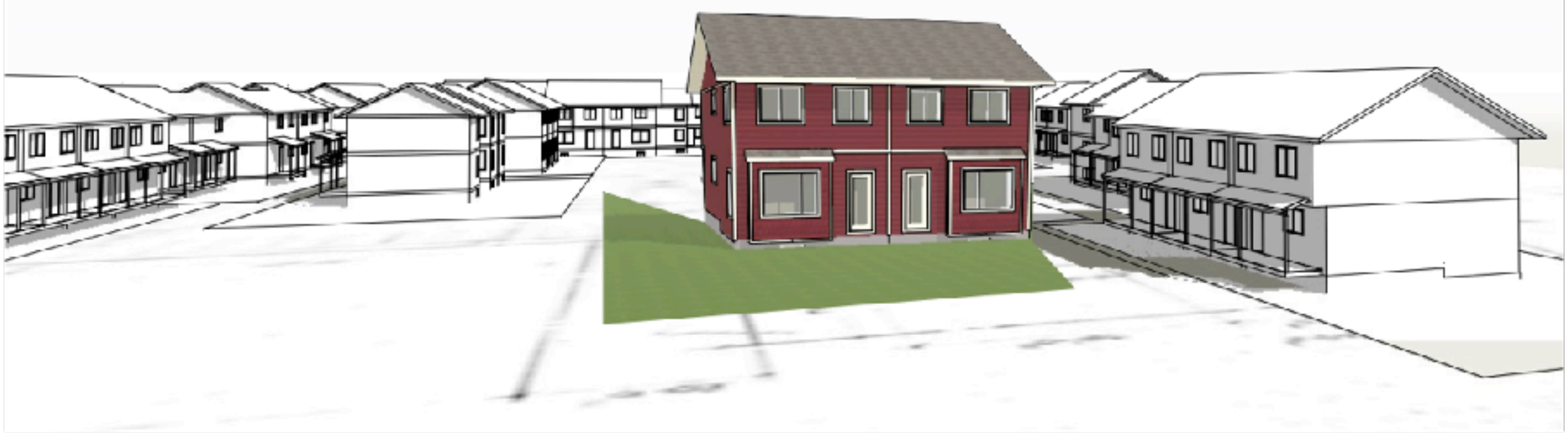
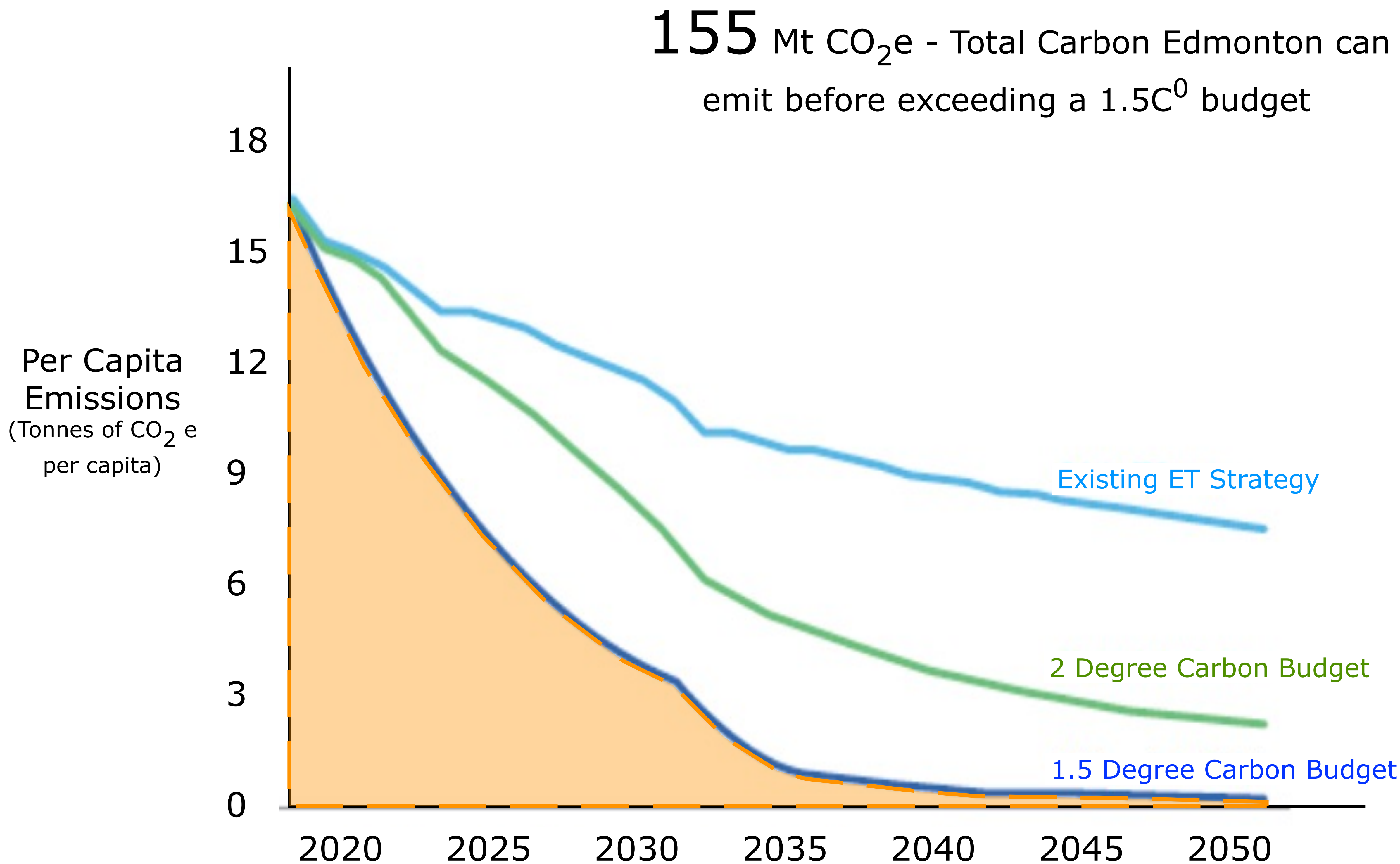
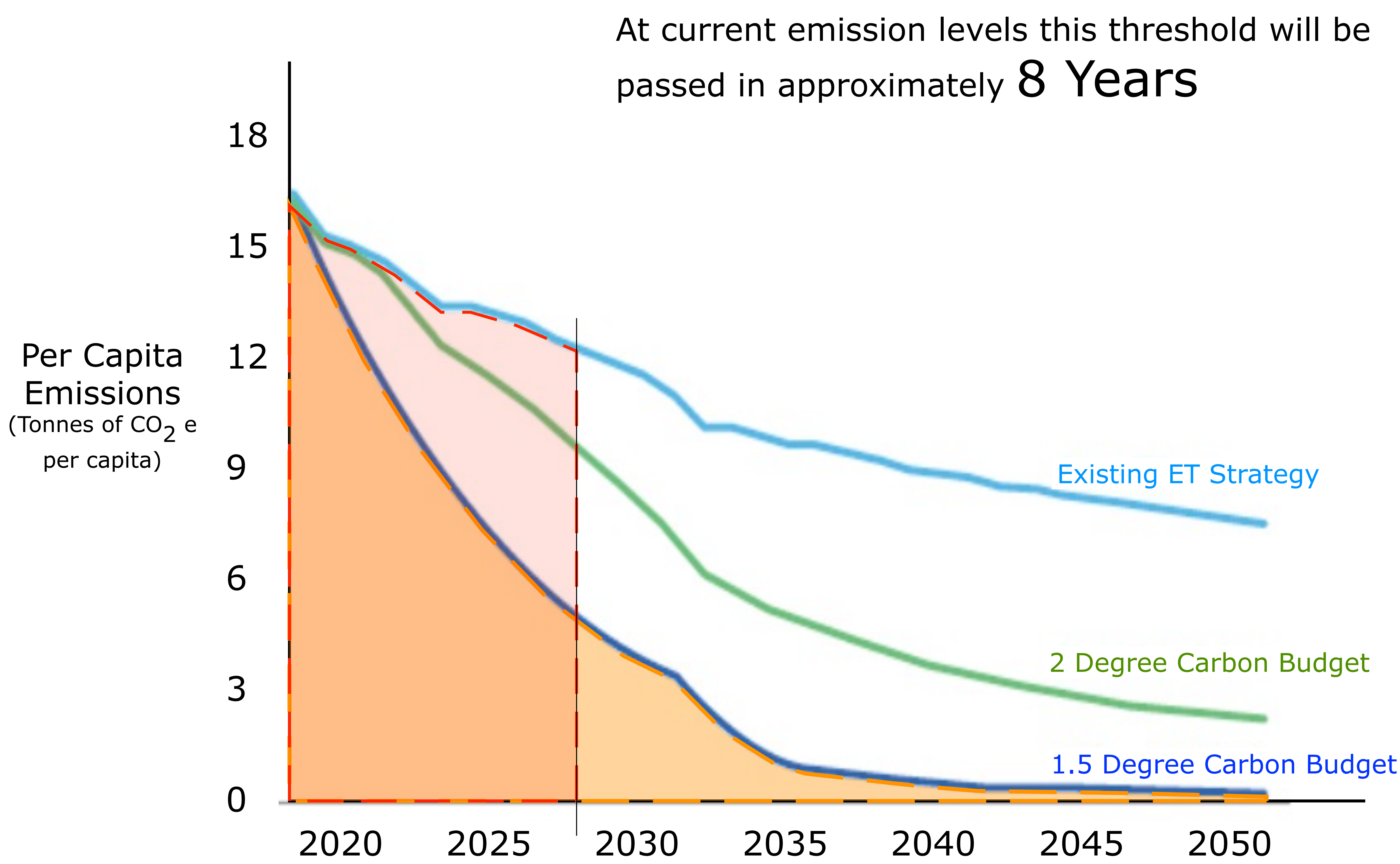
Sundance Housing Co-op
Deep Energy Retrofit
Phase 1 Pilot



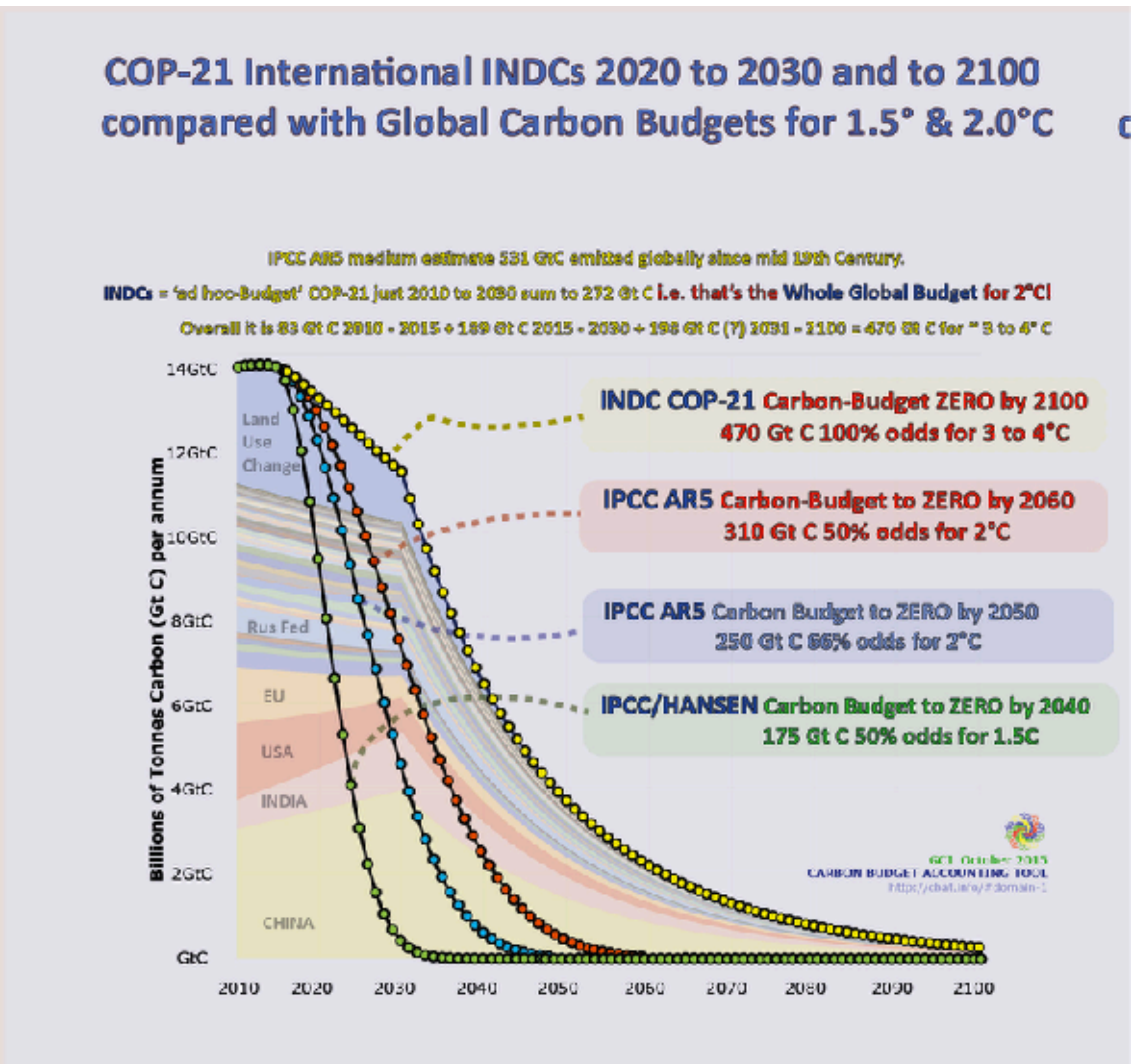


155 Mt CO_2e - Total Carbon Edmonton can emit before exceeding a 1.5C^0 budget
Per Capita Emissions
(Tonnes of CO_2 e per capita)
18
15
12
9
6
3
0
2020
2025
2030
2035
2040
2045
2050
Existing ET Strategy
2 Degree Carbon Budget
1.5 Degree Carbon Budget

