Building a House as a System: Achieving Net Zero in Cranbrook, BC

WEBINAR

February 15th, 2022, 12PM MST

APPROVED — Continuing Professional Development — Registrar BC Housing

Join local builder, Bruce Murdoch, of K-Country Homes to learn about balancing cost & energy efficiency, achieving air-tightness and selecting mechanical systems.

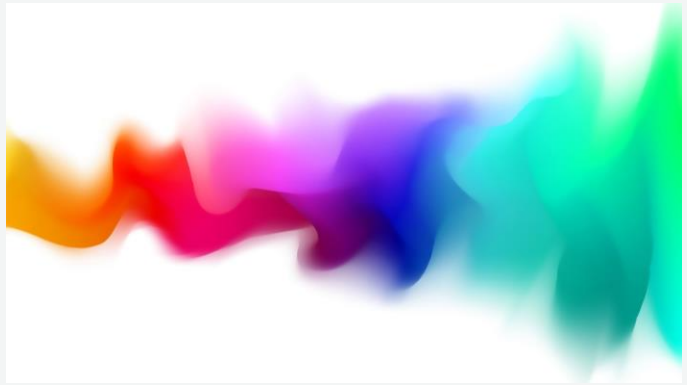
Community Energy Association

Building A Legacy
Building local knowledge, opportunity, and capacity

BC Hydro Power smart

Regional District of East Kootenay

ENERGY STEPCODE
BUILDING BEYOND THE STANDARD



Case Study---Net Zero Home

House as a System

What is Net Zero?

A Net Zero home is one that produces as much energy as it consumes.

Four areas of focus:

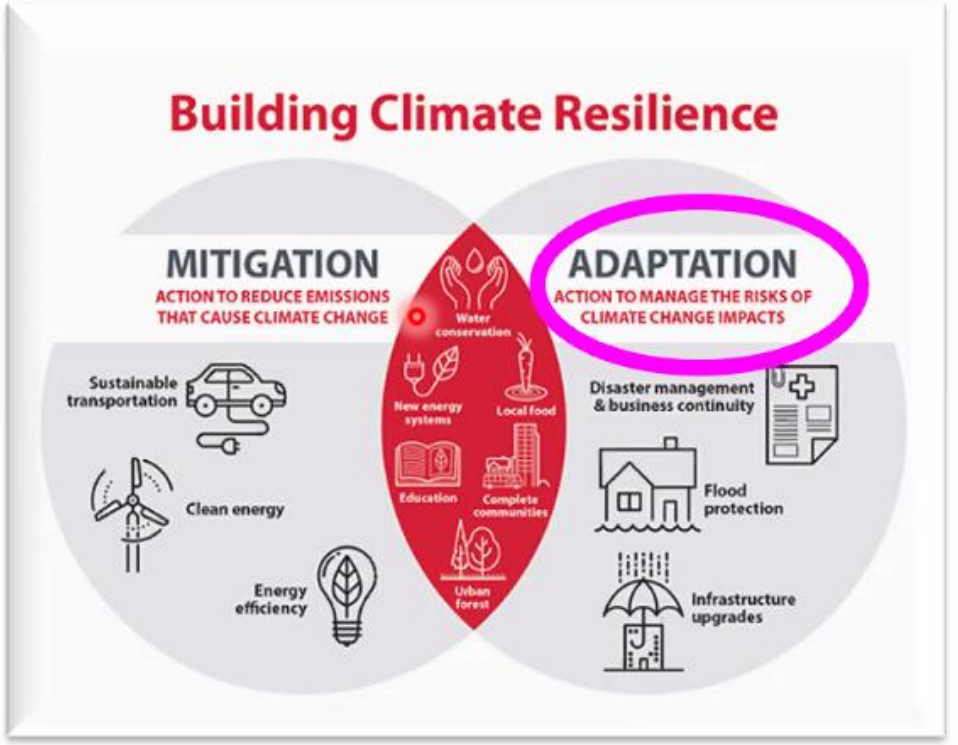
1. The envelope: (a) air tightness and (b) high thermal value
2. Mechanical systems: heating/cooling and hot water production.
3. Appliances
4. Power production: PV solar panels in most cases in our area.

