



Shifting Gears: A Passive House Car Dealership in the Making

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PHI CPD Credits

PHNW conference seminars are approved
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https://service.passivehouse.com/en/profis/advanced_training

Project Background

- **Client:** The Scottsville Group
- **Building:** Car dealership and repair shop
- **TFA:** 1,500m² (16,000 ft²)
- **Location:** Red Deer, Alberta
- **Design Temp:** -29°C (-20°F)



The Client

- **Business:**

- Owns several dealerships: GMC, Buick, Nissan
- “Service + Value + Integrity”
- 50th anniversary of their GM store



- **Corporate:**

- PH aligns with Subaru environmental strategy
E.g. Partial Zero Emission Vehicles (PZEV)
- Inspired by Subaru of Indiana Automotive assembly plant
First zero-landfill factory in the U.S.

Project Requirements/Goals



- **Performance:**
 - Owner not environmentalist
 - Recognized importance of looking beyond BAU
 - Saw PH as a better way
 - “Important statement to the industry and the country [flowing from the land of oil and gas]”
 - Garrett Scott
- **Long-term benefits:**
 - legacy project that will cost us virtually nothing to heat and cool the building
- **Service:**
 - PH should not disrupt service – to customers or vehicles

Cold Climate Overview

- **Cold temperatures**
 - Every decision matters more
 - Airtightness has huge impact
 - Frost protection, (low) humidity become problematic
 - Design temps influence functionality of equipment
- **Product Availability**
 - No local manufacturer of cold climate products
 - Very few on EU market
 - Some EU companies won't export
- **Design:**
 - we walked a fine line to meet the targets