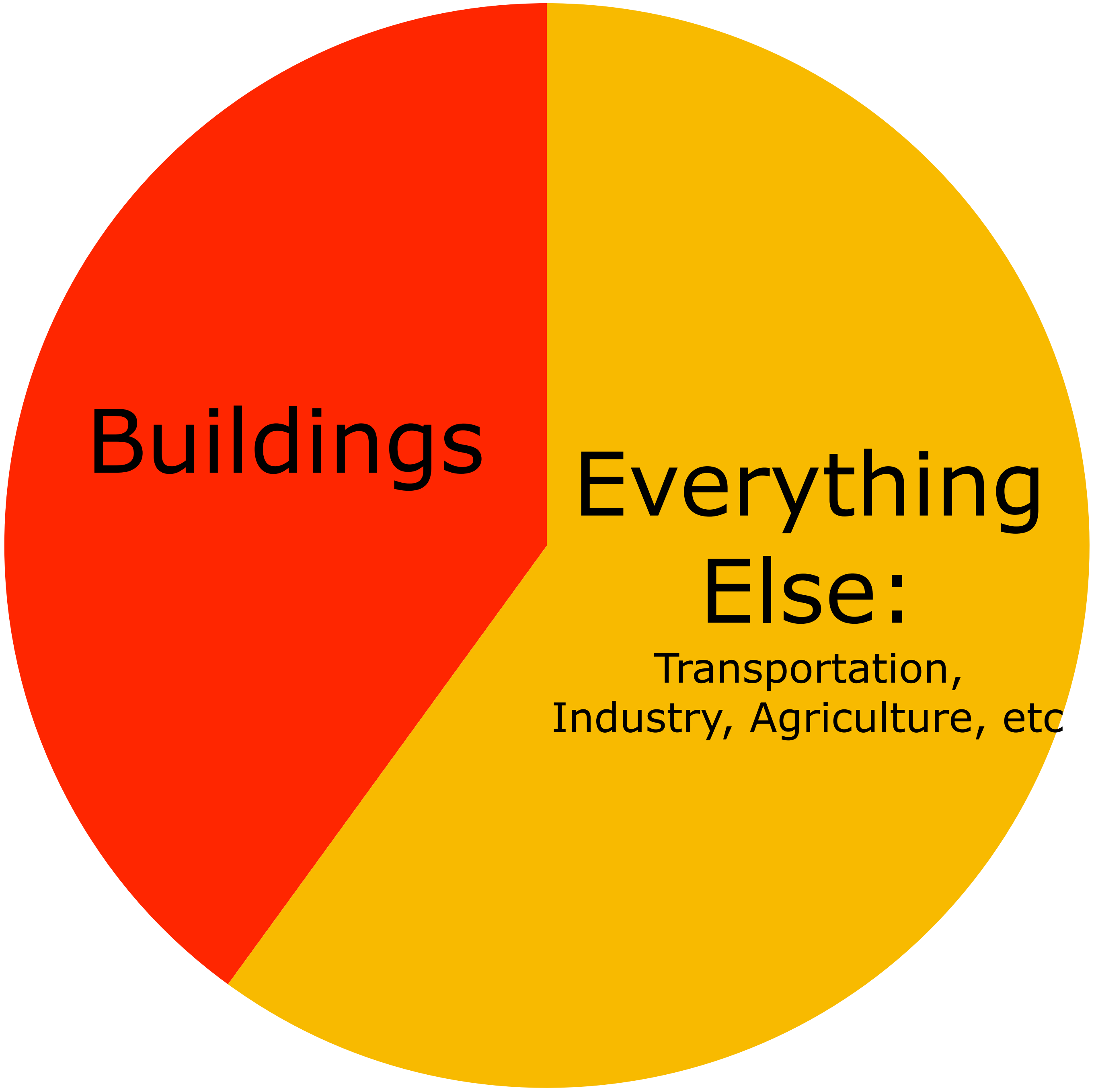


At current emission levels this threshold will be passed in approximately 8 Years
Per Capita Emissions
(Tonnes of CO_2 e per capita)
18
15
12
9
6
3
0
2020
2025
2030
2035
2040
2045
2050
Existing ET Strategy
2 Degree Carbon Budget
1.5 Degree Carbon Budget

The world needs to reduce greenhouses gas emissions by over 90% before 2050 to maintain a habitable climate for our children



Buildings are responsible for ~40% of total global greenhouse gasses



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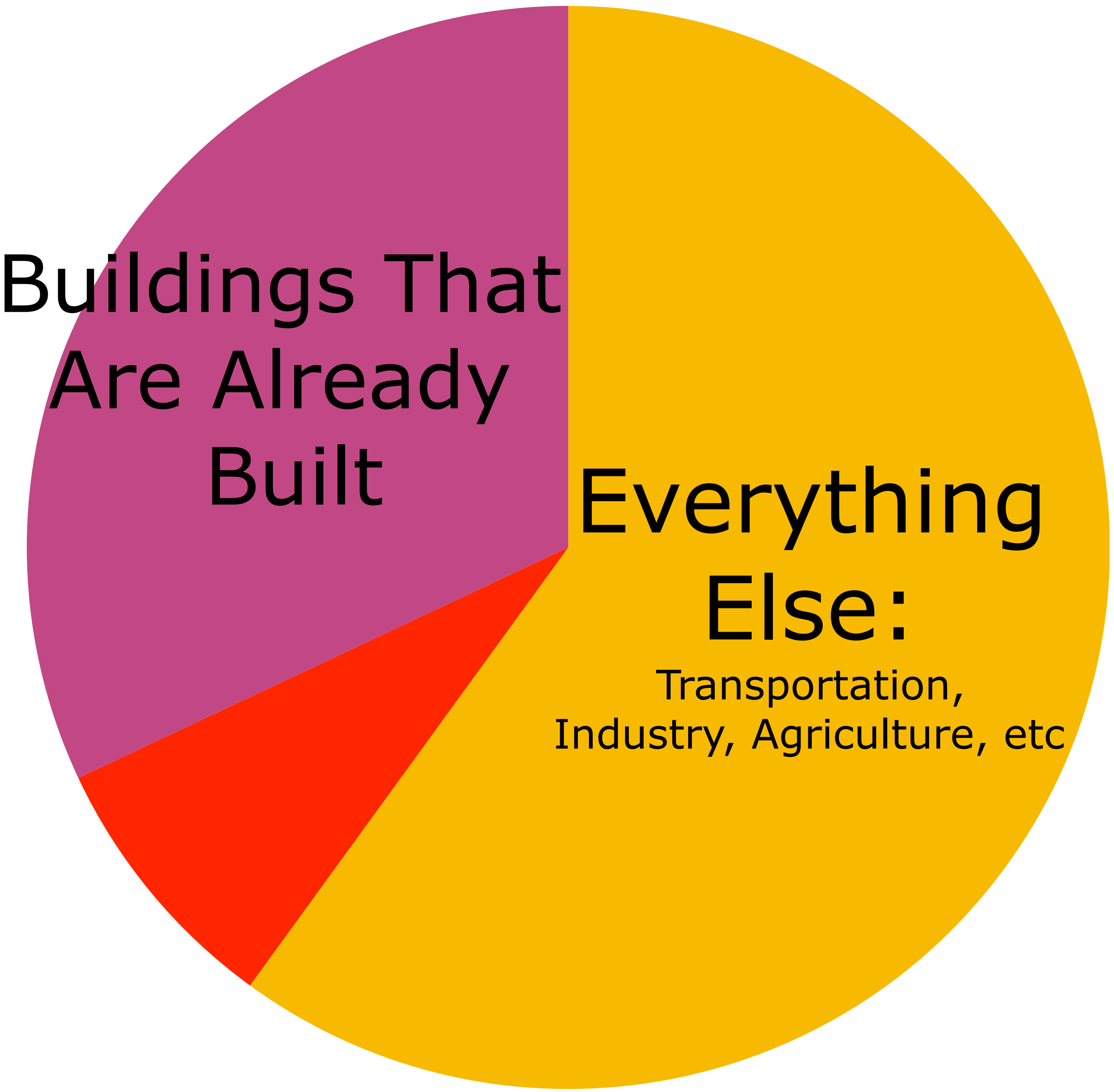
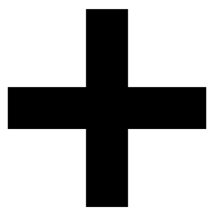
70 to 80 % of the buildings we will be using in 2050 are already built





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NO path to a decent future for our children without industrial scale, deep energy retrofits to existing buildings

- A Dutch system of factory built, panelized, deep energy retrofits
- 5000 units completed
- 10,000 units underway
- 110,000 units planned

EnergieSprong

Visit to the Netherlands

Advantages of Panelized DERs

- Lowest total cost of ownership
- Less expensive than component by component replacement.
- Higher quality: Opportunity to solve long term maintenance problems with durable, comprehensive, engineered, factory built solutions.
- Faster, less disruptive to residents
- Easier to manage
- Better total solution: results in beautiful, superbly comfortable, healthy living
- Likely the only way to affordably make existing buildings zero carbon ready

Incremental Retrofits

- Half measures will make what needs to be done in the long run more difficult and more expensive.
- Half measures will lock in the emissions from those buildings for generations and may well prevent them from ever being zero carbon ready.
- May make sense to delay and save until you can afford to do it right


Sundance Housing Co-op
Sundance Housing
Cooperative
87 St NW
87 St NW
87 St NW
87 St NW
87 St NW

Unit #22

Similar to Unit #15, Unit #22 has a history of occupant complaints due to cold rooms and wall surfaces. We undertook a similar thermal imaging review of this unit, with findings summarized in Figure 8 and 9. Similarly, we found minor areas with raised surface temperature, mostly around the front patio wall to ceiling connection. This area could certainly lead to a localized cold spot on the interior of the unit, however, we'd suggest that a proper volume of heating air supply should maintain internal comfort. The main wall areas show a relatively uniform surface temperature, which suggests current insulation levels are quite consistent. We'd suggest that if thermal comfort continues to be an issue in this unit, then a service contractor could be brought into assess the airflow balance of the furnace.

Figure 8: Infrared Thermal Images of Sundance Unit #15, taken just after sunrise on November 15, 2017. IR images shown on the left, with corresponding regular image shown to the right. The color legend represents the range in temperature present in the image; note that glass temperature is not accurately reflected in these images.

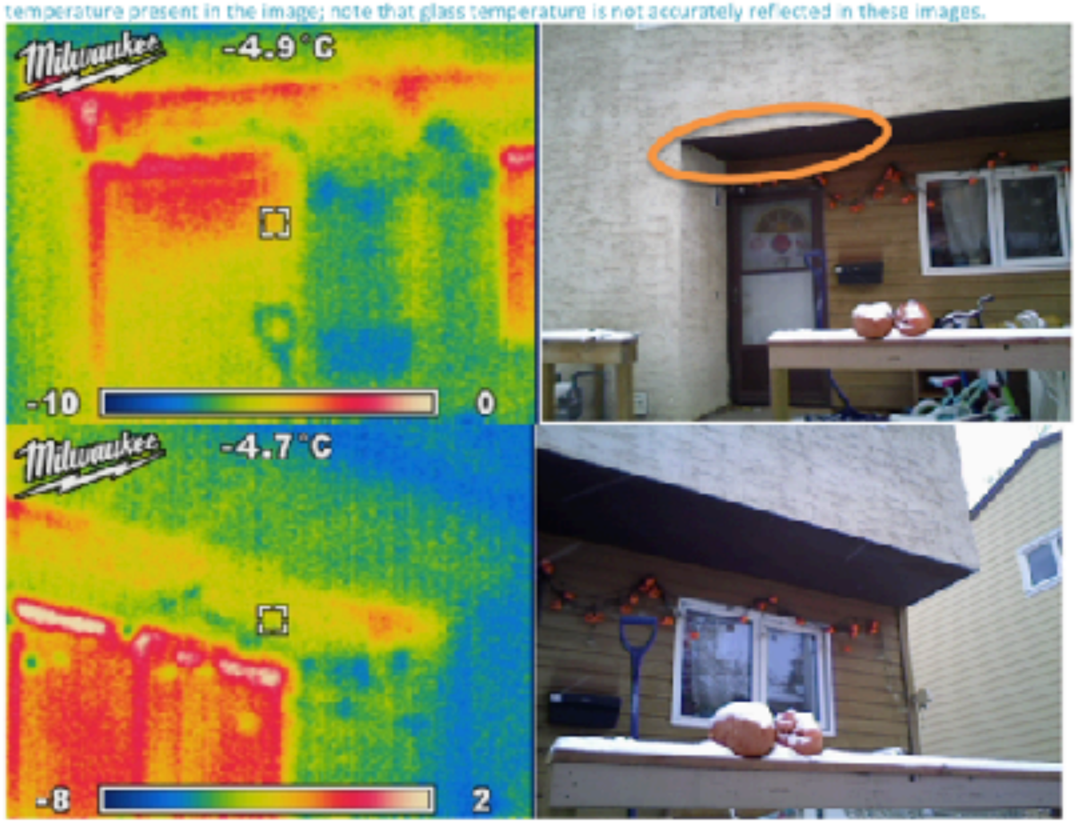


Figure 9: Infrared Thermal Images of Sundance Unit #15, taken just after sunrise on November 15, 2017. IR images shown on the left, with corresponding regular image shown to the right. The color legend represents the range in temperature present in the image; note that glass temperature is not accurately reflected in these images.

