	0.50	
HRV:	60%	60%	60%	60%	60%	60%	
DWHR:	No	No	No	None	No	60"	
DHW:	Elec. Tank	HPHW	NG. 0.67EF	Cond. Tank 0.95EF	NG. 0.67EF	NG tank	
Space:	Elec BB	ASHP	96% Furnace	ASHP	96% Furnace	ASHP	

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Next Steps on Costing

- Testing/refinement of spreadsheet tool (spring/summer)
- Pilot costing workshop (June 2019 in BC)
- Atlantic Canada workshop trial (Fall 2019)

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