Two driving forces toward Net Zero

1. Government regulations to mitigate and adapt to climate change

2. Consumer demand. Multiple reasons, more in a later slide.

THE NEED TO BUILD BETTER



Canadas Climate Change Action Plan

Government Mandates

New homes to be progressively more efficient to move toward Net Zero Ready in 2032 in BC through the BC Step Code.

New homes to be zero emissions by 2030 in BC. (BC's Roadmap 2030 announced early Nov/21)

No mandate for embodied carbon yet.

Existing Buildings to be net zero by 2050 throughout Canada

BC Step Code Phase In

BC Roadmap to 2030 Zero Carbon

Zero-carbon new construction by 2030

Current requirements for new construction focus on energy efficiency without directly addressing the issue of GHG emissions. Since natural gas is still a dominant, low-cost energy source for buildings, efficiency requirements alone are not enough to meet our climate targets.

That's why we're adding a new carbon pollution standard to the BC Building Code, supporting a transition to zero-carbon new buildings by 2030. We're already working with local governments to develop voluntary carbon pollution standards. Those communities will serve as pilots for future province-wide requirements. The standard will be performance-based, allowing for a variety of options including electrification, low carbon fuels like renewable natural gas, and low carbon district energy.

In 2023, we'll review our progress and, based on what we've learned, we'll start phasing in provincial regulations over time (2024, 2027, 2030). We'll also incorporate energy-efficiency standards for existing buildings into the BC Building Code starting in 2024.

Highest efficiency standards for new space and water heating equipment

Space and water heating are the primary drivers of GHG emissions from buildings. To meet our targets, we need to ensure these functions are super-efficient, improve resilience and, wherever possible, run on clean electricity or other renewable fuels. To help accelerate this transition, we're committing to highest-efficiency standards for new space and water heating equipment by 2030, and earlier where feasible.

Net Zero Certification.

Single family home with a secondary suite will meet BC Step Code 5 and be CHBA certified as Net Zero