Figure 4: Screen capture of IES<VE> energy model representing the Sundance Housing Cooperative, plan view.

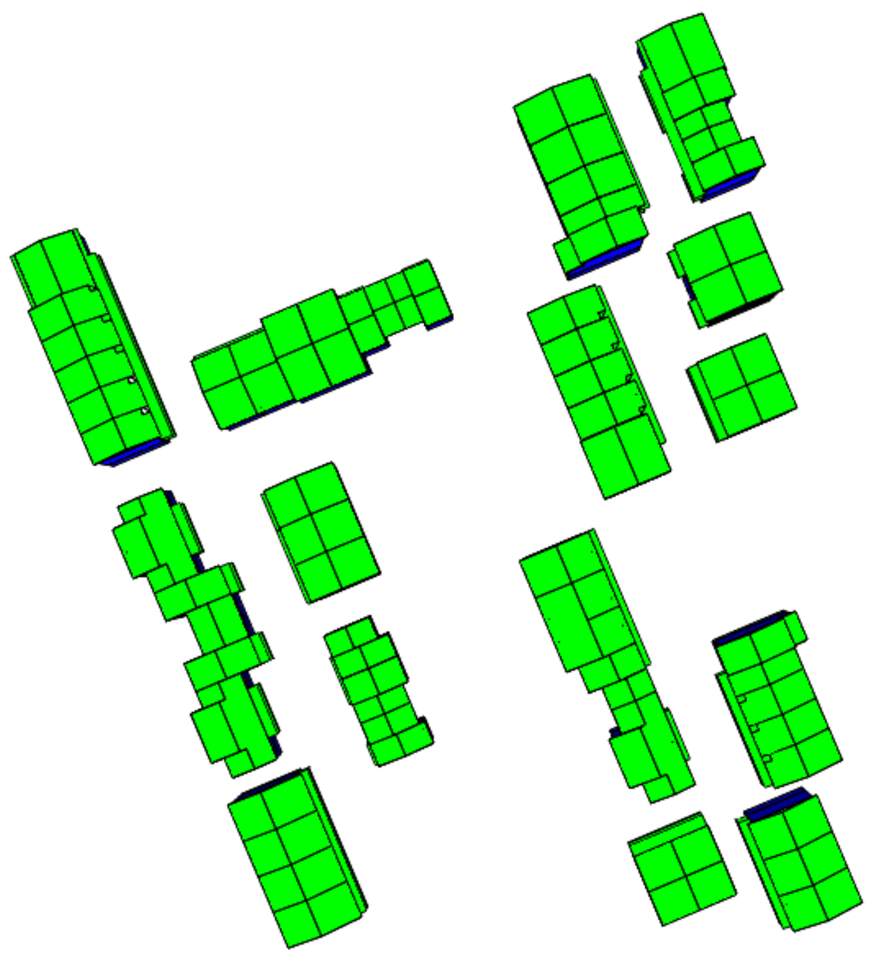


Table 1: Thermal description of the building envelope scenarios modelled as part of this Sundance BCA.

Sundance Housing Cooperative Building Envelope Scenarios				
Envelope Elements	Scenario #1	Scenario #2	Scenario #3B	Scenario #3A
Roof	R20	R60	R68	R68
Walls Above Grade	R13.6	R17.5	R42	R42
Foundation Walls	R1 + Contact	R1 + Contact	R1 + Contact	R20
Slab	R1 + Contact	R1 + Contact	R1 + Contact	R10
Exposed Floor	R12	R28.5	R28.5	R28.5
Windows	R2, SHGC:0.24	R2, SHGC: 0.24	R8, SHGC: 0.24	R8, SHGC: 0.24
Door	R1.2	R1.2	R7.5	R7.5
Airtightness (ACH@50Pa)	3.0	2.0	0.5	0.5
ERV Efficiency (%)	No HRV	No HRV	90%	90%

Our energy modelling has produced estimated peak heating and cooling load data for the Sundance site, shown in Table 2, as well as annual heating and cooling energy demand, shown in Table 3.

Table 2: Summary of estimated Sundance retrofit peak heating and cooling loads, using ASHREAE Heat Balance Method. Heating setpoint of 22°C, Cooling setpoint of 24°C.

Sundance - Avg Retrofit Heating & Cooling Load				
Scenario	Peak Load (BTU/h)		% Decrease in Peak Load	
	Heating	Cooling	Heating	Cooling
Scenario #1	37769	8141	-	-
Scenario #2	33618	7311	11%	10%
Scenario #3B	24399	5818	35%	29%
Scenario #3A	16309	5067	57%	38%

Table 3: Summary of estimated Sundance retrofit annual heating and cooling energy demand, from IES energy modelling. Heating setpoint of 22°C, Cooling setpoint of 24°C.

Annual Heating and Cooling Demand for Each Scenario				
Scenario	Ann. Demand (kWh)		% Decrease in Ann Demand	
	Heating	Cooling	Heating	Cooling
Scenario #1	1719108	12259	-	-
Scenario #2	1497241	10192	13%	17%
Scenario #3B	690119	8744	60%	29%
Scenario #3A	304354	9648	82%	21%

Our team has worked with Butterwick Construction and NüEnergy Systems to produce detailed capital cost estimates for the three proposed building envelope retrofit scenarios. This data is summarized in Table 4.

Energy

Energy Sources and Distribution

Energy Efficiency

Energy Resources

Energy Pipeline Projects

Mission Innovation

International Energy Cooperation

Funding, Grants and Incentives

Current funding opportunities

Current Investments

Green Infrastructure programs

Clean Growth Program

Sundance Housing Rehabilitation Project

Strategic Area

Energy Efficient Buildings and Communities

Status

Active

Partners

Butterwick Construction & Carpentry Ltd.

Fund

Green Infrastructure

Year

2018

GI Contribution

$ 2,500,000

Project Total

$ 5,350,700

Location

Edmonton, AB

Lead Proponent

Sundance Housing Cooperative

Project Objectives

This project will demonstrate a deep energy retrofit approach to 15 buildings (59 units) of a 1970s wood frame townhouse complex to achieve net-zero energy ready performance levels and develop the infrastructure to make retrofits commercially viable through a repeatable, modular retrofit process.

Project aims to accelerate the uptake of panelized prefabricated deep energy retrofits across North America by driving down costs, inspiring replication, and sharing the lessons learned as widely as possible.

Expected Results

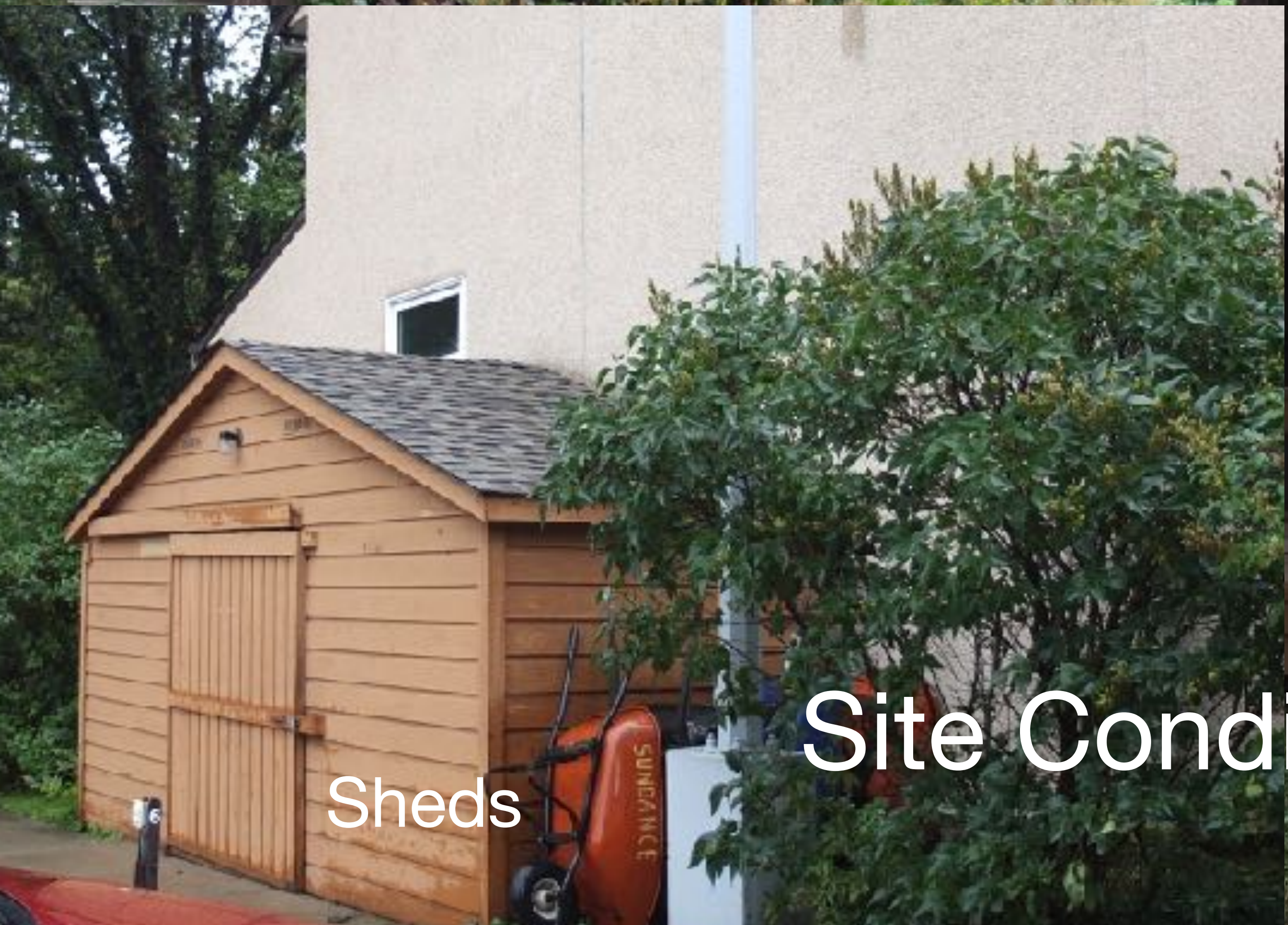
The building retrofits are expected to reduce GHG emissions and energy consumption by 70 to 80%, making the buildings net-zero energy ready.

The Project will contribute to building a retrofit economy by providing a business case for large-scale, cost effective deep energy retrofits that can be impl Screenshot anada.