Ground Floor

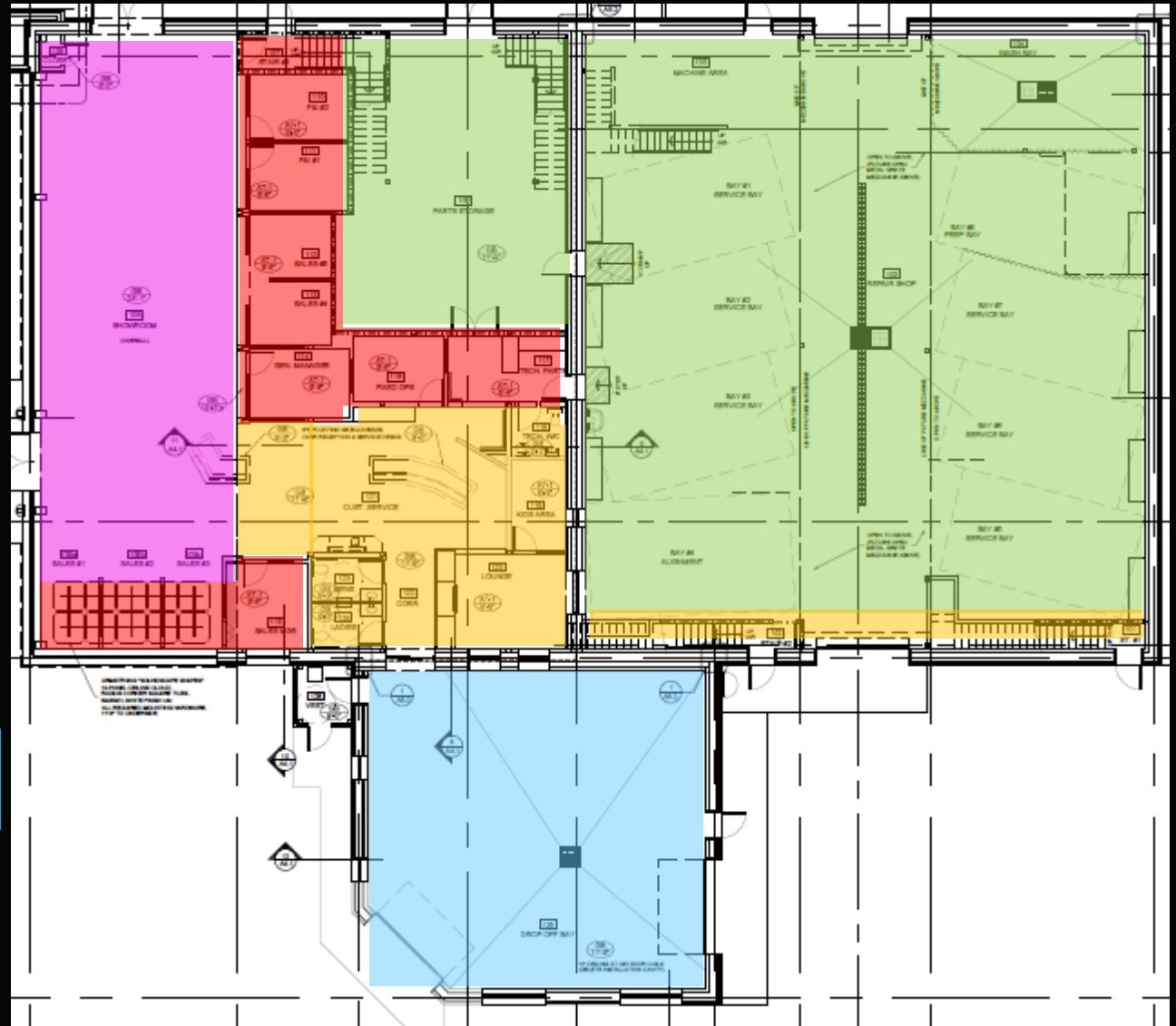
Showroom

Circulation/
Reception

Sales/Office

Service

Dropoff Area



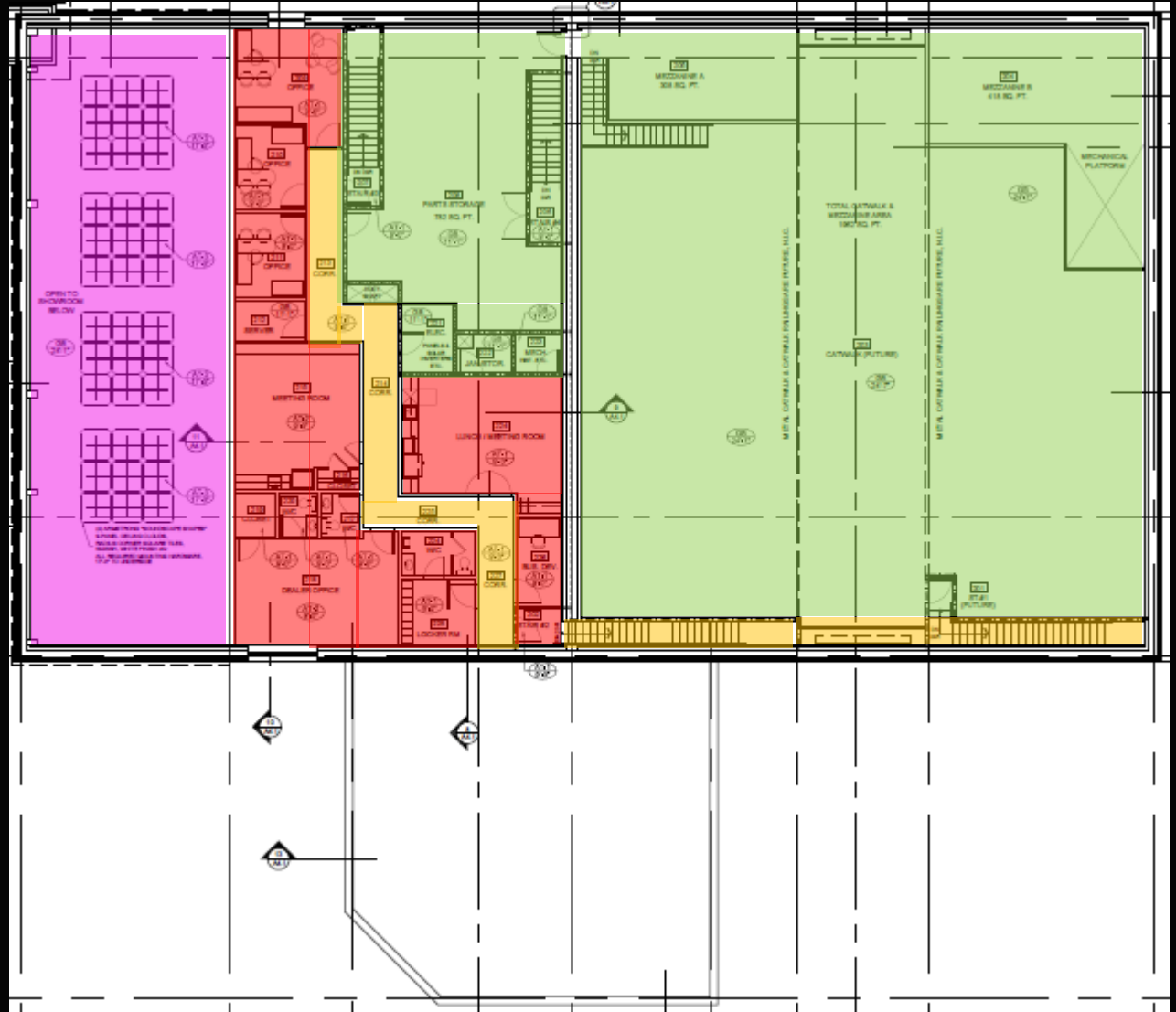
Second Floor

Double Height

Circulation/
Reception

Sales/Office

Service/Dlg Hgt



Building Design

- 2 storeys
- Typical Car Dealership aesthetic
 - Corporate image guidelines were non-negotiable
- Compact Form
- Highly glazed front facade
 - West: 55% (showroom: 65%)
 - Other: 1-17%

Southwest Facade



West Glazing

- Highly glazed façade must face West entrance
- Alberta is sunny!
 - 50% more West radiation than Germany
- Overhangs not permitted
(Corporate guidelines)



City	Hours
Calgary, Alberta	2396
Winnipeg, Manitoba	2353
Edmonton, Alberta	2345
Regina, Saskatchewan	2318
Saskatoon, Saskatchewan	2268
Thunder Bay, Ontario	2121
Hamilton, Ontario	2111
Victoria, British Columbia	2109
Ottawa, Ontario	2084
Toronto, Ontario	2066

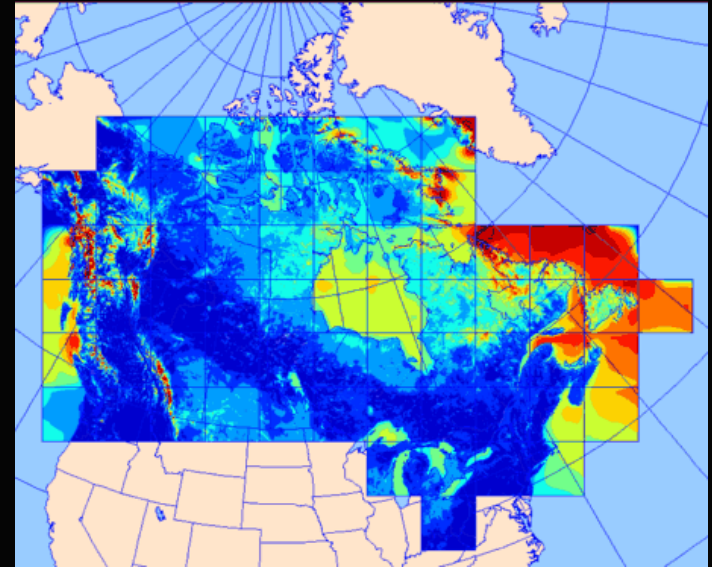
West Glazing

- Low amount natural shading
 - 1-2 storey
 - Low tree lines
- Tree Planting
 - Blocked too much sun – jeopardized space heating demand target



West Glazing

- Operable external Blinds
 - Too windy!
 - Up to 103 kph (64 mph) from West
 - Canada's windiest: St John's 137 kph
 - Toronto: 61 kph
 - Average doesn't matter for durability
 - Integration with tall curtain walls is difficult
 - Client concerned with aesthetics