netzero home

The ultimate in comfort and efficiency

The Process to Net Zero

1. Initial Design

2. Energy Modeling by Energy Advisor. Actual design is compared to a 2017/8 code built reference house.

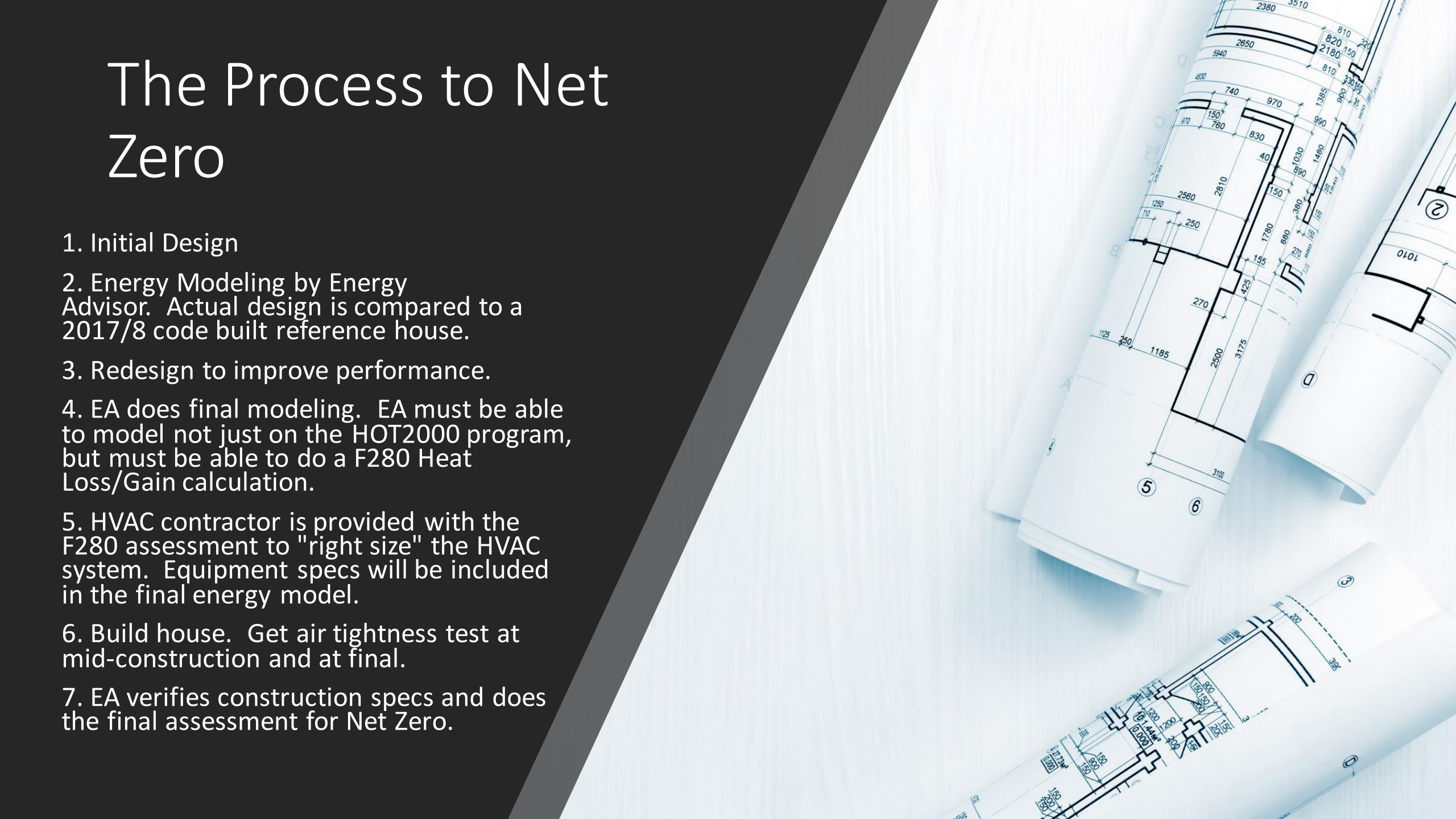
3. Redesign to improve performance.

4. EA does final modeling. EA must be able to model not just on the HOT2000 program, but must be able to do a F280 Heat Loss/Gain calculation.

5. HVAC contractor is provided with the F280 assessment to "right size" the HVAC system. Equipment specs will be included in the final energy model.

6. Build house. Get air tightness test at mid-construction and at final.

7. EA verifies construction specs and does the final assessment for Net Zero.



Design Elements of Net Zero Home

- Design square as possible, straight lines and deliberate with windows. House as a system.
- SIP Envelope average R38 (Greenstone ICE panels)
- Underslab 4" EPS R14.2
- Super airtight. Mid construction just over .9 ACH@50pa
- Triple glazed windows
- Fujitsu cold climate heat pumps
- 65 gal Rheem hybrid heat pump hot water heater with mixing valve
- ERV (not HRV) 83% efficient heat recovery
- Hot water drain heat recovery
- Far infrared underfloor back up heat film
- Less than 40 solar panels
- Heat pump dryers and induction stoves

Performance Summary

Energy Consumption (ERS) With Baseloads		Savings
Reference	101 GJ/yr	39.3%
Proposed	61 GJ/yr	
Energy Generation		**Savings**
Solar	30 GJ/yr	69.1%
Net	31 GJ/yr	

Energy Consumption Without Baseloads		Savings
Reference	70.3 GJ/yr	56.5%
Proposed	30.6 GJ/yr	