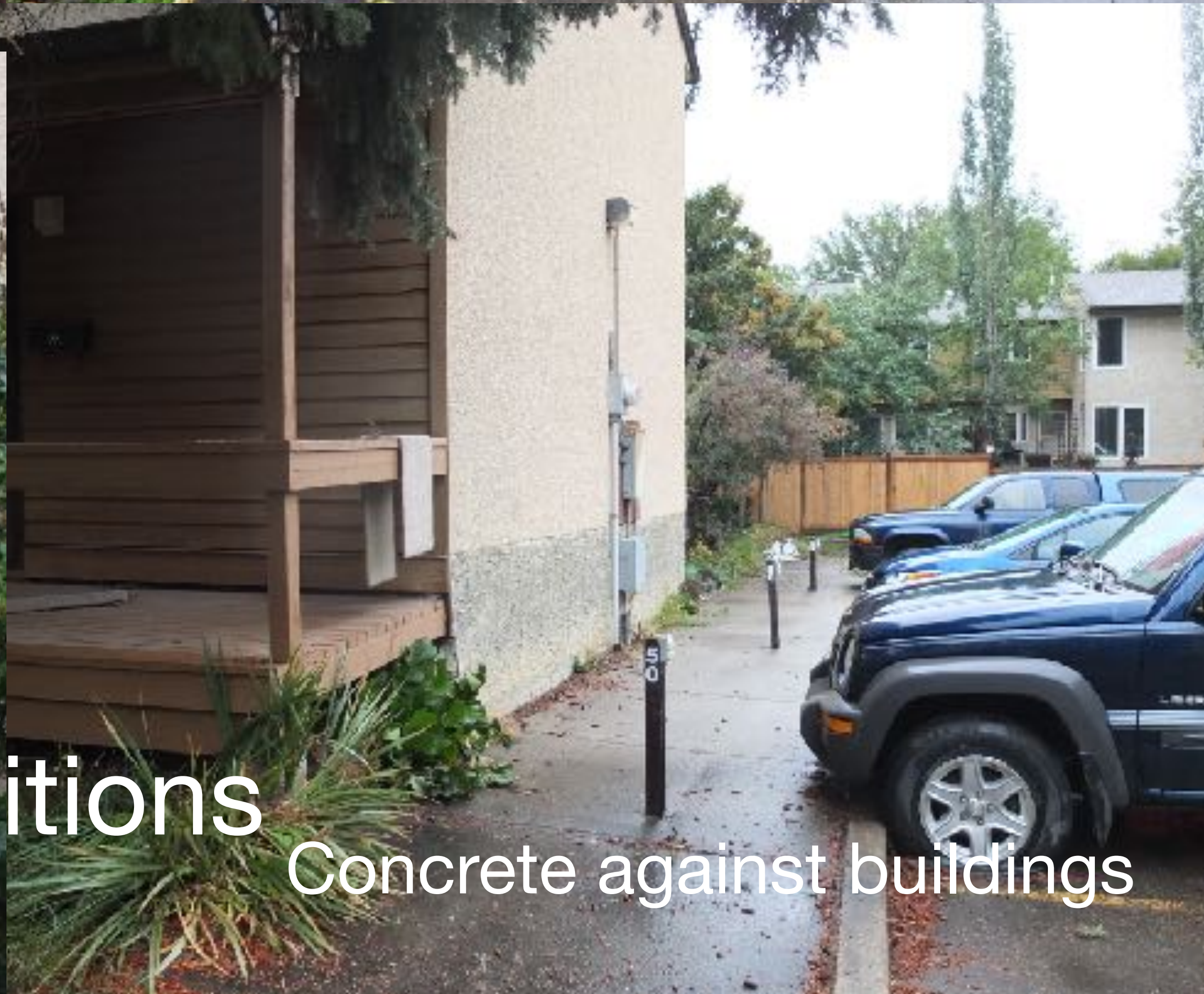
Site Conditions

Mature Landscaping

Fences



Sheds



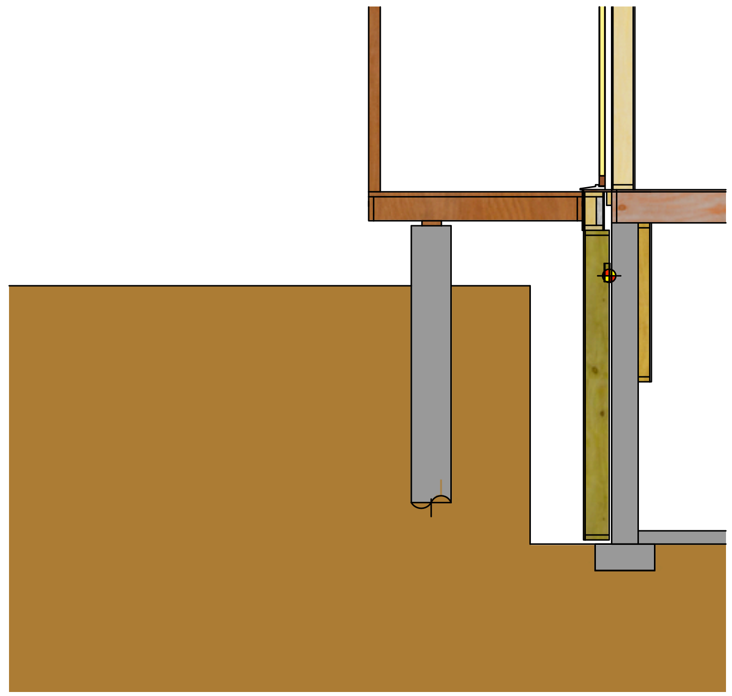
Concrete against buildings


Lower roof junctions
Tight jogs
Utility Connections
Porches
Vents and Hose bibs
Member built additions
Openings tight to inside corners
Cantilevers
Site Conditions

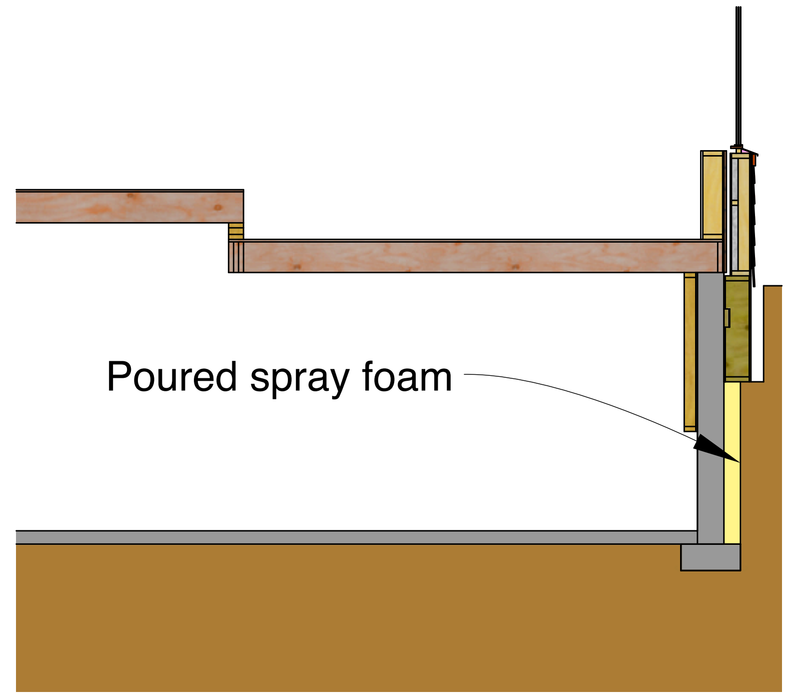
Before and After Specifications

	Before	After
Foundation Insulation	Partial (top 4') R10 (nominal) frost wall	Upper 2' - R 38: R30 panel support box beam plus original R8 (effective) frost wall. Lower 6'6"- R 25 EPS
Basement Slab	No insulation	No insulation
Wall insulation	2x6 16'OC with nominal R20 fibreglas -~R15 effective	R41 : Original wall plus new panel- minimum 8" of dense cellulose:
Ceiling insulation	R 28 Cellulose	R 78: Original R28 plus R50 in new scissor trusses
Windows	~ R3 (COG) PVC frames dual glazed argon filled	R 8.6 (COG) Firbreglass frames
Air tightness	6.5 ACH 50(average)	0.7ACH50 (envelope only, guarded, pressurized
Ventilation	None	Van EE G2400HE HRV
Heating	One mid, one high efficient gas furnace	Cold climate air source heat pump TBC
Hot water	Open vent gas hot water tank	AO Smith ASHP water heater

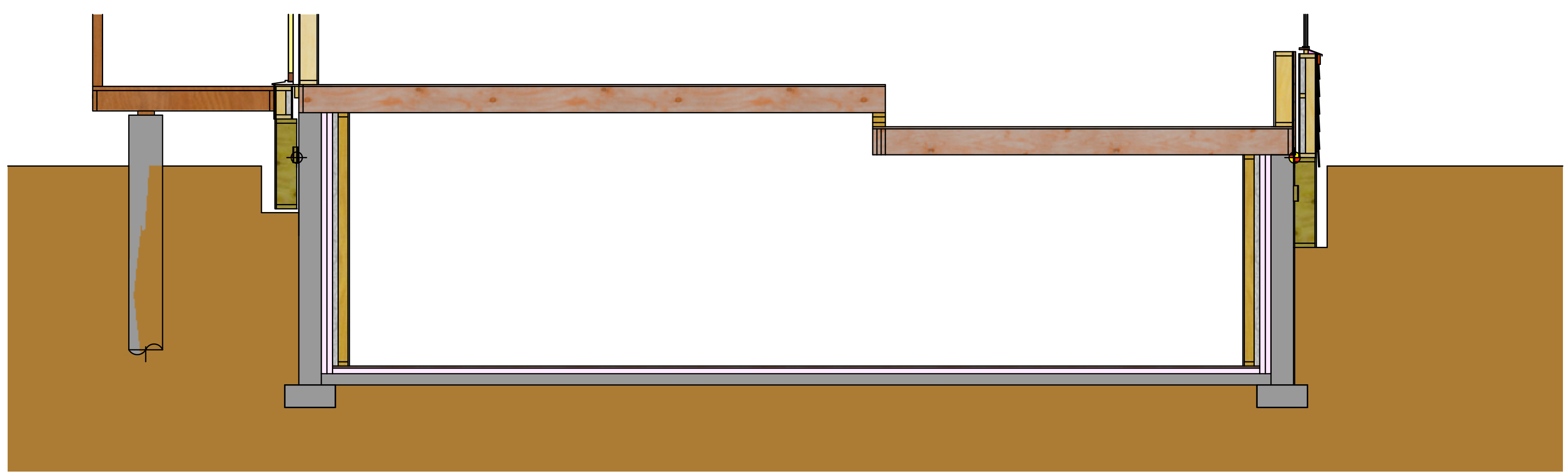
Foundation Options



Full Height 2x8 PFW Exterior Wall



Partial 2x8 PFW Exterior Wall
w/ Poured Spray foam Below



Inside R 35 Frostwall with R 10 Basement Floor Insulation

Cost Benefit Using Modelling Results*

Entire Retrofit

	Annual Heating Demand (kWh/a)	Cost
As built	1719108	
Scenario 3B from BCA #2	690119	$4,878,508.00
Reduction from 3B measures	1028989	
Cost per annual kWh saved		$4.74

Foundation Options

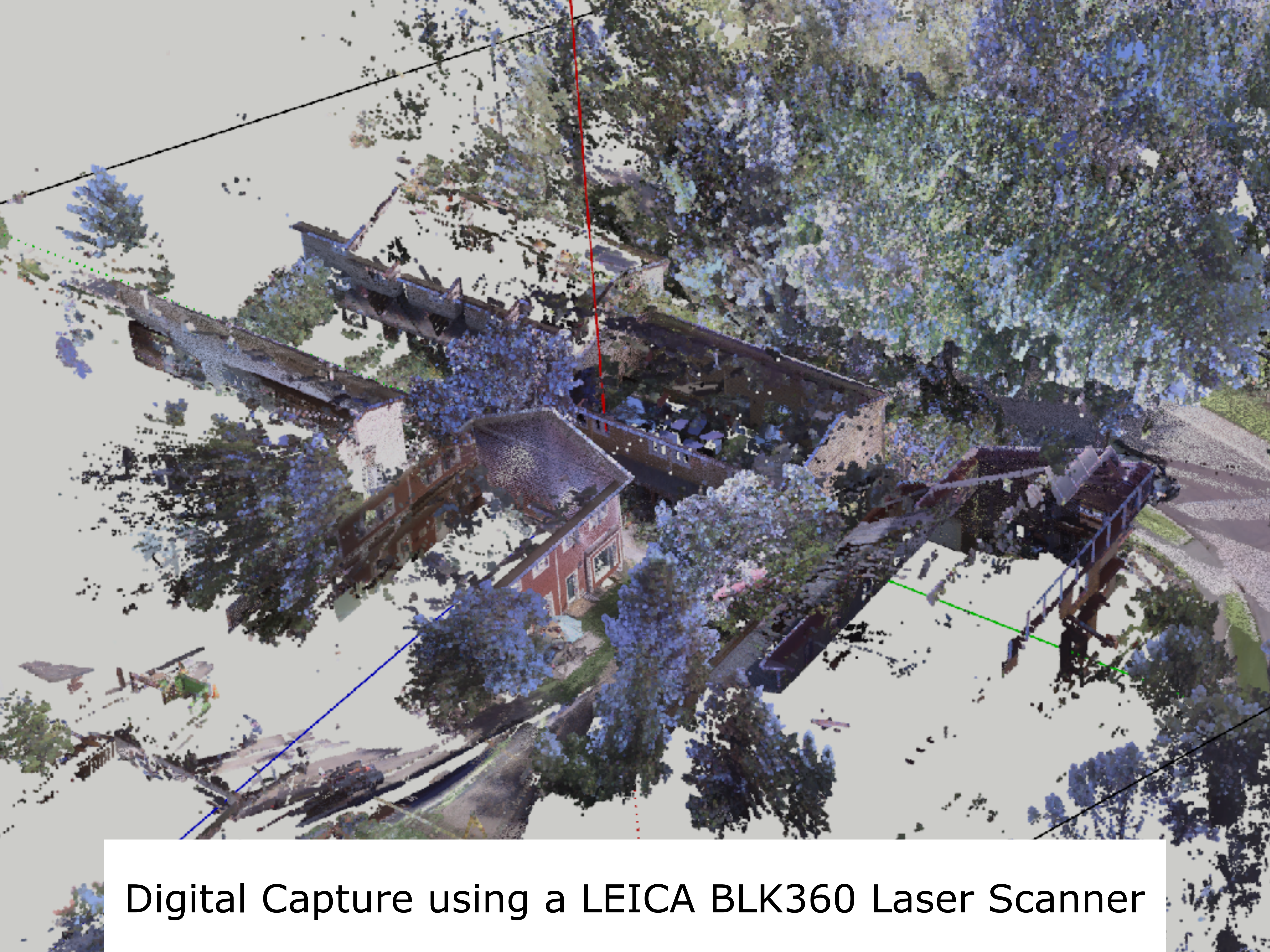
Scenario	Description	Annual Heating (kWh/a) Demand	Reduction from Scenario #2
1	As built	9557	
2	Energiesprong roof, wall upgrade including windows, 1.25ACH 50, No foundation insulation (kWh/a)	4146	5411
3	2 plus inside inside - wall only, 1.0 ACH50 (kWh/a)	2446	1700
4	2 plus outside insulation- wall only, 1.0 ACH50 (kWh/a)	2190	1956
6	Inside Wall Insulation R35 , Slab at R10 , No Thermal bridge (kWh/a)	1812	2334
	Annual Heating demand reduction from insulating the floor (kWh/a) (Scenario 4- Scenario 6)		378
	Cost difference to Insulate the floor (from BCA#2)		$5,250.00
	Cost per Annual kWh saved		$13.89

