



Solis House

- Urban Single Family -



THIRD
QUADRANT
DESIGN



THE UNIVERSITY
OF BRITISH COLUMBIA

student leads

Architecture



Jasmine Lee

Energy & Electrical



Wenoa Teves

Water



Alicia Hobamier

Civil / Geo



Shea Mills

Structural



Mandi Unick

Mechanical



Milan Jaan



Jade Lissel



Zoe Le Hong



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Partnerships



THE UNIVERSITY OF BRITISH COLUMBIA
Applied Science



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Civil Engineering



ENGINEERS &
GEOSCIENTISTS
BRITISH COLUMBIA



Engine



Vancouver, BC, Canada

- Climate zone 4 (mild, temperate)
- High precipitation
- Low solar insolation

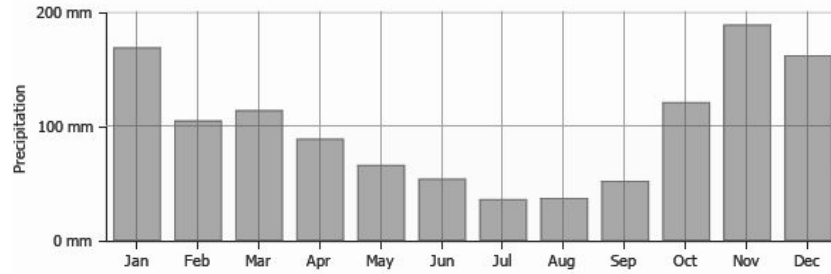


Figure 1: Annual average precipitation in Vancouver (weather-and-climate.com)

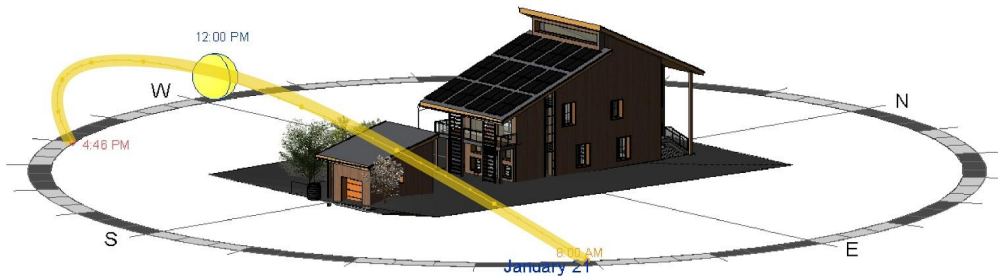


Figure 3: Sun-path on shortest day of the year (January 21st)