Design Performance Summary

4 Elements
www.4Elements.eco

Load Short Form
Entire House
4 Elements Integrated Design LTD

Job: 42133
Date: Sep 20, 2021
By: Cooper Le

Cert.#: 15671(RHLG)
110 32 Avenue NE, Calgary, AB T2E 2G4 Phone: 4032505514 Email: cooper@4elements.eco Web: https://www.4elements.eco/

Project Information

For: Bruce Murdoch, K-Country Homes
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Web: http://www.kcountryhomes.com/ Email: bgmurdoch@gmail.com

Design Information

	Htg	Clg
Outside db (°F)	-15	90
Inside db (°F)	70	75
Design TD (°F)	85	15
Daily range	-	M
Inside humidity (%)	50	50
Moisture difference (gr/lb)	53	0

Infiltration

Method	F280-12
Expos. categ	Heavy shielding
Const. categ	Custom - BDT values
Number of stories	2.0

HEATING EQUIPMENT

Make	Generic		
Trade			
Model	SEER 14.0, HSPF 8.1		
AHRI ref			
Efficiency	8.1 HSPF		
Heating input			
Heating output	17423	Btuh @ 47°F	
Temperature rise	28	°F	
Actual air flow	584	cfm	
Air flow factor	0.029	cfm/Btuh	
Static pressure	0	in H2O	
Space thermostat			

Capacity balance point = 10 °F

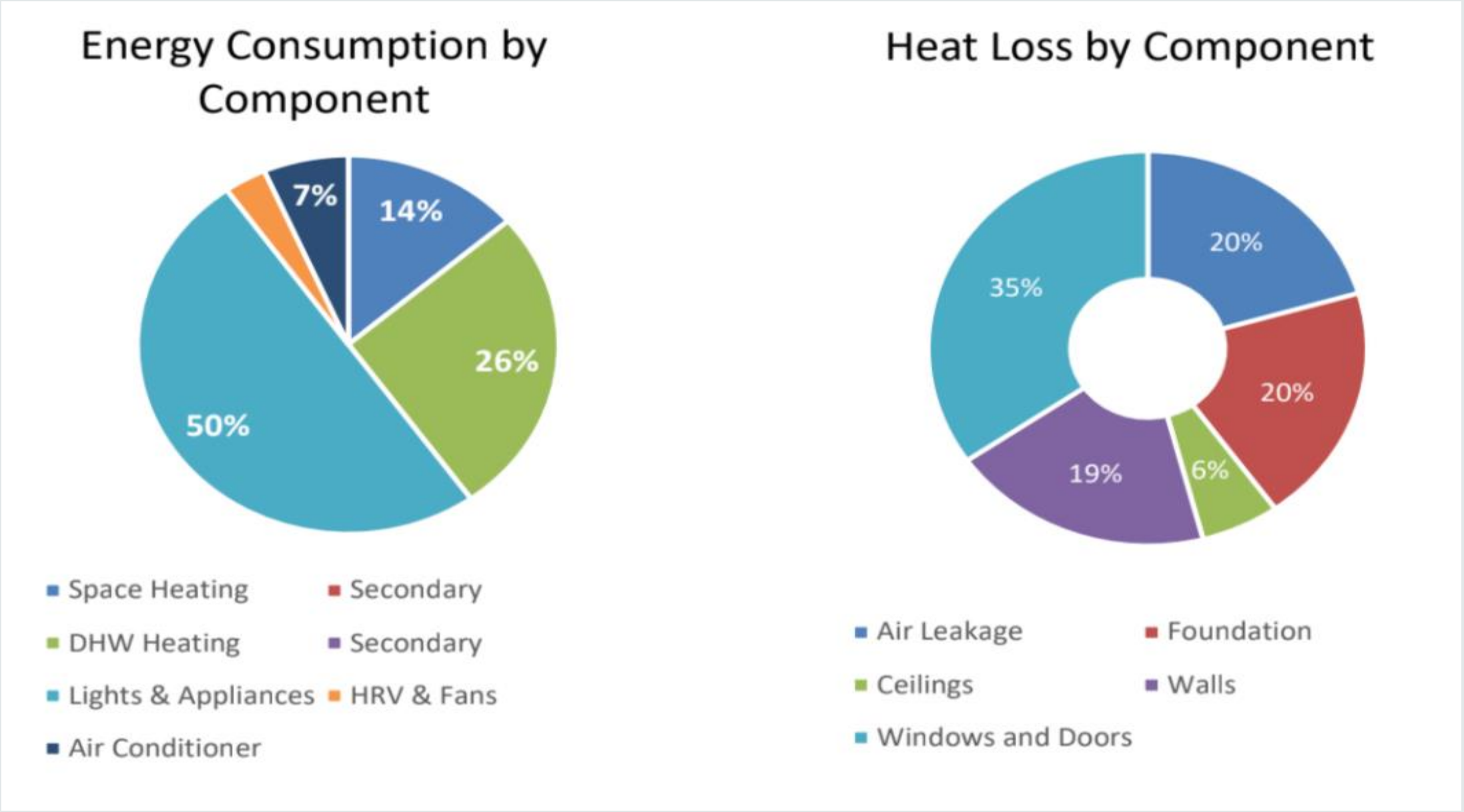
Backup: Elec baseboard
Input = 23716 Btuh, Output = 23716 Btuh, 100 EFF