*From HOT2000 and IES>VE

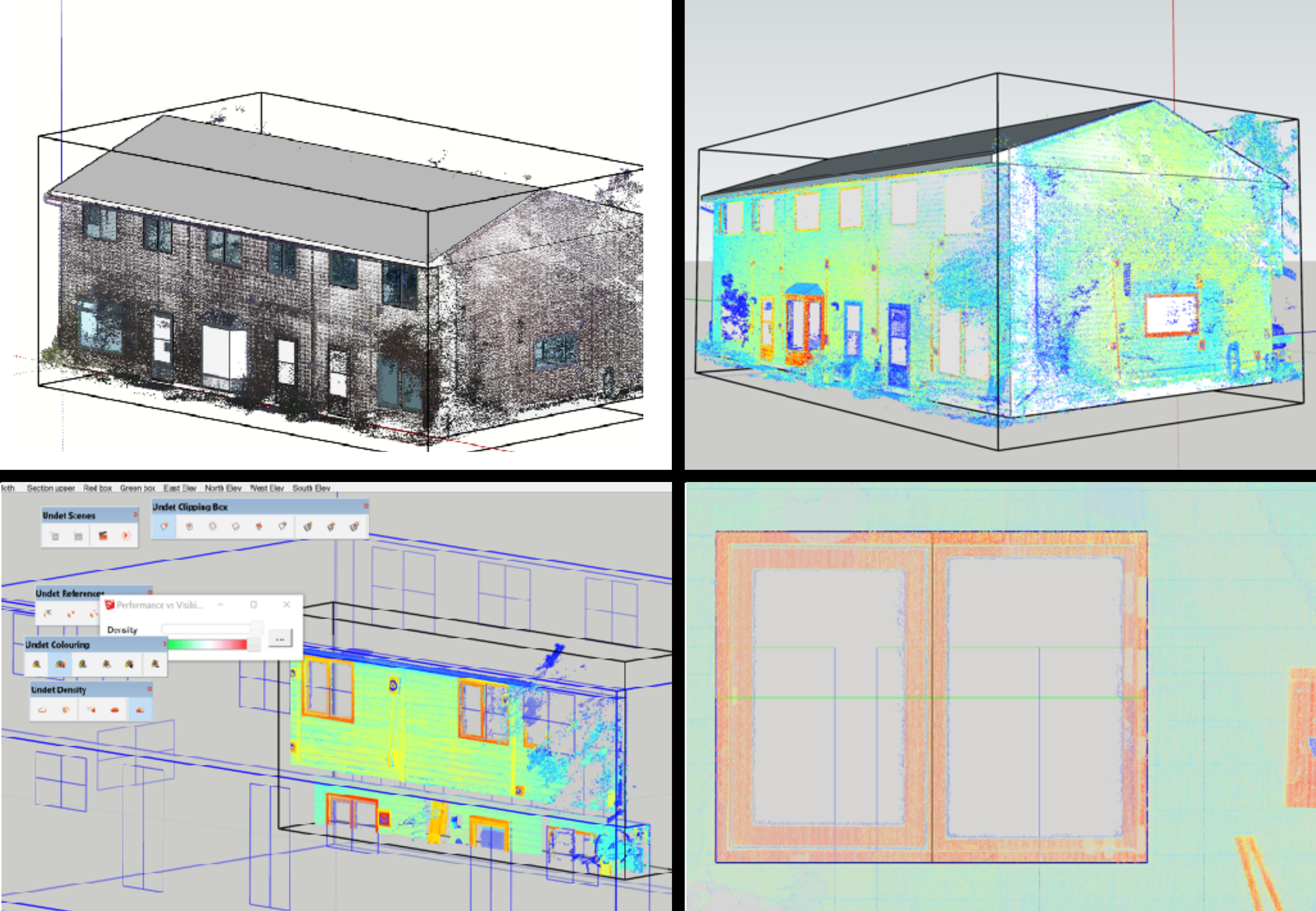
Fit

- Panelized Deep Energy Retrofits are a new, demanding kind of construction- not like a typical one piece at a time renovation and not like new construction.
- Panels that are built off site, weeks in advance, need to fit buildings that are not likely level, plumb or square.
- One small mistake can stop you in your tracks - you and your crew of 6 workers with a crane - negating the advantages of offsite construction.

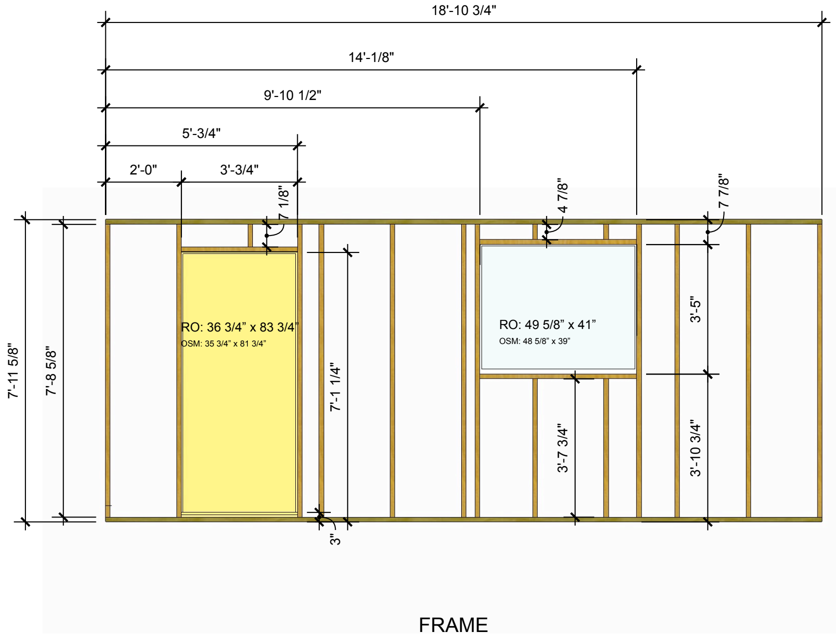
Digital Capture Using Photogrammetry



Digital Capture using a LEICA BLK360 Laser Scanner

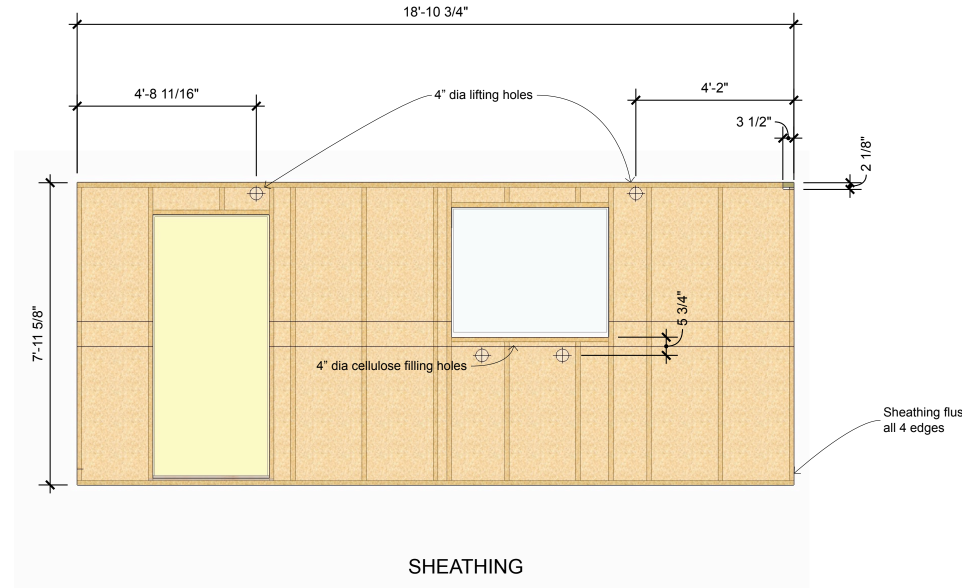


Geometry extraction using Undet point cloud software in Sketchup



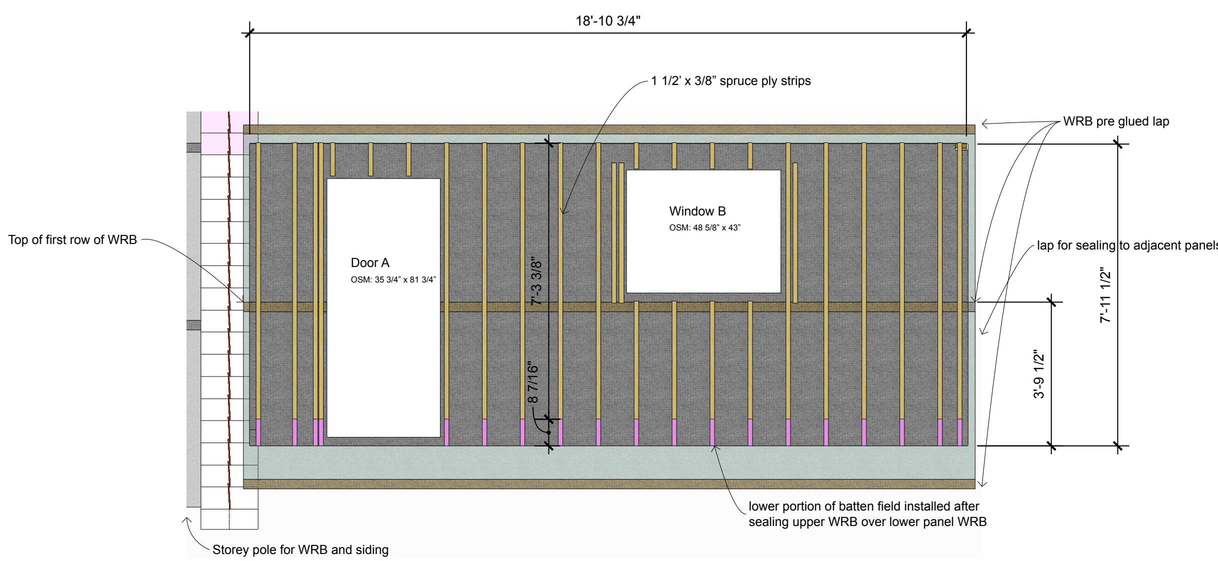
FRAME

NOTES:
1. Use 2x4 LSL lumber for top/bottom plates and window framing
2. Balance of lumber to be SPF 1/2



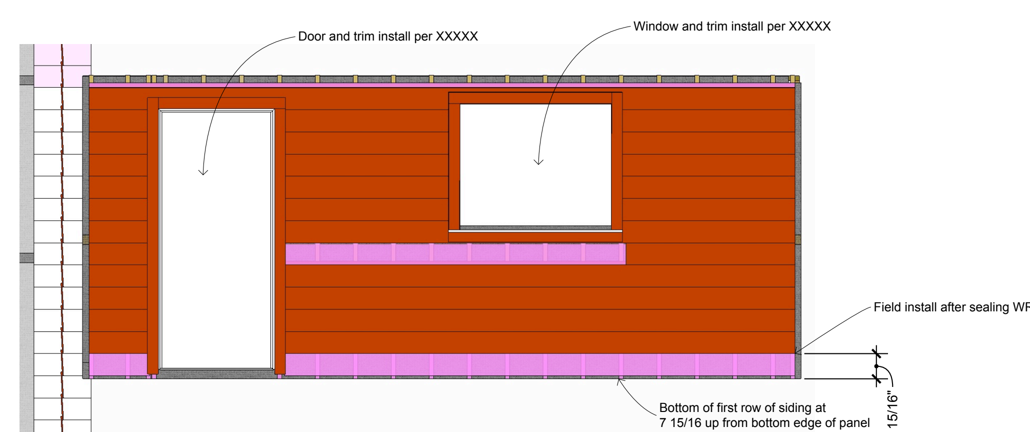
SHEATHING

NOTES:
1. 7/16 OSB Sheathing
2. Extra fastener within 3'-0" from lifting holes



WRB and RAINSCREEN BATTENS

NOTES:
1. WRB is Delta Vent S Plus with approved compatible tape
2. Do not install battens over lifting or blowing holes
3. Pink Coloured battens to be installed after panel installation and WRB sealing



SIDING and TRIM

NOTES:
1. Hardie 8 1/4' lap siding with 7" coverage
2. Siding to stay back 2" from corners
3. Pink coloured siding to be installed by others after panel installation

PANEL AREA

Gross Panel Area	Net Panel Area
150 ft2	115 ft2

Not for construction

Butterwick DESIGN. PLAN. BUILD.