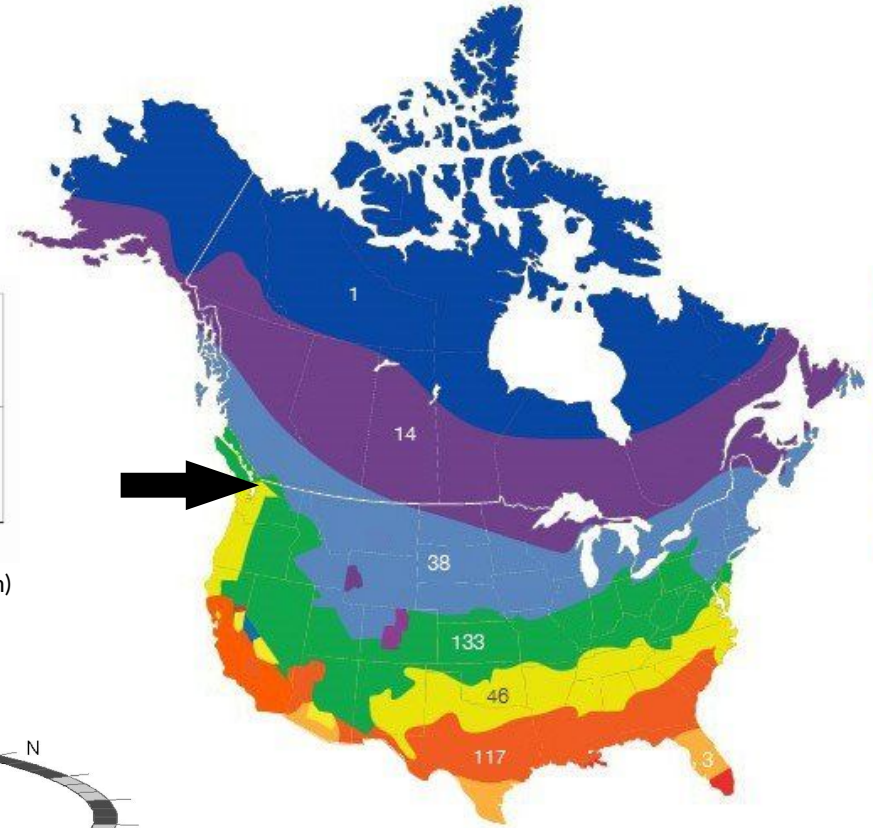
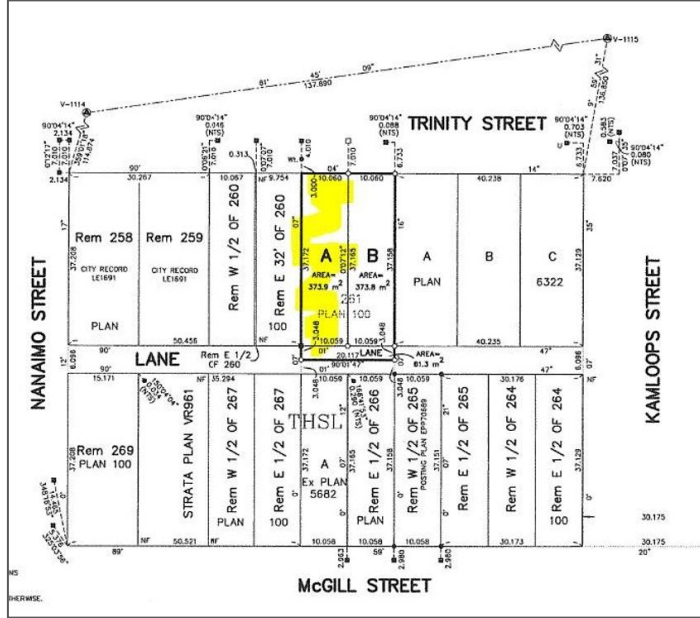


Figure 2: Location of Vancouver on an ASHRAE climate zone map



VANCOUVER'S HASTINGS-SUNRISE NEIGHBOURHOOD

Average Income

\$86,000

Average Household Size

2.7

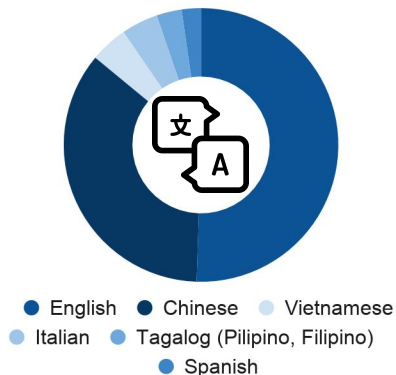
Census Population

34,575

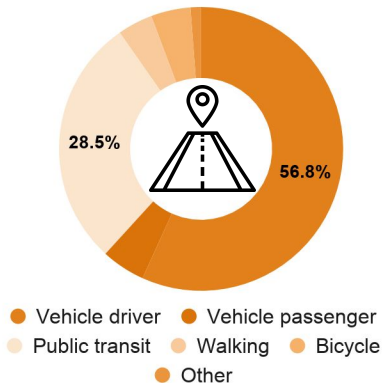
Population in Low
Income Households

19%

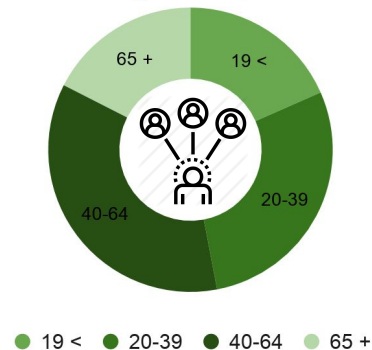
Language



Mode of Travel to Work



Age Groups





VANCOUVER'S HASTINGS-SUNRISE NEIGHBOURHOOD





Market Driven Design

1

- Community centered & competitively priced
- Flawless integration with landscape & community character