COOLING EQUIPMENT

Make	Generic		
Trade			
Cond	SEER 14.0, HSPF 8.1		
Coil			
AHRI ref			
Efficiency	12.2 EER, 14 SEER		
Sensible cooling	12258	Btuh	
Latent cooling	5253	Btuh	
Total cooling	17511	Btuh	
Actual air flow	584	cfm	
Air flow factor	0.050	cfm/Btuh	
Static pressure	0	in H2O	
Load sensible heat ratio	0.77		

ROOM NAME		Area (ft²)	Htg load (Btuh)	Clg load (Btuh)	Htg AVF (cfm)	Clg AVF (cfm)
BSMT	p	696	8739	2560 2120	251	106
1F	p	577	6041	1770 7066	173	354
2F	p	713	5582	1635 2478	160	124
Entire House	d	1985	20362	5964 11663	584	584
Other equip loads			3354	983 594		
Equip. @ 1.00 RSM				12257		
L[illegible]				3677		
TOTALS		1985	23716	15935	584	584

Energy Consumption and Heat Loss



Structural Insulated Panels by Greenstone

Conventional Footings

SIP Foundation

Panelized, about 4' wide panels. Fast installation.


Waterproof
basement

First floor walls, both floor I-Joists


K-COUNTRY
HOMES
#3


Roof
structure
REDMI NOTE 9 PRO
BGM

Envelope complete

SUB SLAB INSULATION

FOAMULAR® CODEBORD® NGX™

BENEFITS

Thermal:

- *Comfortable space year-round, no more cold feet, can accommodate multiple finishes above concrete slab*

Moisture:

- *Better indoor air quality; no dampness, no mold, no smells*

Air/Vapor:

- *Durability (no condensation)*

Windows

Mostly tripled glazed.

Reduced number of vented windows because of mechanical ventilation. Improves air tightness.

House as a system. Increased thermal value reduces number of solar panels.

Mid-construction airtightness test

Air Tightness sealing.

Attention to detail is important.

Air Tightness.

House as a system

- Pros: substantially reduces heating and cooling loads at a small cost.
- Con: lowers air quality . Solution: add energy efficient ventilation (HRV or ERV)
- Con: causes negative air pressure when exhaust appliances are operating. Solution: eliminate all exhaust appliances except the required kitchen hood fan.
- Or, install a makeup air system.