5628-82 Avenue
Edmonton, Alberta
Tel: (780) 434-3559
Canmore: (403) 678-8160
www.butterwick.ca

SUNDANCE HOUSING CO-OP DEEP ENERGY RETROFIT

87 Street & 99 Avenue
Edmonton, Alberta
T5H 4B4

Sundance Housing CO-OP

Document Date:
August 17, 2019

Document Phase:
Panel pricing

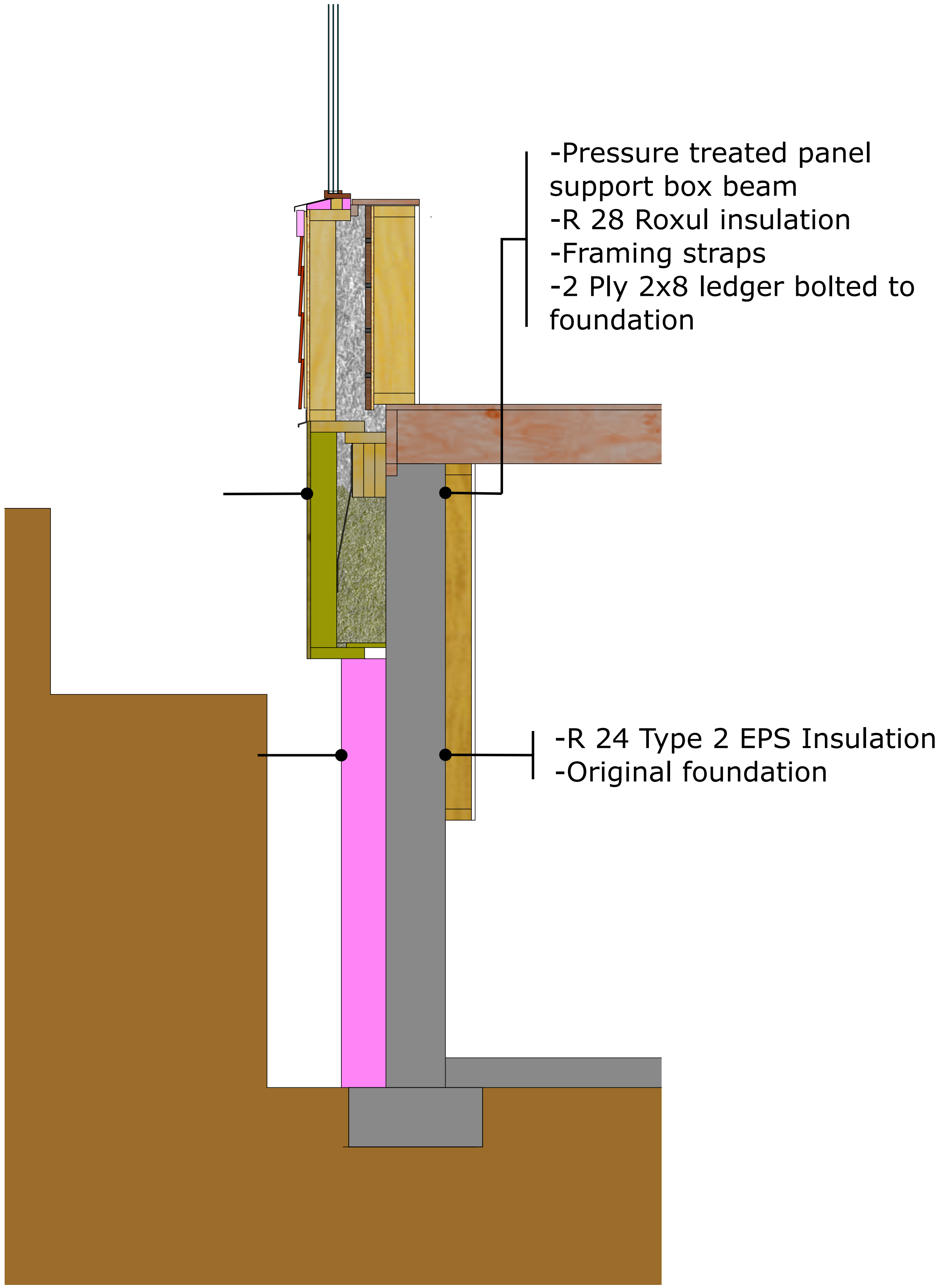
rev.	date	remark
1		
2		
3		
4		

Panel A7 LF

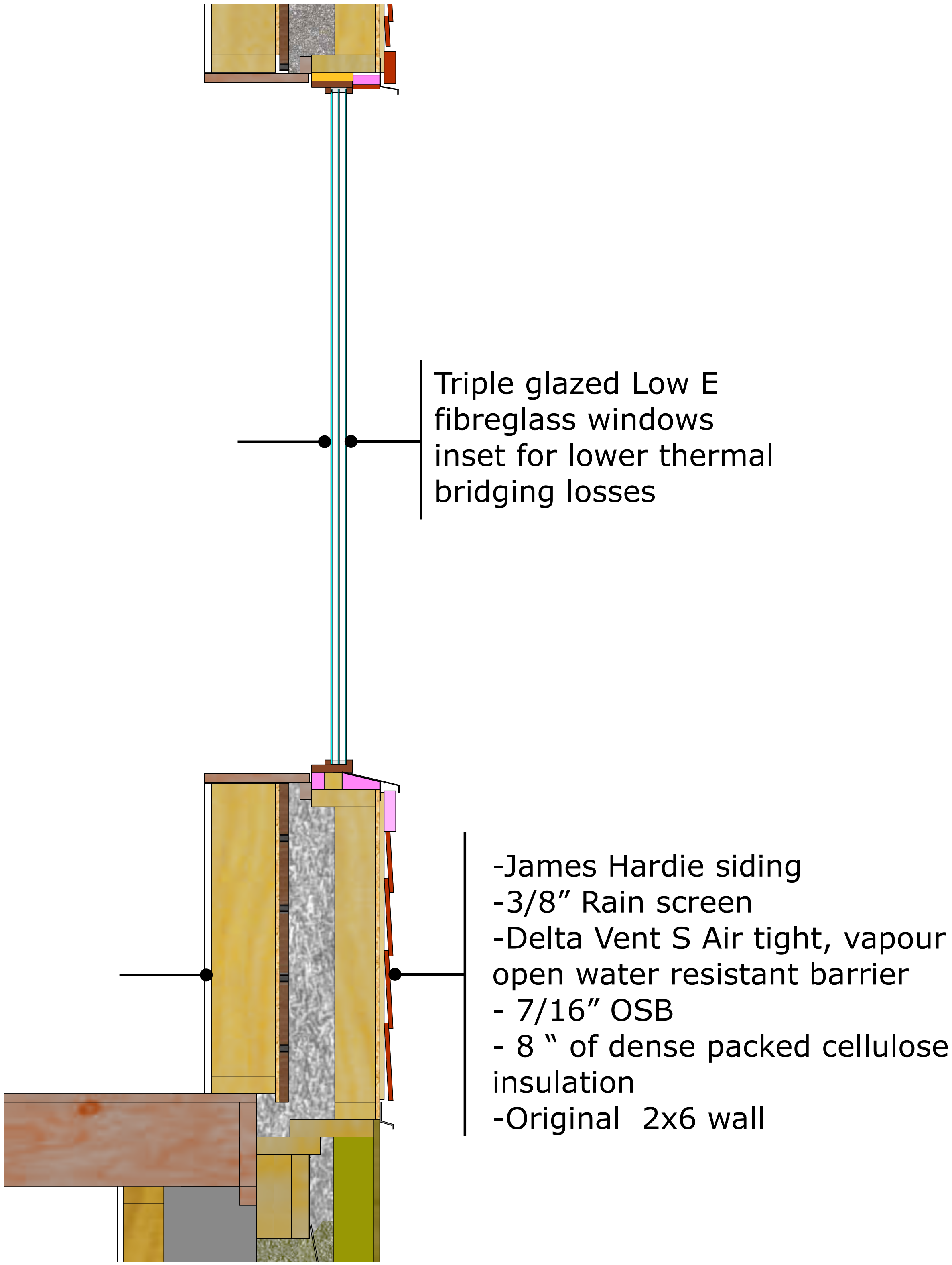
Scale: 1/2" = 1'-0"

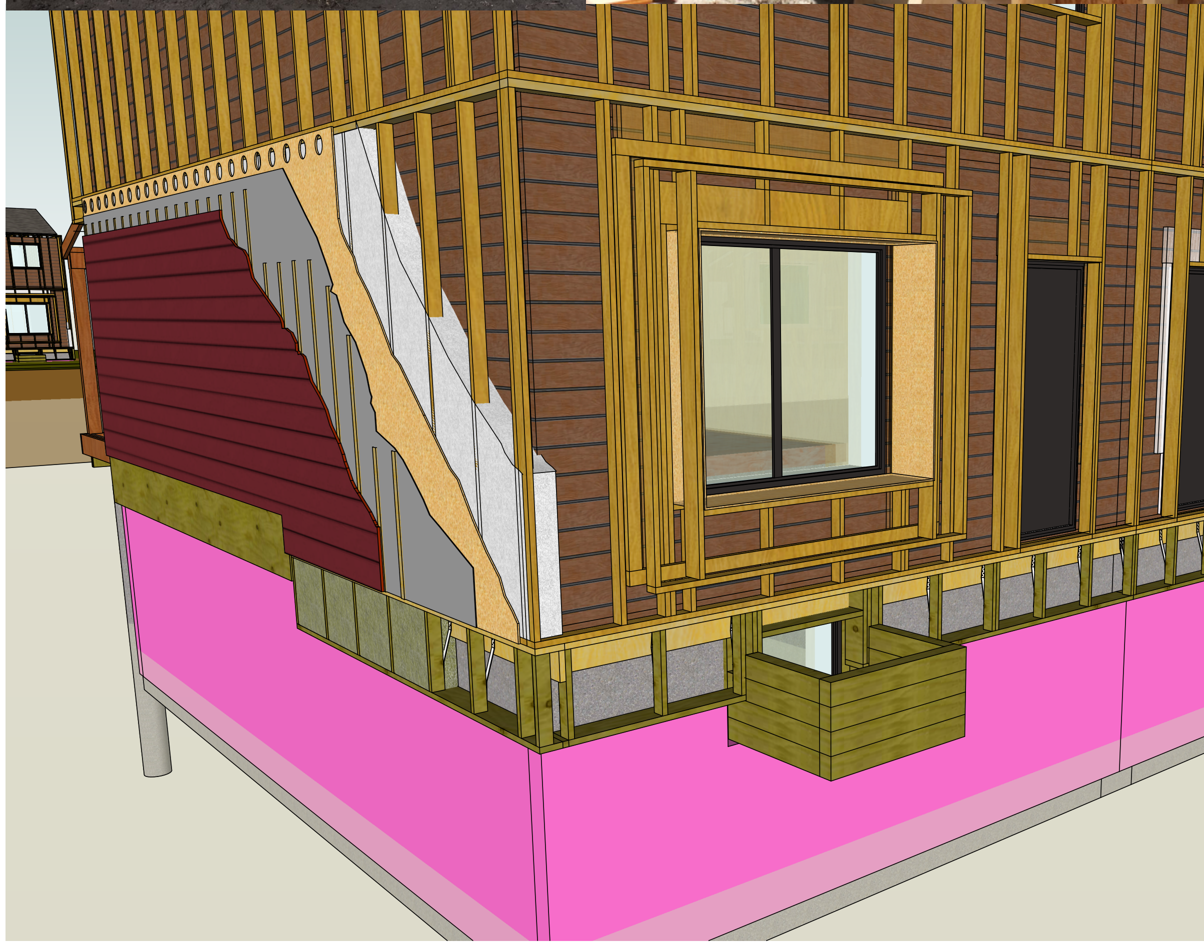
A3.3

Foundation


-Pressure treated panel
support box beam
-R 28 Roxul insulation
-Framing straps
-2 Ply 2x8 ledger bolted to
foundation
-R 24 Type 2 EPS Insulation
-Original foundation