West Glazing



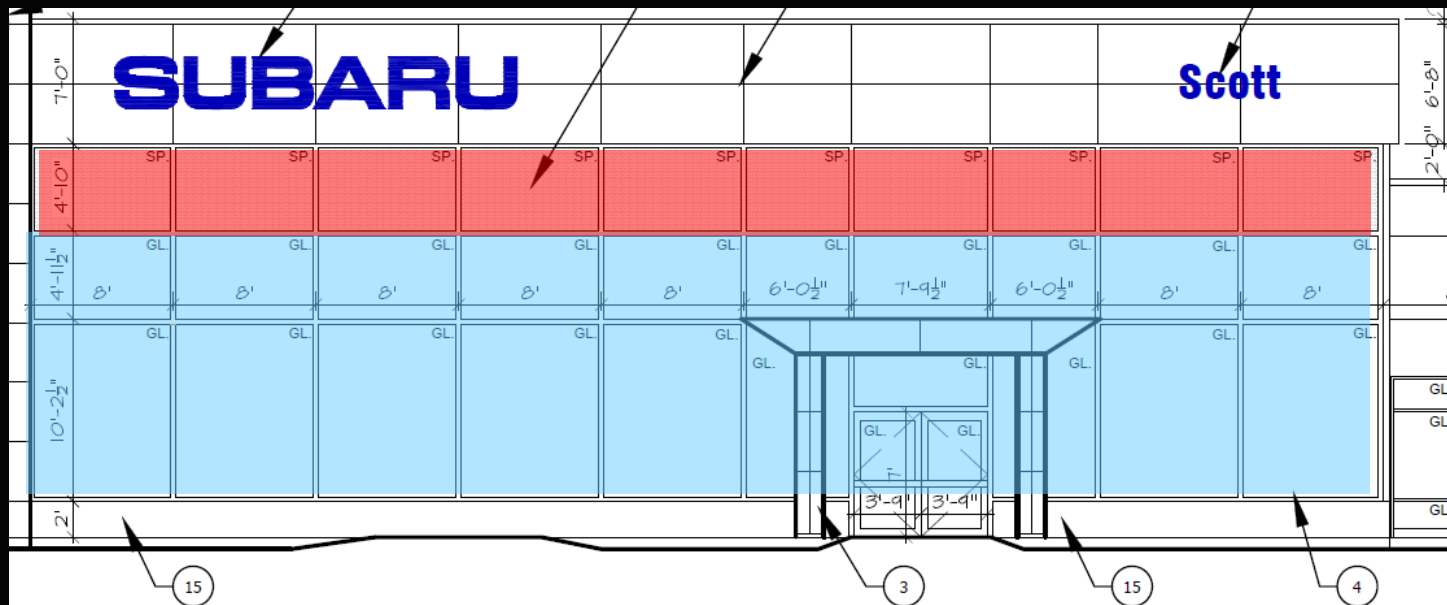
- **Electrochromatic Glazing**

- Expensive
- Solar characteristics not suitable for meeting space heating demand target or window comfort criteria
 - *SHGC: 0.09-0.41 max*
 - *$U_g = 0.8 \text{ W/m}^2\text{K}$ (0.14 Btu)*

West Glazing

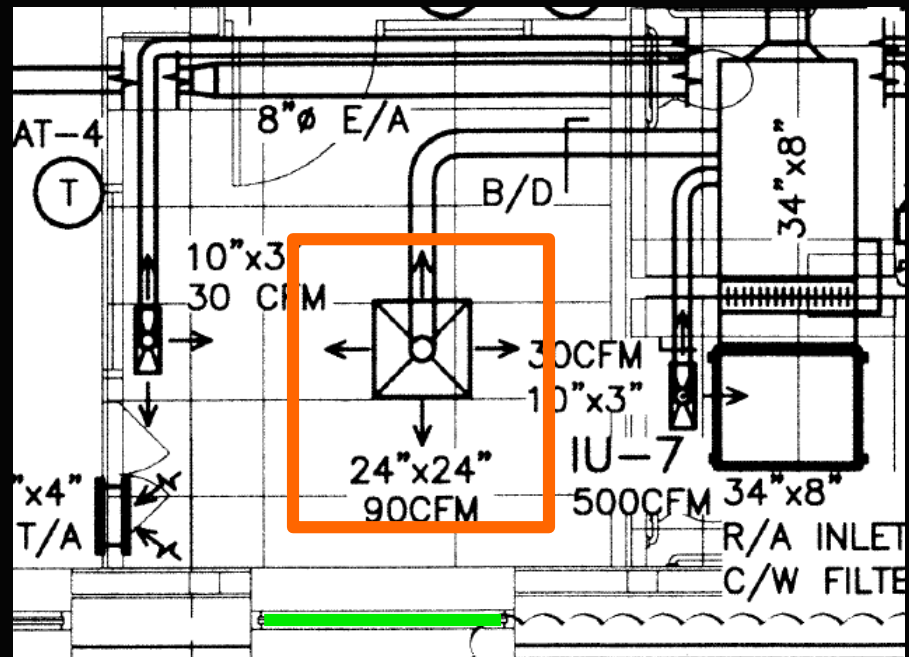
- Solution

- Automated operable internal blinds (with manual override)
- Insulated Spandrel panels in top row
- Deal with additional peak cooling load



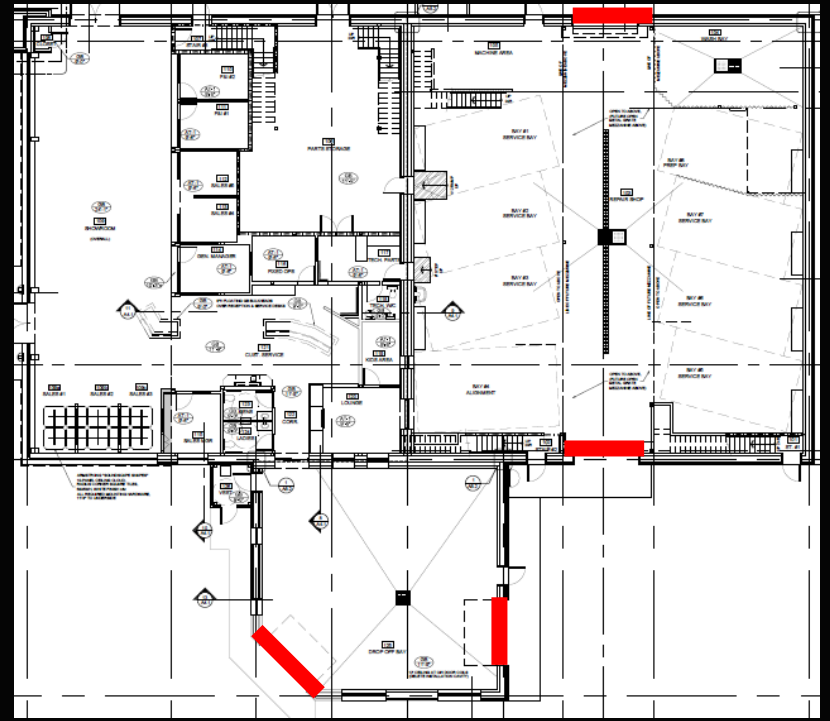
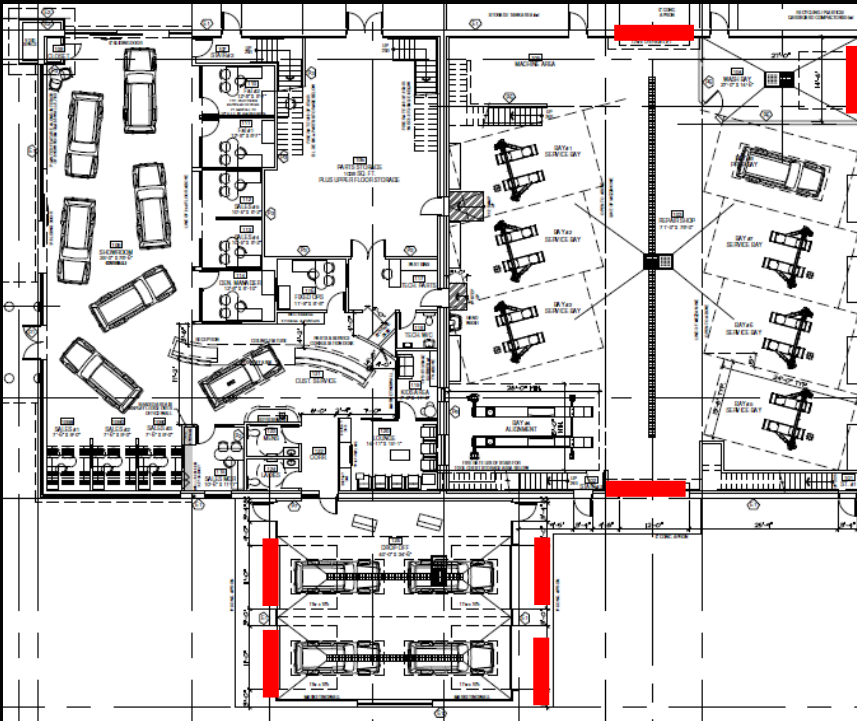
Windows