Air sealing with AeroBarrier

Mini Split Heat Pumps

Effective to –26C

2 Ductless and 1 Ducted (top floor)

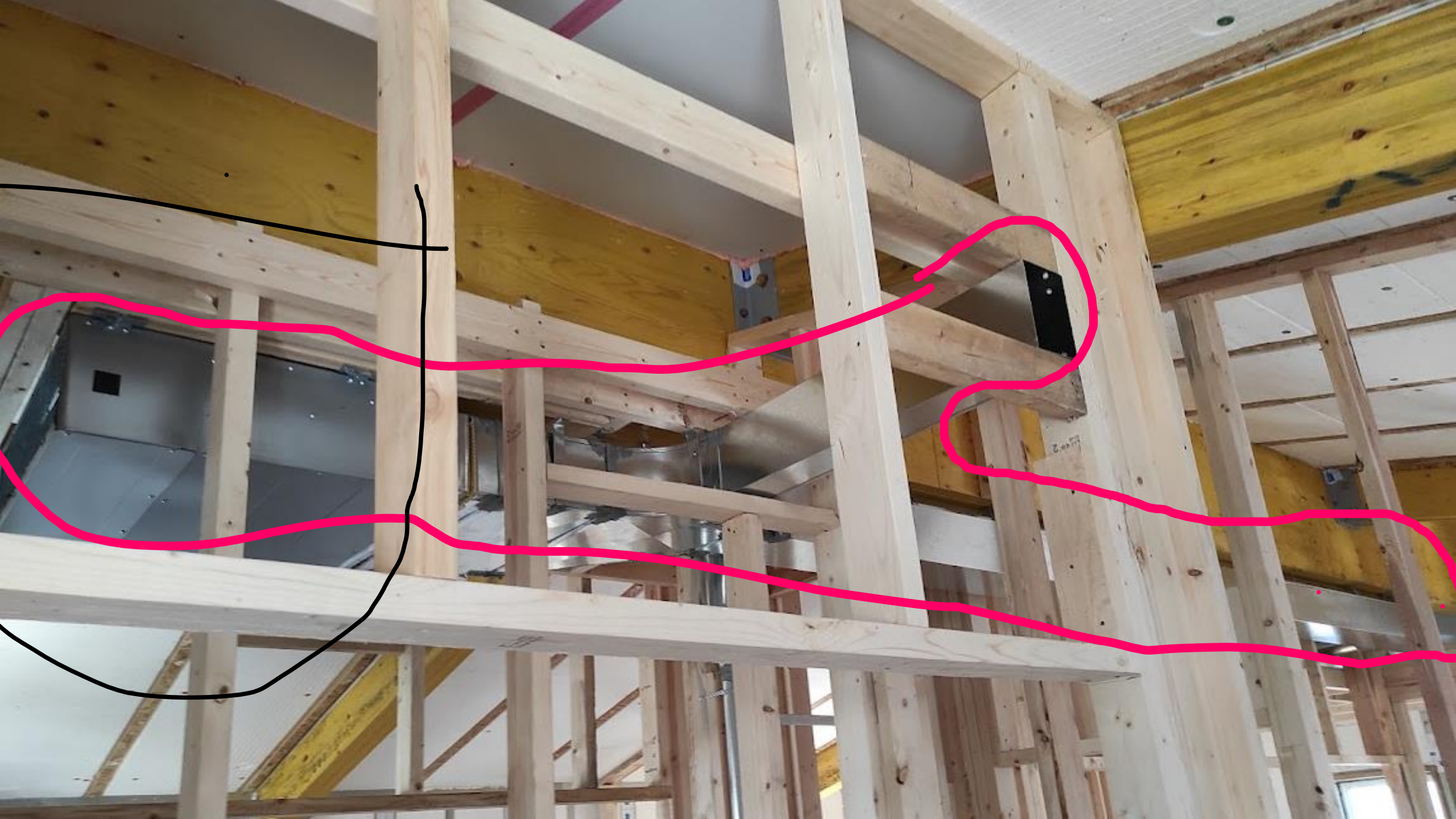
Set it and forget it.