Constructable

2

- Modular construction
- Mass-timber design



Self Sufficient & Sustaining

3

- On-site food & energy production
- Smart-home controls



Earthquakes



Flooding



Climate Change



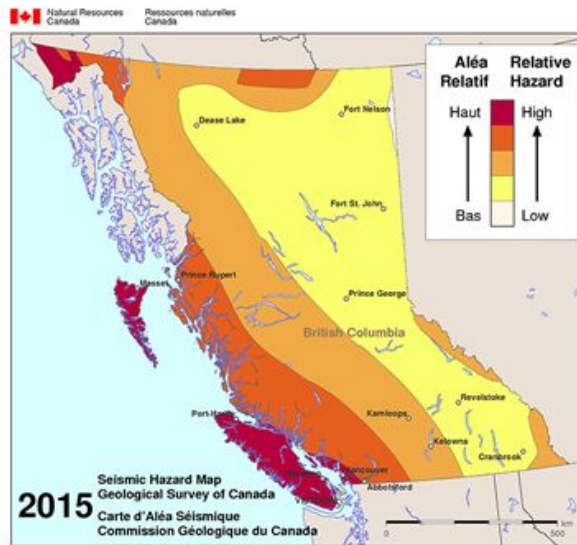
Grid
Connectivity



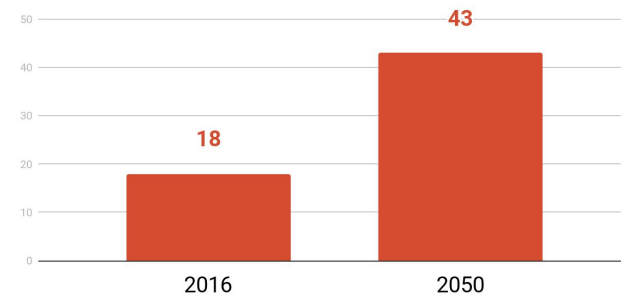
Moisture
Balance



Income
Crisis



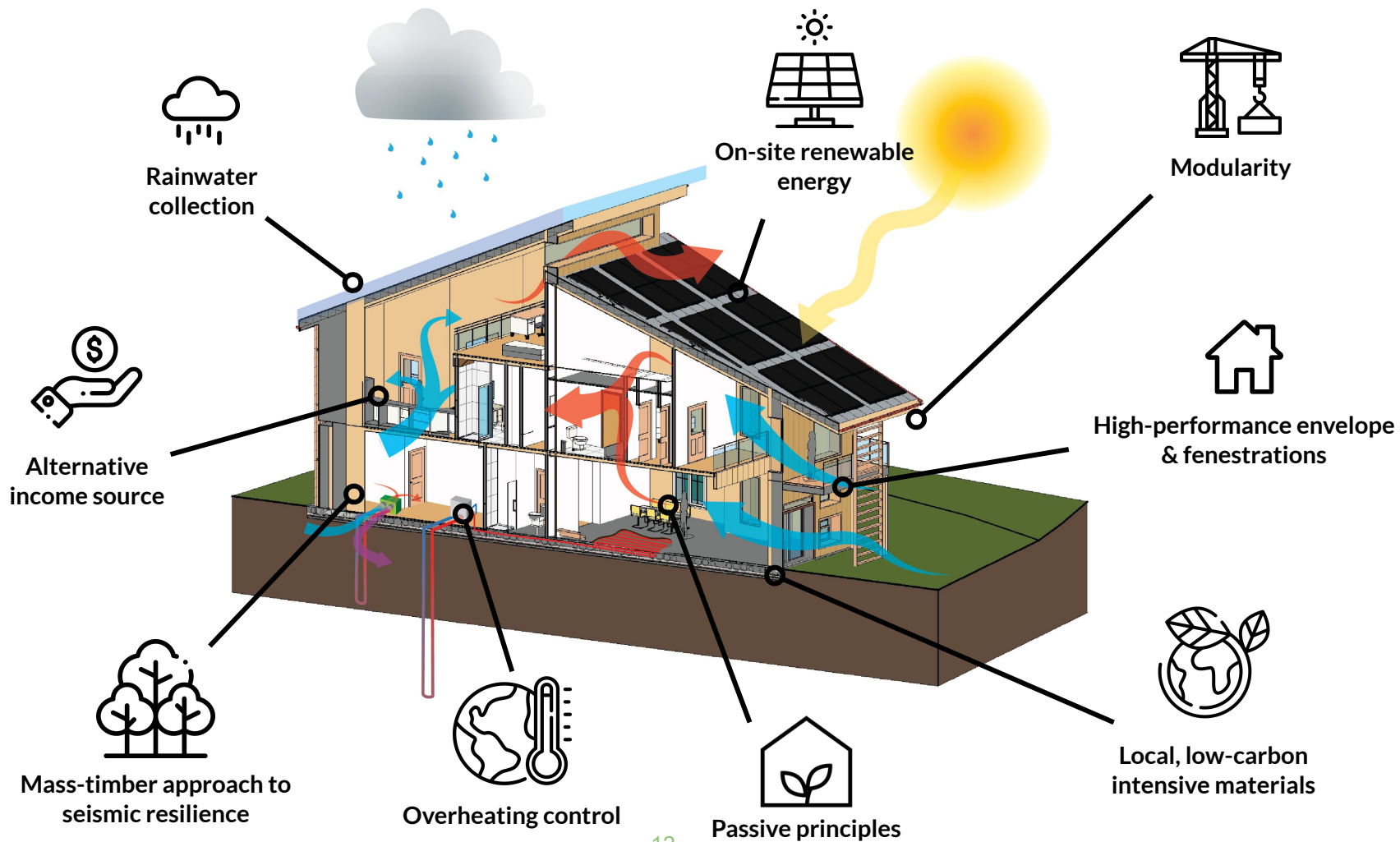
Increase in Cooling Days



DESIGN CONCEPT

create a dwelling that addresses *all levels of sustainability*: low embodied and operational emissions and long-term resilience.

The design will be approached with a *passive systems-first* mentality, and utilising transdisciplinary communication to ensure seamless integration of active systems.