- Comfort Requirement: $U_{w,installed} \leq 0.61 \text{ W/m}^2\text{K}$ (0.11 BTU)
- Only one certified cold climate window available
 - Price was comparable to cool-temperate certified windows
- No certified cold climate curtain wall
- Relied on **window heating**
- Wicona series
 - C/W: Wicline 50HI
 - Windows: WL/WS 75 Evo
 - Doors: Wicline 95



Overhead Doors

- Initial Design had 7 doors
- We proposed designed that reduced to 2
- Client thought it would disrupt service
- Ultimately agreed to 4



Overhead Doors

- Initial concern over heat loss due to operation
 - Investigation revealed minimum heat loss
 - 15 m³/h/event (9 CFM)
- Greater concern was standby air leakage
 - 17% of transparent envelope (4% of wall area)
 - Conventional doors: no regards for airtightness
- Airtightness classification
 - Referred to EU system
 - Class 2 would increase AT by 0.08 ACH@50Pa
 - Whole Buildings Target is 0.4! (so 20%)
 - Best we could locate was Class 3 → increase by 0.04 (10%)
 - Manufacturer (Efaflex) could demonstrate performance



Overhead Doors

- Subsequently discovered that a Canadian-made door used on
- Initial investigation did not reveal a PH option from company



Wood Innovation Research Lab
- Prince George, BC



Internal Heat Gains

- Obtained Equipment List from Client early on
 - Impacts Heating & Cooling Demands and PER
 - 55% of IHGs in Repair shop

Item	Quantity	rating	Unit	Notes
Air Compressor	1	25	HP	Intermittant usage. Say 40% duty cycle during operating hours.
Tire Mounting Machine	1	800	W	Very intermittant, say 5% duty cycle during operating hours
Hoists	6	2200	W	Very intermittant, say 5% duty cycle during operating hours
Alignment Hoist	1	2200	W	Very intermittant, say 5% duty cycle during operating hours
Alignment Equipment	1	500	W	Very intermittant, say 5% duty cycle during operating hours

Internal Heat Gains

- **Temperature Difference**
 - Repair Shop and Dropoff: 18°C (64°F)
 - Showroom: 20°C (68°F)
 - Considered losses between areas
- **Heat gain (and loss) from car engines**
 - Cars brought in warm and cold
 - *Heat flows happened to balance out*
 - Cars engines run during repairs
 - *Exhaust reaches 650°F*
 - *14% of IHGs (could be more if long engine run time)*



M&E

Ventilation Systems

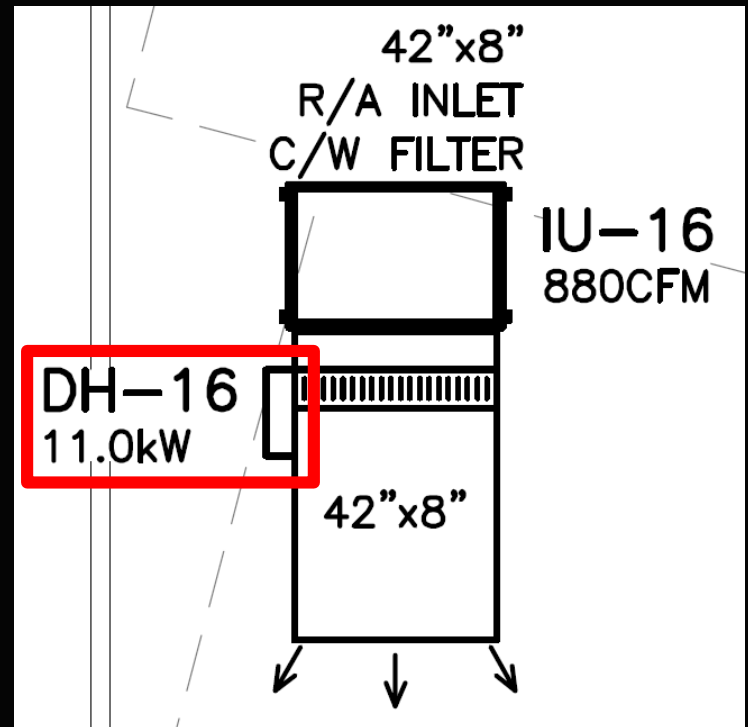
- Subaru does not produce diesel cars, but services them



- Separate car exhaust system required
 - Tubes clipped to car exhaust and direct vented
 - 2,400 CFM (400 CFM/service bay x 6 bays)
 - Normally, all bays are exhausted if only 1 bay requires exhaust
 - Convinced engineer to run each bay on separate extract fan

Heating & Cooling

- VRF system
 - Heads installed in suspended ceiling of corridors and ducted to each room
 - Considered residential model
 - Concern over longevity
 - Does not operate at winter design temperature
 - Requires electric backup



Heating System Capacity

Heating

- System size x3 more than conservative estimate of heating load (no gains)

Method	Heating Load (kW)
PHPP	13
PHPP w/o gains	21
Engineer	64

Cooling

- Different story
- Large West facing glazing problematic

Element	PHPP	Peak Day - Reasonable gains	Peak Day – worst gains	Peak 3 hours – worst gains
Solar radiation - West (W/m2)	235	235	235	909
interior shading RF	60%	60%	100%	100%
net IHGs	1911	4859	9215	9215
Peak Cooling Load (kW)	10.7	15.4	24.3	52.9

Engineer's Calculation: 57

DHW

Showroom

- Low demand – handwashing
- Supplied by Sanden CO2 heat pump



Repair Shop

- Each car is washed after maintenance work
- 2020 L/day @ 60°C equiv
(530 gal/day @ 140°F)
- On-demand gas heater was only option
- Large PER impact
 - 34 kWh/m²/yr (11 kBtu/ft²/yr)