Backup heat is far infrared underfloor heat in bathrooms and convection wall heaters in other main rooms

HRV/ERV

Lifebreath ERV, 83% efficient. Efficiencies range from under 70% to over 90%.

ERV recaptures humidity for dry climates.



Hybrid Heat Pump Hot Water

65 gal Rheem. WiFi connected.

Pro: about $50/yr to operate

Con: slow recovery. Solution: add mixing valve to the exit.

Solution: Drain Water Heat Recovery Unit

Solution to avoid: using the resistance coils (adds operating cost).

Drain Water Heat Recovery Unit

Recaptures at least 30% of shower hot water and puts it back into the hot water tank.
Payback 2-10 years.

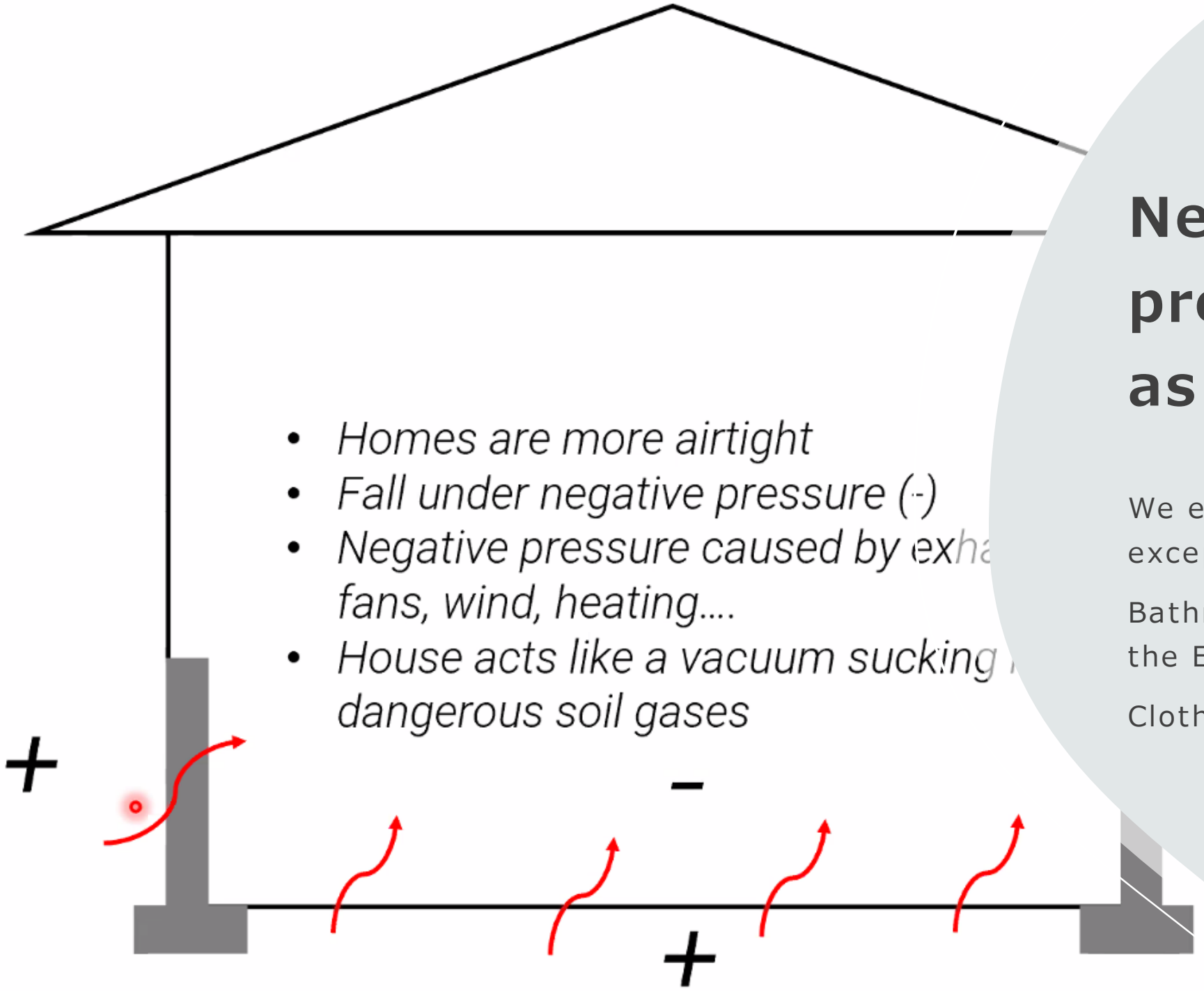
1. ENERGY STAR® Most Efficient
2. Self-Cleaning Condenser
3. Home Connect™
4. EasyStart
5. Energy Consumption
6. Status Updates
7. Remote Diagnostics
8. Large Capacity
9. Quick 15 Dry Cycle
10. Laundry Plug Adaptor