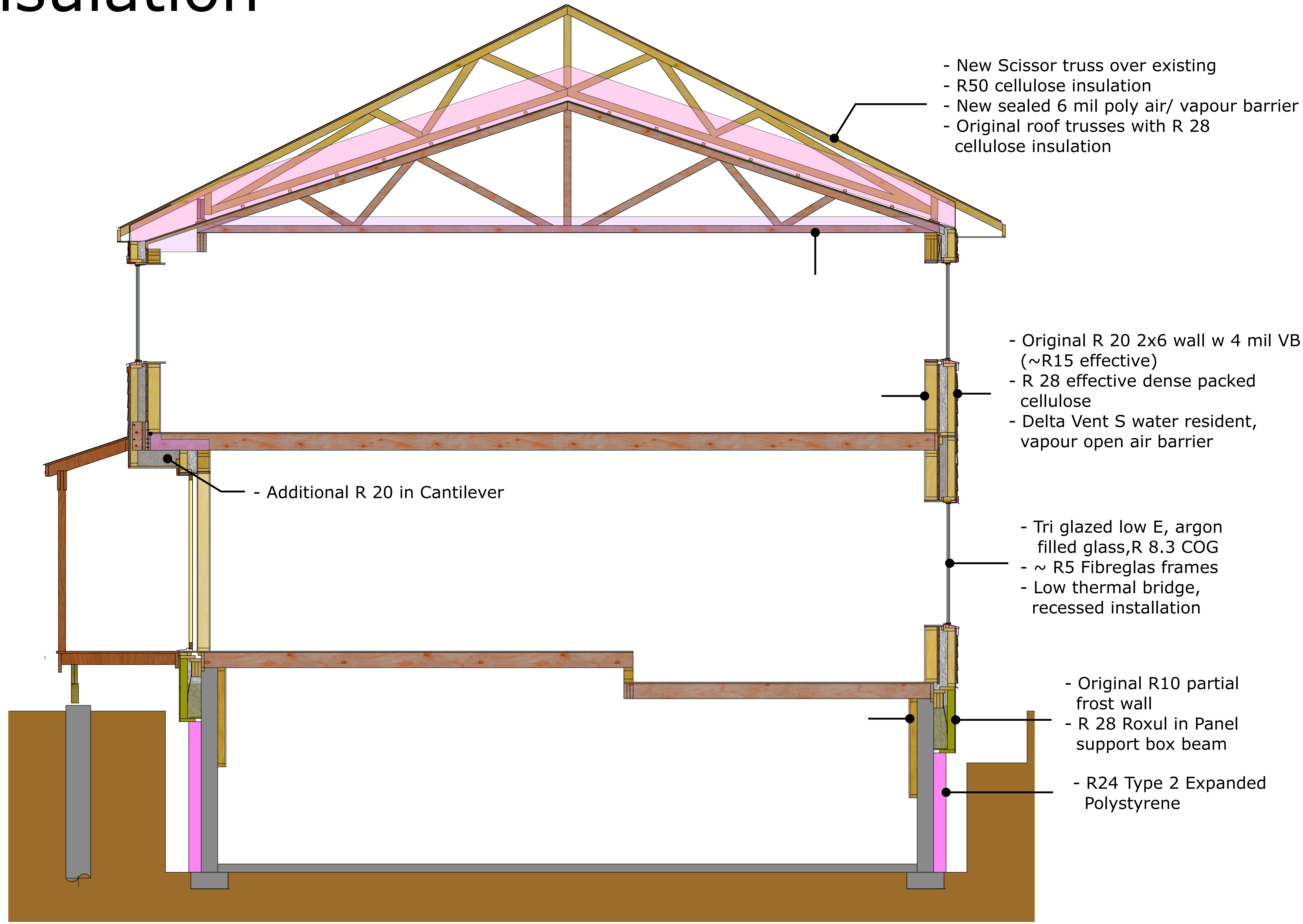
On Site Panel Construction





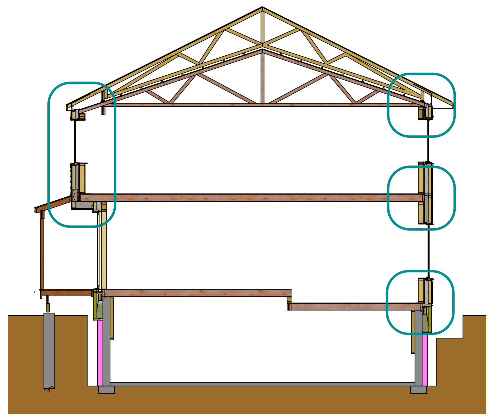

Panel Installation

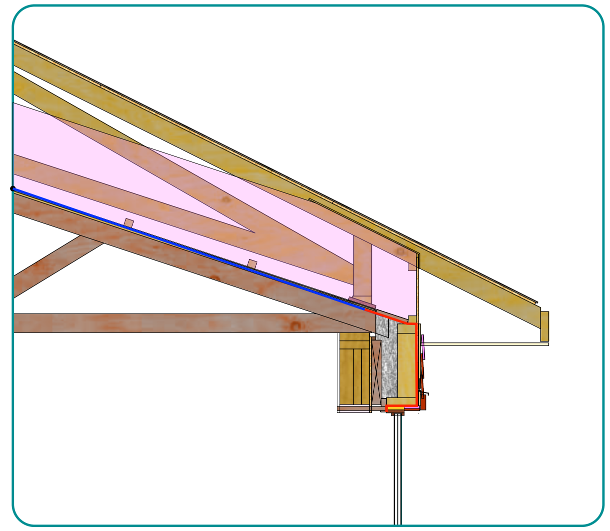
Insulation

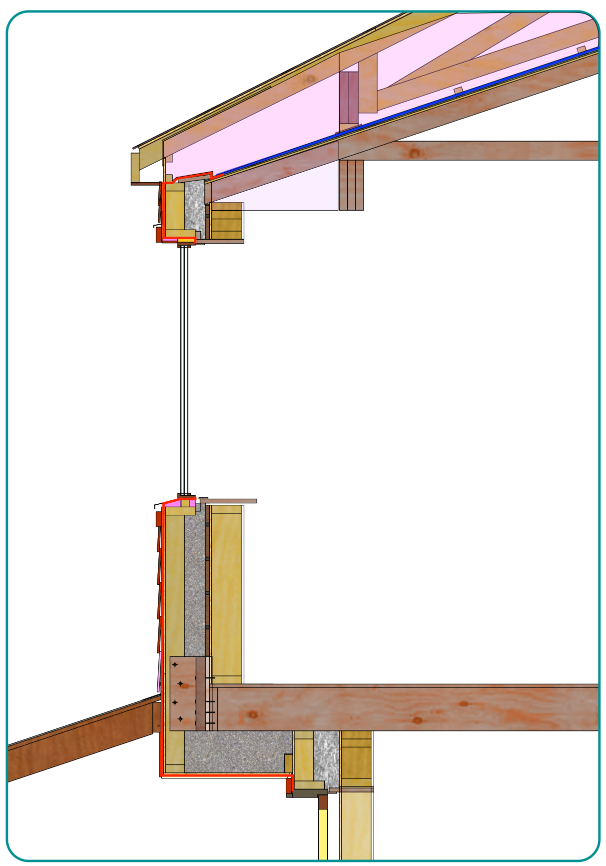


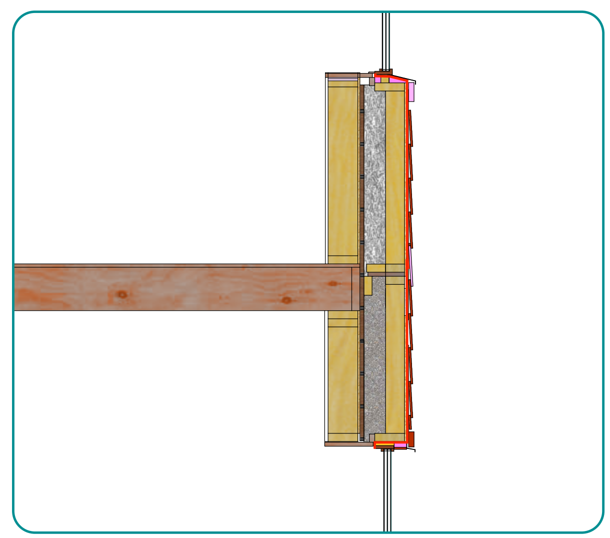
- New Scissor truss over existing
- R50 cellulose insulation
- New sealed 6 mil poly air/ vapour barrier
- Original roof trusses with R 28 cellulose insulation
- Original R 20 2x6 wall w 4 mil VB (~R15 effective)
- R 28 effective dense packed cellulose
- Delta Vent S water resident, vapour open air barrier
- Additional R 20 in Cantilever
- Tri glazed low E, argon filled glass,R 8.3 COG
- ~ R5 Fibreglas frames
- Low thermal bridge, recessed installation
- Original R10 partial frost wall
- R 28 Roxul in Panel support box beam
- R24 Type 2 Expanded Polystyrene