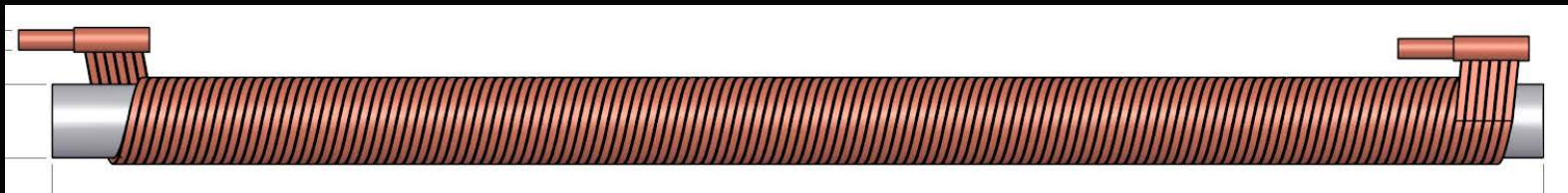


Heat Recovery & Extraction

- Investigated numerous options for heat recovery from car exhaust system
 - HRV
 - Tube in tube
 - Wrap around coil
 - Heat pipe
- None were workable
- Considered earth tube or ground loop
 - 2400 CFM – large capacity would be required
 - Average ground temperate = 4°C (39°F)

DHW heat recovery

- Car wash load was good candidate for heat recovery
 - High volume
 - High temperature (76°C)
 - Frequent use
- Initially identified horizontal shower-type unit
 - Company stopped manufacturing (trade issues)
 - Was willing to create custom unit, but eventually abandoned it
- Eventually settled on vertical unit installed horizontally
 - 10 ft long



Summary

- Think through the details early
 - Estimate equipment & occupant loads
 - Identify all energy flows
 - Not everything is predictable → add some buffer
- Cold Climates demand everything you've got
 - Simplified approach is critical
- Find engineers who are willing to explore options
- Cold climate product innovation required
- If you like a challenge, design a Passive House car dealership in a cold climate

Questions?

Thank you for your attention



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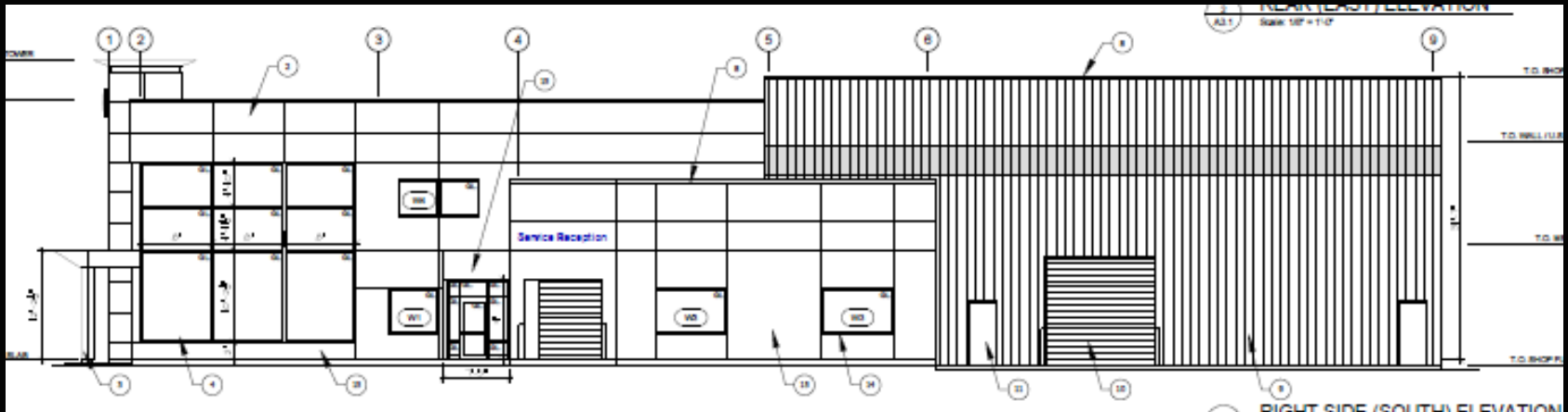
e: andrew@peelpassivehouse.ca

w: peelpassivehouse.ca

Additional Slides

Internal Heat Gains

- Repair shop has high Internal Heat Gains
 - 6.5 W / m^2 (0.6 W / ft^2)
 - Solar gains not beneficial



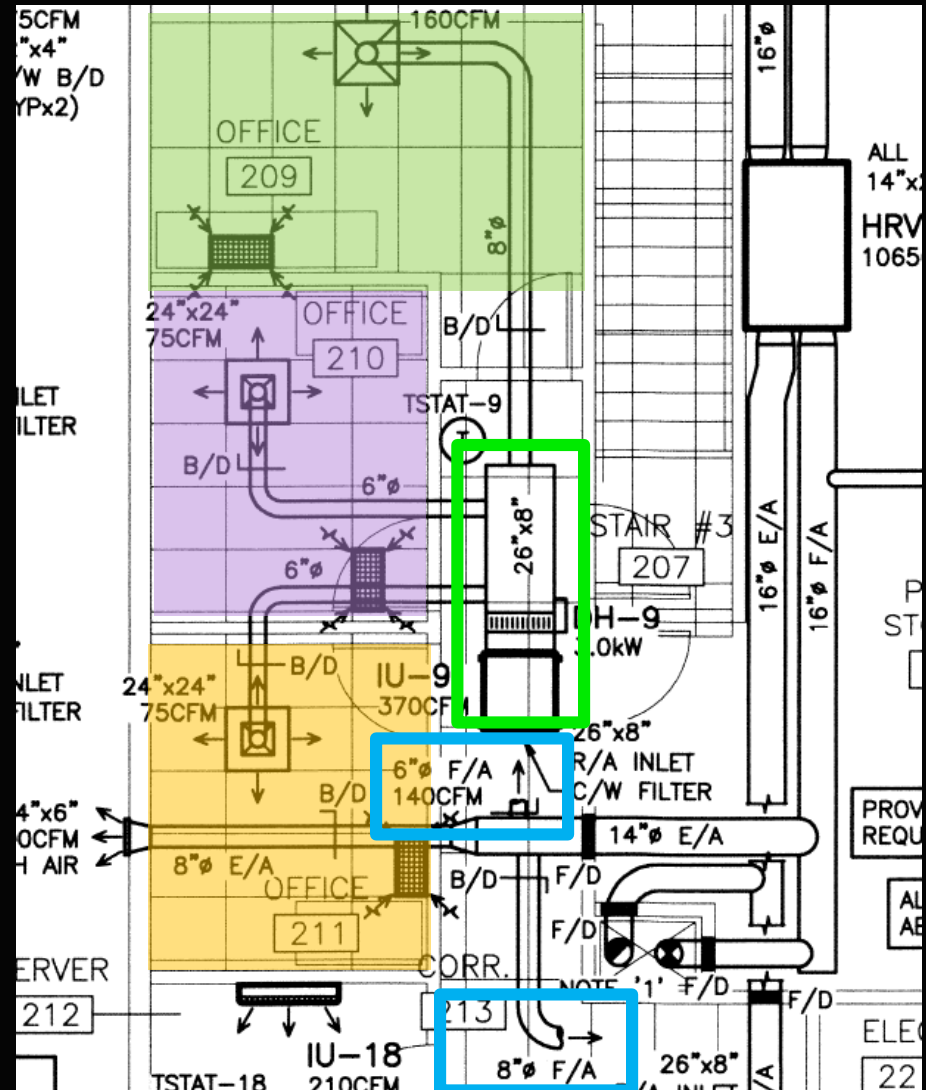
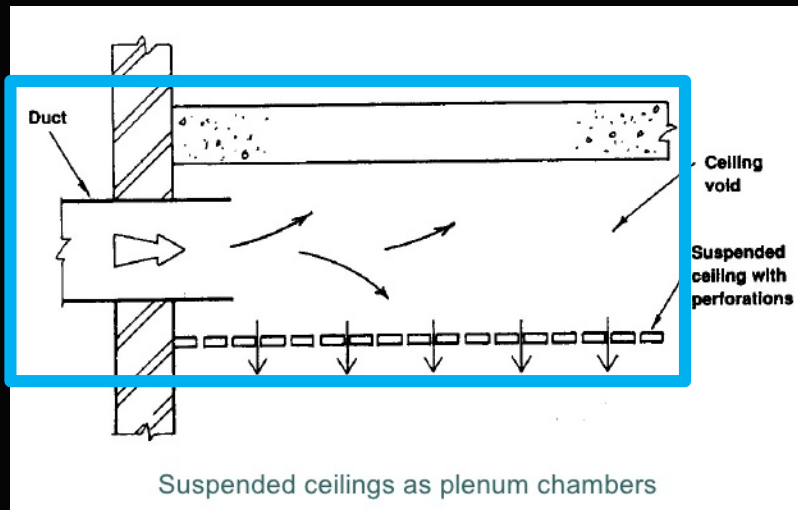
Ventilation Systems