Heat Pump Clothes Dryer
no venting, rated at 123kWh/year (under $15)

Induction Range

2-3X more efficient than gas range.

15-20% more efficient than electric resistance



Negative air pressure, house as a system

We eliminated all exhaust except for the range hoods.

Bathrooms are ventilated by the ERV.

Clothes dryers do not exhaust


Solar

Solar Production

Model requires about 40 panels at 335 watts each = 13.4 kW system. Final calculations will be much lower due to the following improvements:

1. More airtight than model. Model 1.5 ACH and we expect .5 ACH
2. More insulation under basement slab.
3. Triple glazed windows.
3. Heat pump hot water tank and drain water heat recovery.
4. Heat pump dryer and induction stoves.

What is Attractive about Net Zero to Homeowners?

ENERGY COST SAVINGS IS NOT THE MAIN ATTRACTION PER CHBA SURVEYS.

GENERALLY, IT'S A BETTER LIVING EXPERIENCE.

- Attractive Features of a High Performance Building

Quiet. Better wall assemblies and windows provide better separation from the outside.

High Indoor Air Quality IAQ. HRVs and ERVs.

Comfortable. Right sized HVAC, including cooling. No hot and cold spots.

Healthier. Filtered fresh air, radon mitigation, less offgassing.

Longer life expectancy of the building. Should expect 200 year life.

Carries a higher sales value. A Net Zero label establishes higher value.

Protects against future fuel cost increases.

Non-fossil fuel appliances means no major changes required when replacing later.

Environmentally responsible with lower or zero emissions.

Design Mistakes

Roof:

The Greenstone SIPs with the LVL support structure is not cost effective. Conventional trusses with a higher R Value is less costly.

The simple gable is not large enough to handle all the solar panels. The roof should have had a greater south exposure to handle more panels efficiently. Wall mount panels do not produce as much electricity.

Balancing that, we have beautiful vaulted ceilings on the upper floor. Also, the SIPs are easier to make air tight.

Roof line

Unequal roof line to expose more roof to the south.

High Performance Costs

- **To achieve**:
- Step Code 3 $1000
- Step Code 4 $3000
- Step Code 5 Net Zero Ready $15-22,000 source:CHBA
- Net Zero $40-50,000

Rebates

- Changing frequently.
- Check with Clean BC at www.cleanbc.ca

Acknowlegements

COMMUNITY ENERGY.

FELLOW BUILDERS WILLING TO SHARE INFORMATION.

SUB-TRADES WITH IDEAS.

BUILDING OFFICIALS SHARING KNOWLEDGE.

CANADIAN HOME BUILDERS ASSOCIATION FOR THE NET ZERO PROGRAM.

BC HOUSING