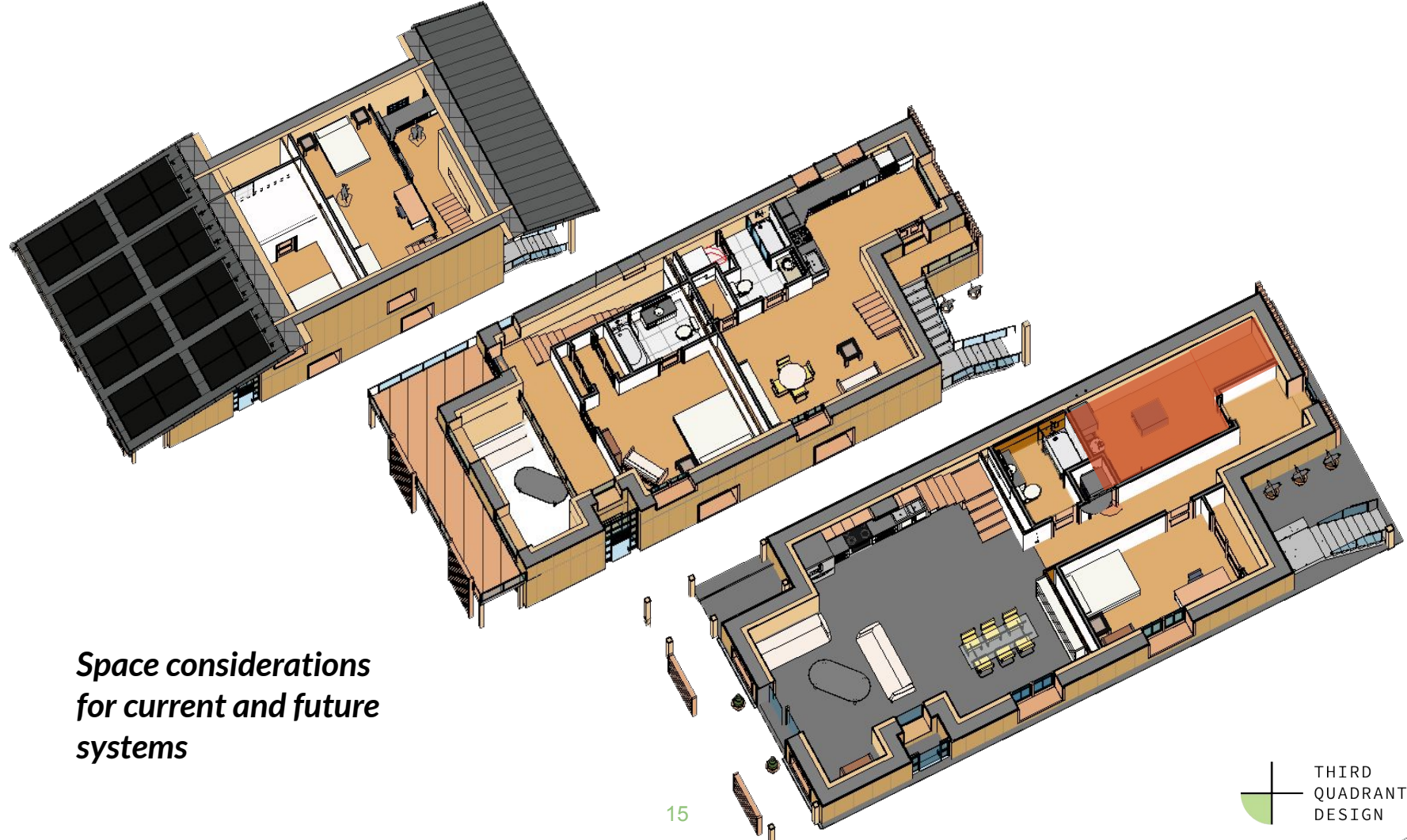
ARCHITECTURE



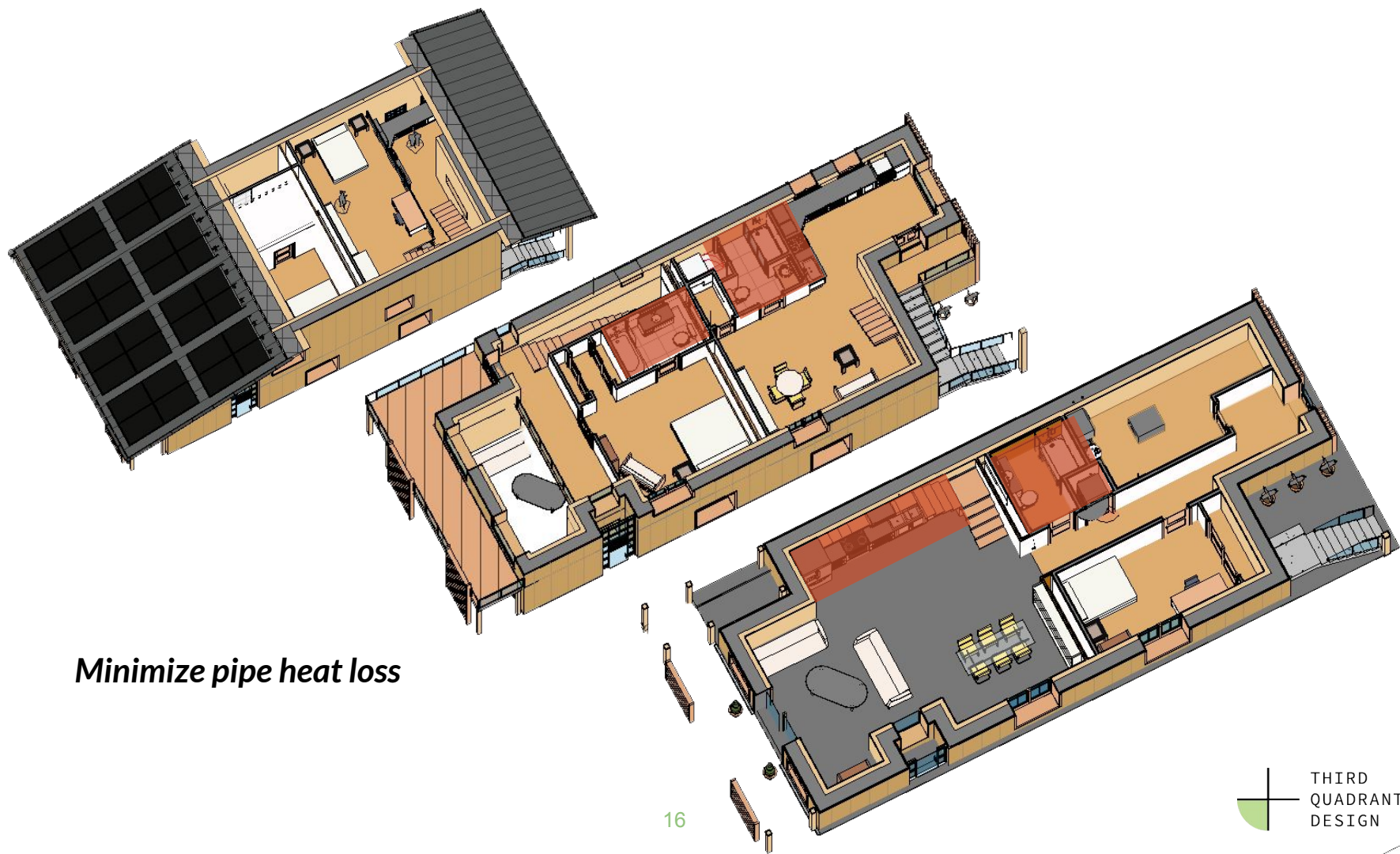
Building form	Simplify building form Minimize surface to volume ratio Maximize south-facing roof area
Internal space	Maximize natural ventilation & lighting Minimize piping heat losses Make use of internal heat gains
Materials	Introduce thermal mass