- We recommended a single ERV for whole building
 - Engineer was not comfortable, due to car exhaust
- **Repair Shop**
 - Standard background rate is 3 ACH
 - Negotiated down to 2 ACH
 - Run intermittently, tied to air quality sensor
- **Showroom**
 - Negotiated initial rates down by > 50% (0.6 → 0.29 ACH)
- **Issue: Dropoff ERV oversized for background rate**
 - Solution: Intermittent operation

Ventilation Distribution

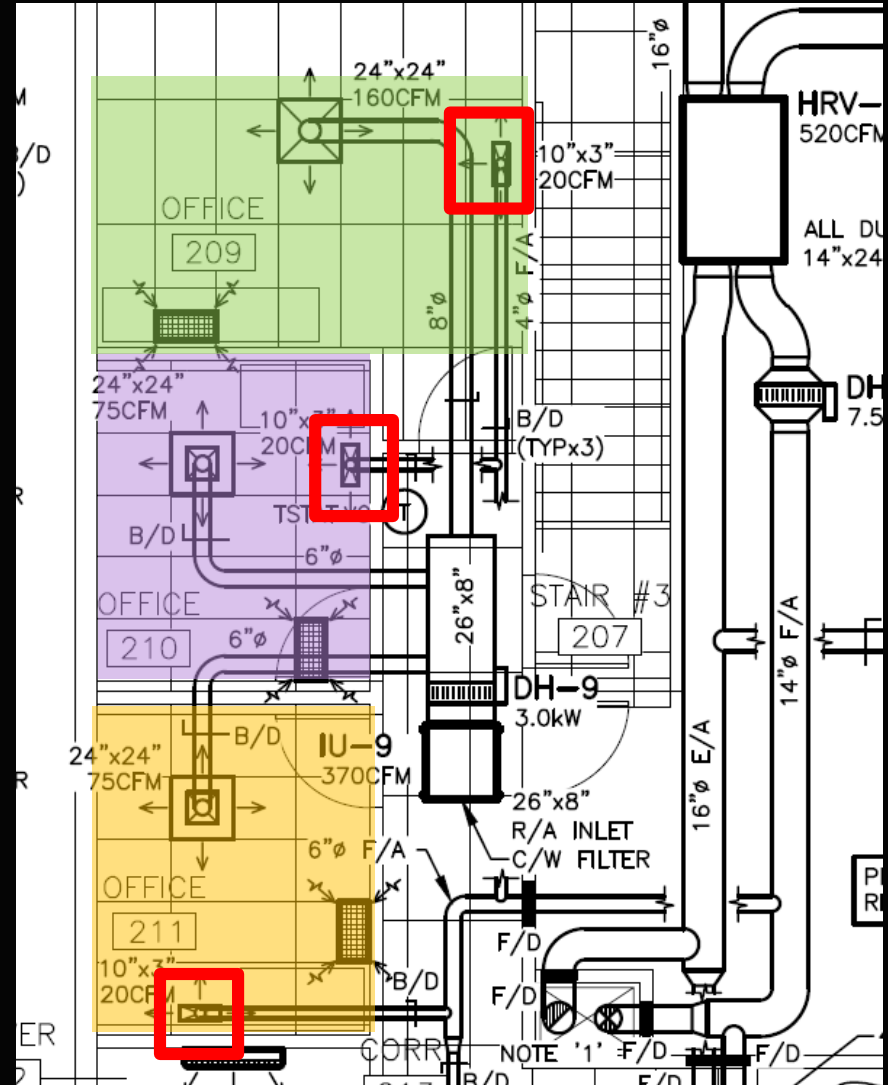
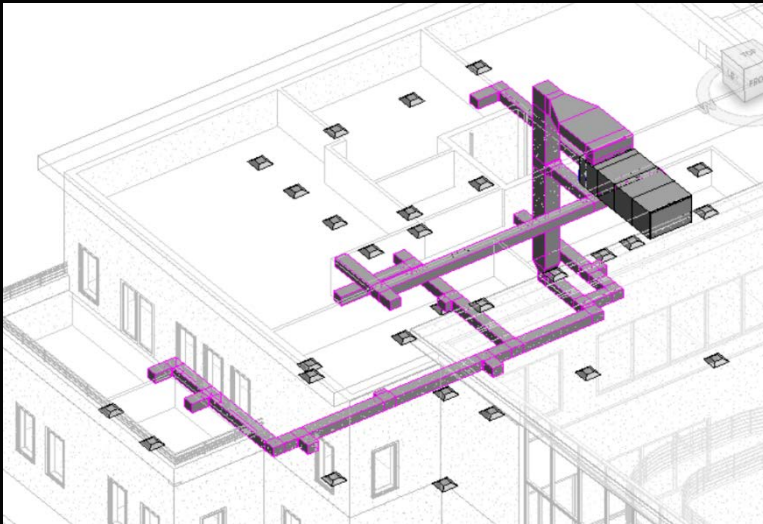
Initial design