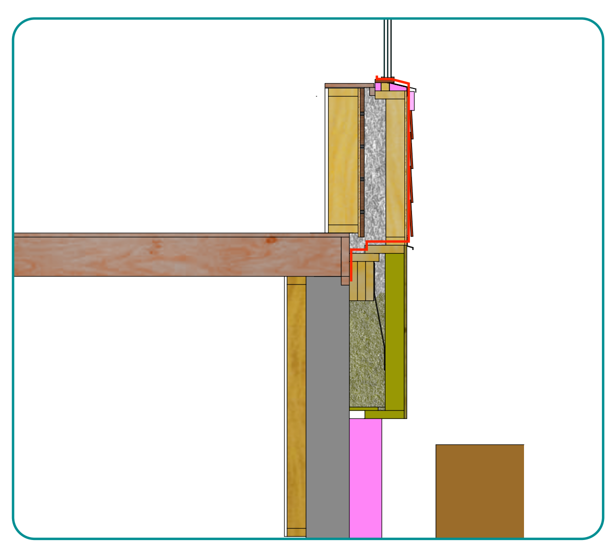
Air and Water Sealing







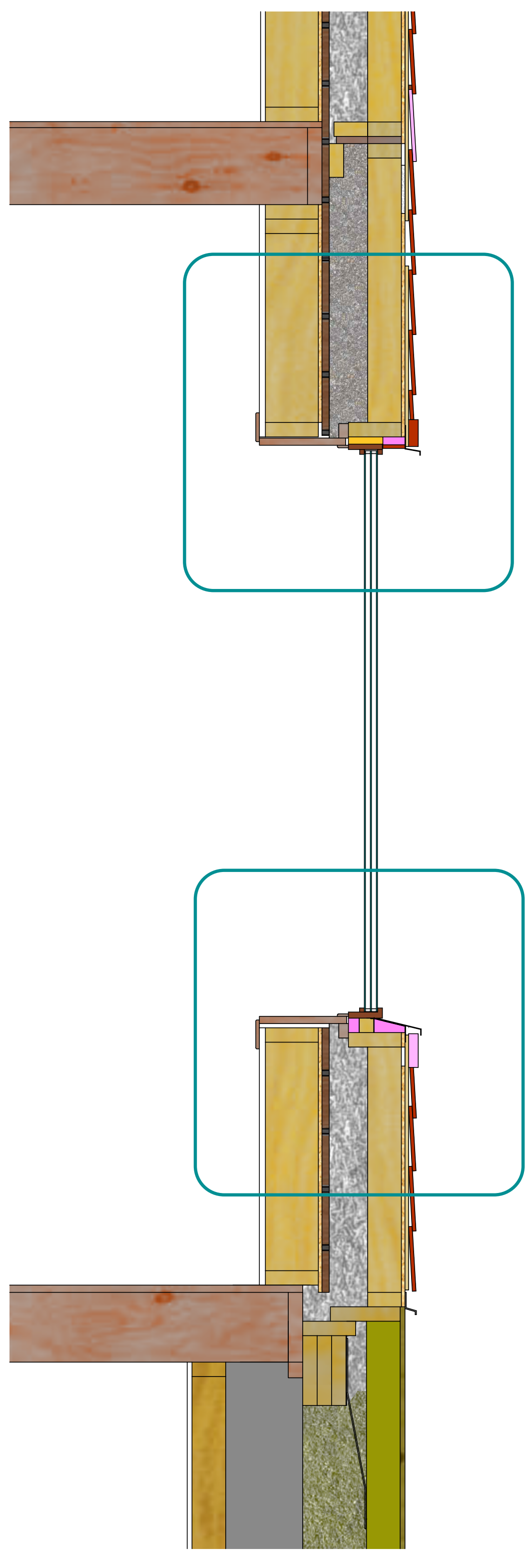


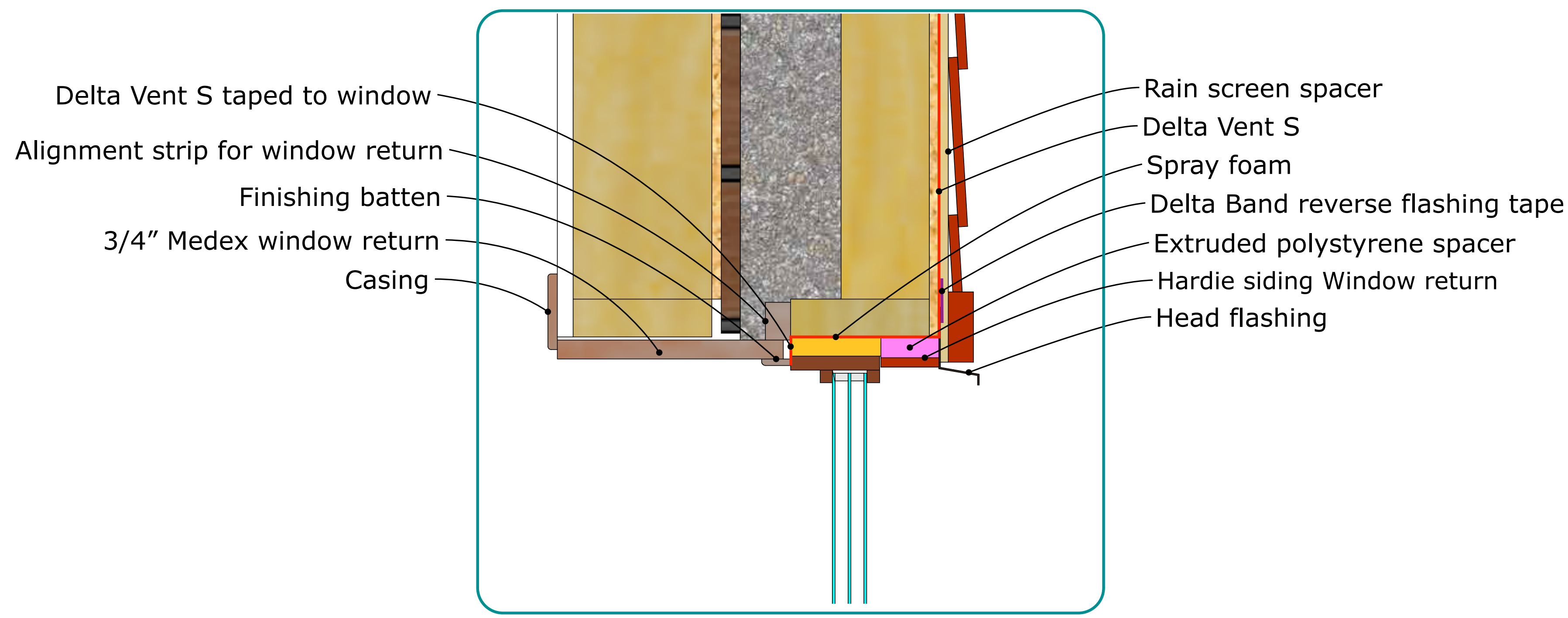


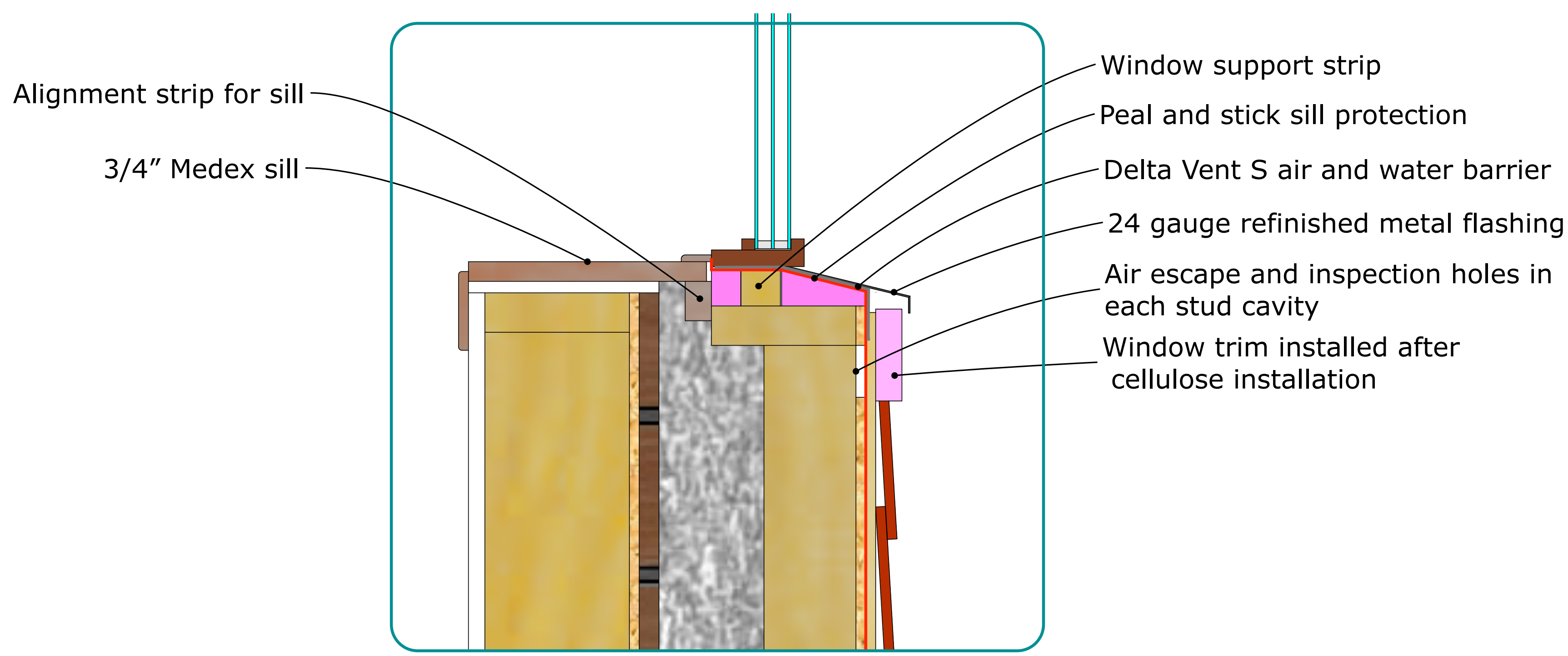
6Mil Poly Air/ Vapour Barrier

Delta Vent S Vapour Open,
Water Resistive, Air Barrier

Window Installation Details







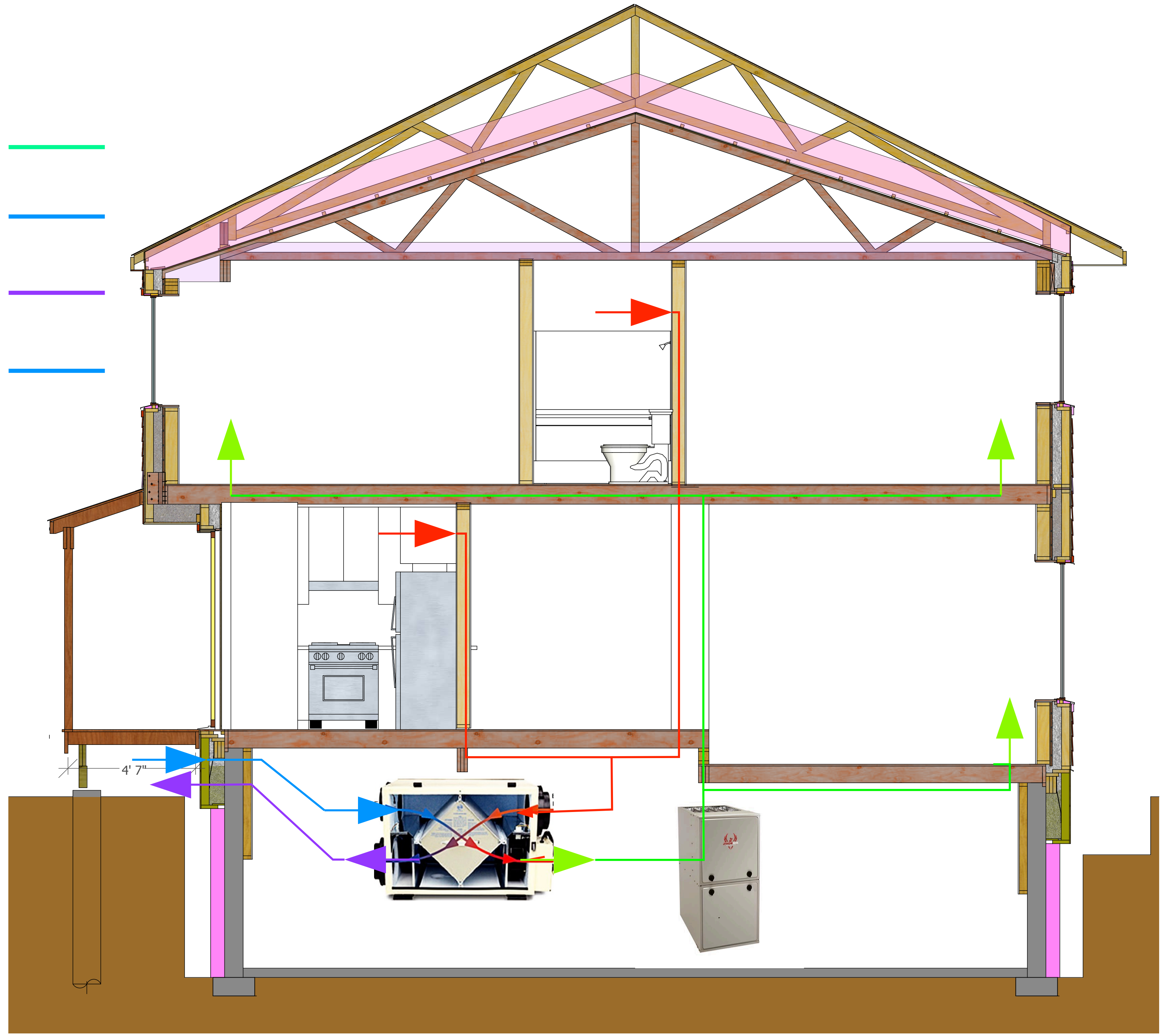
HRV (Heat Recovery Ventilator)

Warmed Fresh Air to Rooms

Stale Air from Kitchen, Bath

Cold Fresh Air to HRV

Cooled Stale Air from HRV



Electrification/Electrical Service Upgrade

- The plan is to abandon the natural gas lines and replace the gas furnaces with air source heat pumps.
- Panels currently have only 60 Amp service- need 100 or 125 Amp to run heat pumps and heat pump hot water tanks
- Will require new transformers, pedestals, conduit, conductors to meet the modern CEC
- Engineering is underway to determine lowest cost and best way to do this.
- Major obstacle in our critical path.
- Getting rid of the gas meters will save each unit ~$650 per year in service cost alone. (~$38,000/ year for the whole co-op)

Replacing Furnaces with Air Source Heat Pumps

- Indoor ASHP units will replace existing natural gas furnaces but use existing ducting for distribution.
- Two Options
  - One single phase Fujitsu ASHP per unit with an electric resistance backup to meet the load below -25^{0}C
  - One 3 Phase Diakin ASHP per 4 units not needing electric resistance backup. Would require a metering and billing system.
- Expected seasonal Coefficient of Performance (C.O.P.) of ~2.0 (i.e. 2 units of heat supplied for each unit of electricity used)


Air Source Heat Pump
Water Heaters
Smith

Costs

- The cost per unit for the two units in the pilot is roughly $120,000 per unit (CA$). To proceed with the other 57 units, our target cost is roughly $85,000 per unit (CA$).
- We have added Air Source Heat Pump space and water heating to the scope at a cost of $12,000 per unit (CA$).
- With offsite panel manufacturing, site efficiencies and economies of scale total cost per unit is sitting at $91,300

Budget Notes

- Had to create a number of new budget categories for Phase 2. The normal timesheets and cost codes are a poor summary of what we did and what actually needs to be done.
- Much more analysis is needed to separate the costs of the thermal upgrade from the cost of maintenance and replacement to support the contention that panelized DERs provide the long term total cost of ownership.

Panel Costs

- We’re a bit nervous that everyone else seems to be choosing foam based panels.
- We have gotten excellent pricing for our 2x4 panels fabricated in a low tech workshop.
- Panel costs are less than 15% of the total cost

People

- It cannot be understated how important it is to consider the impact on the people who will live through this transformation. Earning their tolerance and their trust is absolutely essential.
- Learning how to shorten and minimize disruption for the residents is as necessary as any technical or logistical details.
- The finished product needs to be beautiful and make life better, healthier, and more comfortable.

retrofit canada