- Ventilation air supplied into ceiling plenum
- relied on heat pump fans to circulate ventilation air into each room
- Issue: no heating = no ventilation
- Alternative is to run all the time – Substantial fan energy



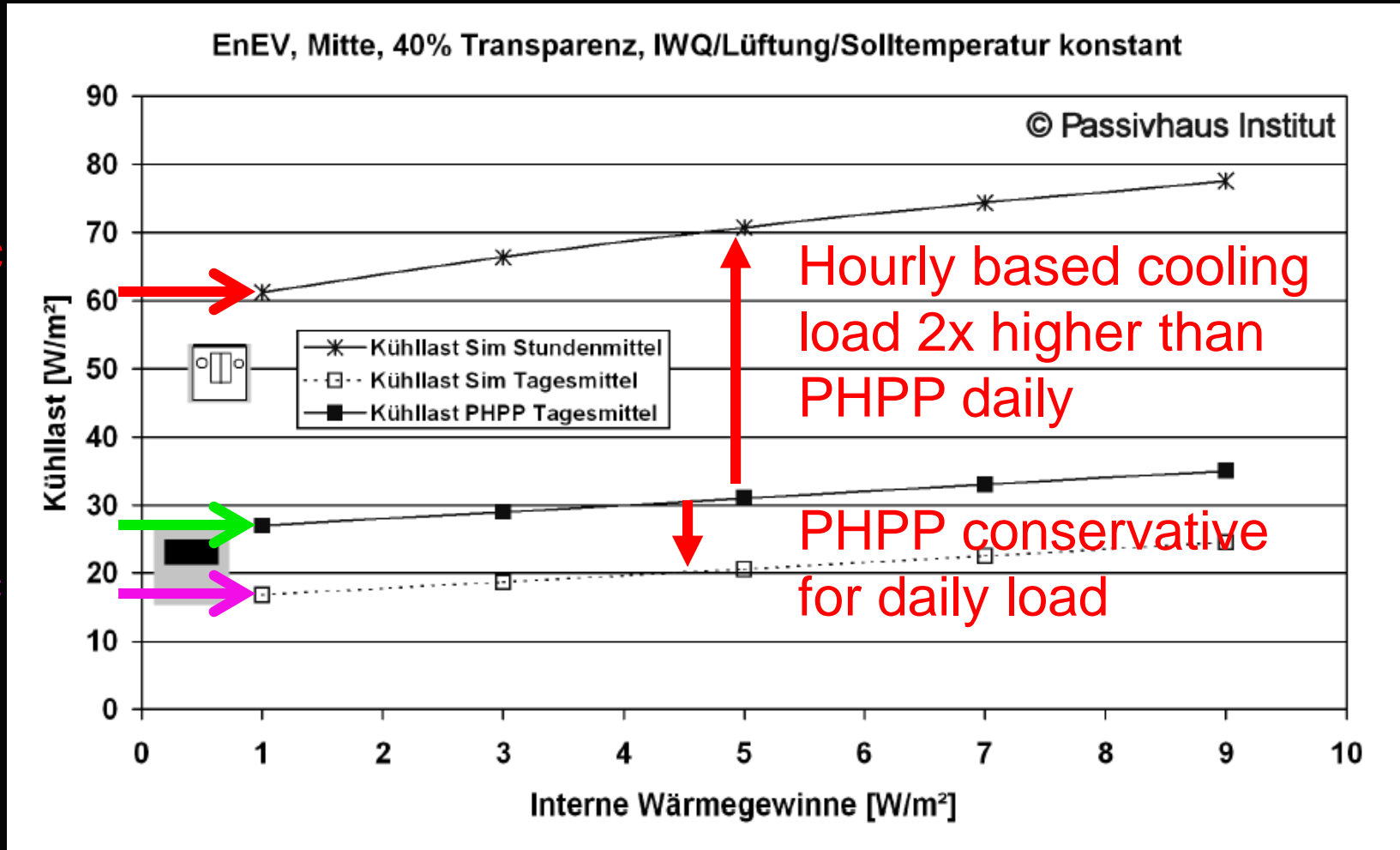
Ventilation Distribution

- Eventually convinced engineer to revise design
- Ventilation air supplied into **each space**
- **No heating = ventilation continues**



Cooling Load

- PHI study supports this result 40% glazing

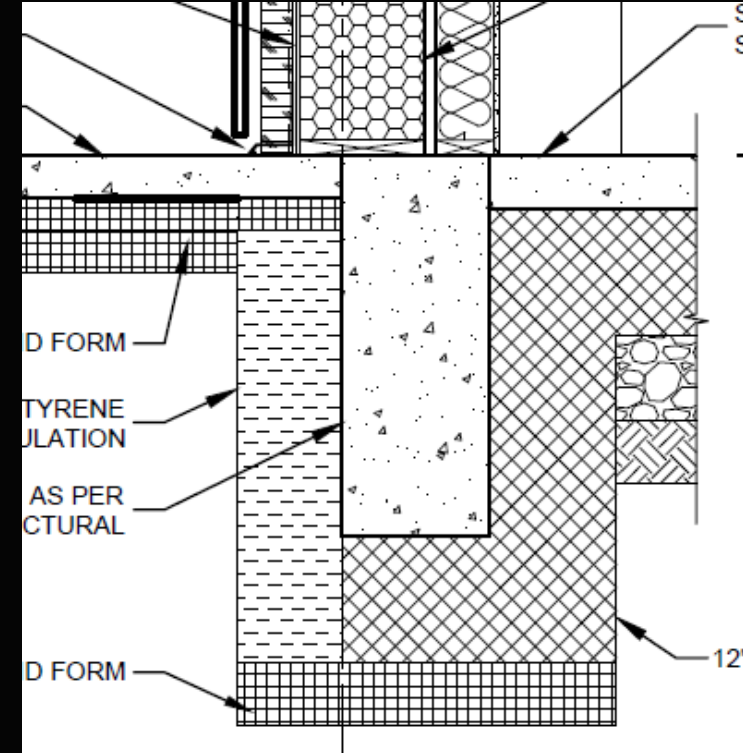


- Insert graph of PER breakdown
- PER exception

Thermal Envelope

Ground Floor

- Poor soil conditions
 - Prevented insulated raft slab
 - Fully wrapped foundation instead



Foundation work

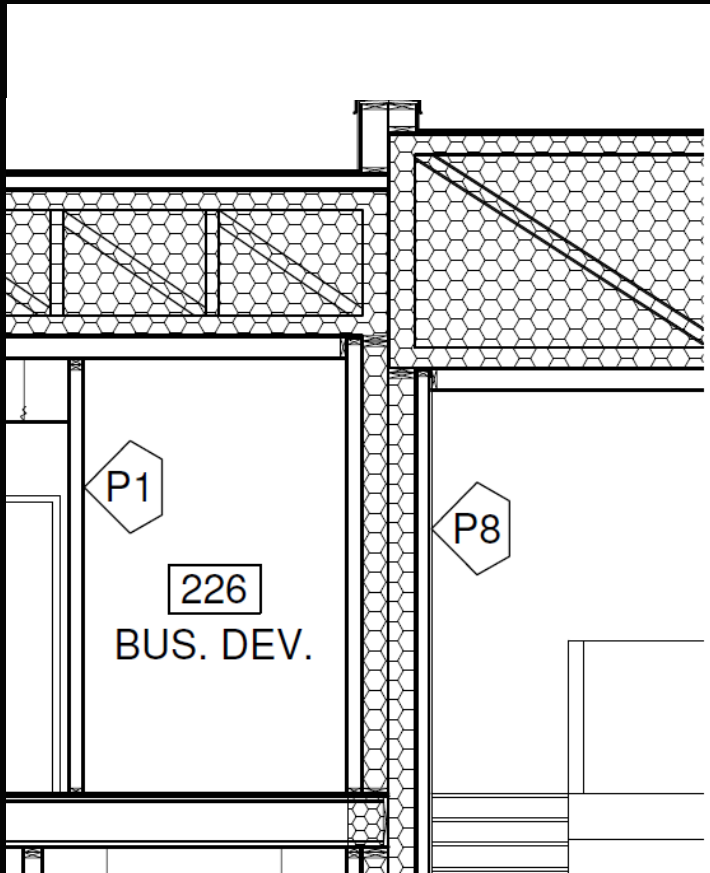
- How to pour concrete in the middle of winter



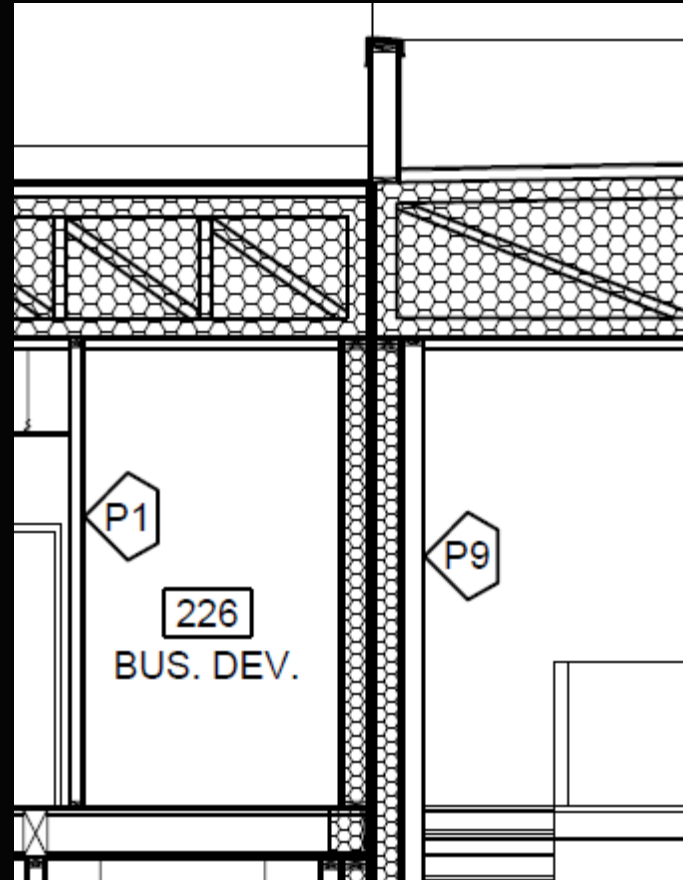
Roof

- Initial drawings had stepped roof
- Revised to flat to simplify construction and reduce cost

Initial

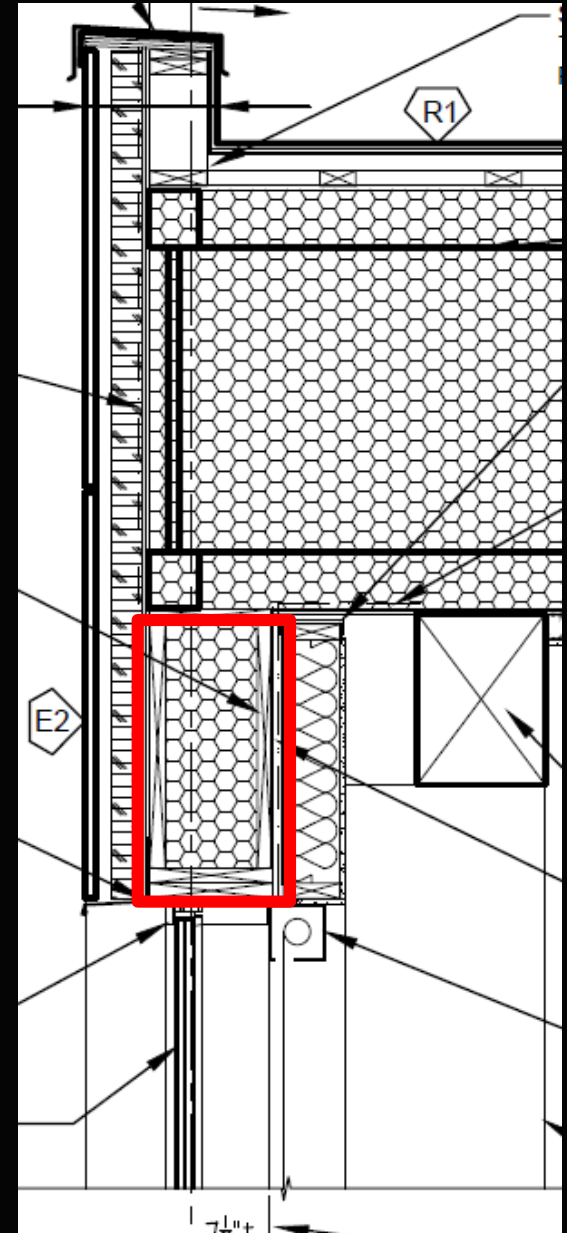


Final



Window & CW Installation

- **Insulated box** as lintel to reduce timber%
- Otherwise, fairly conventional Passive House detailing



Assembly Performance Summary

Element	U-value [W/m ² K]	R-value	Insulation Thickness [mm] (inches)
Floor Slab	0.11	R54	305 (12")
Basement Wall	0.13	R43	510 (20")
Main Wall	0.08	R71	250 (10")
Roof	0.03 – 0.04	R122-R177	1340 (52")

How bout them thick walls!

Airtightness Strategy

- **Basement Floors & Walls**
 - Taped vapour barrier membrane
- **Main Walls**
 - Intello – required to avoid dew point issues
 - Protected by service cavity where services are installed
 - No interruption at intermediate floors
- **Roofs**
 - Taped ½" plywood
- **Windows**
 - Intello taped to window frames/CW
- **Building Target**
 - 0.4 ACH@50Pa – required to meet space heating demand