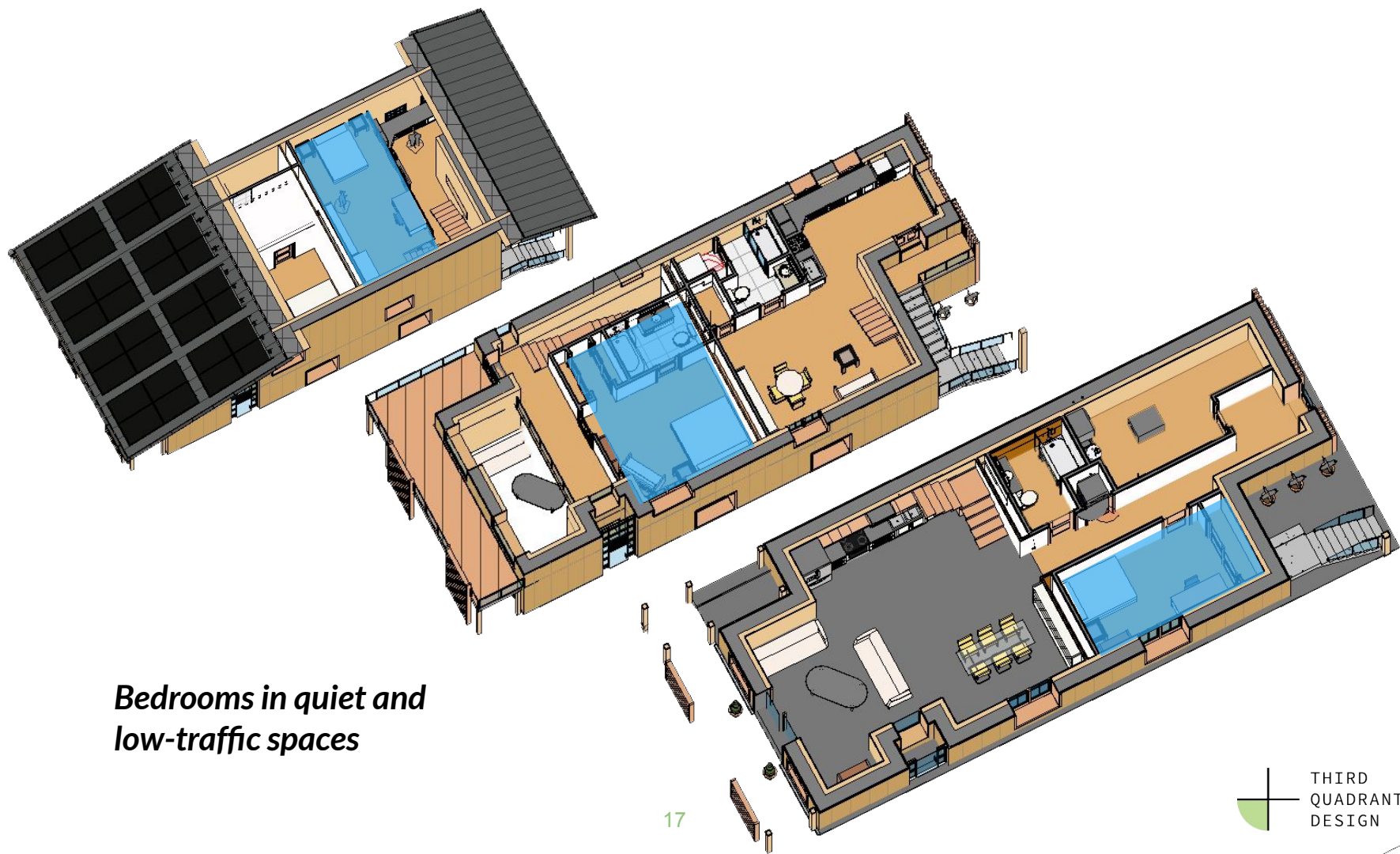
**PASSIVE
PRINCIPLES**



*Space considerations
for current and future
systems*



Minimize pipe heat loss

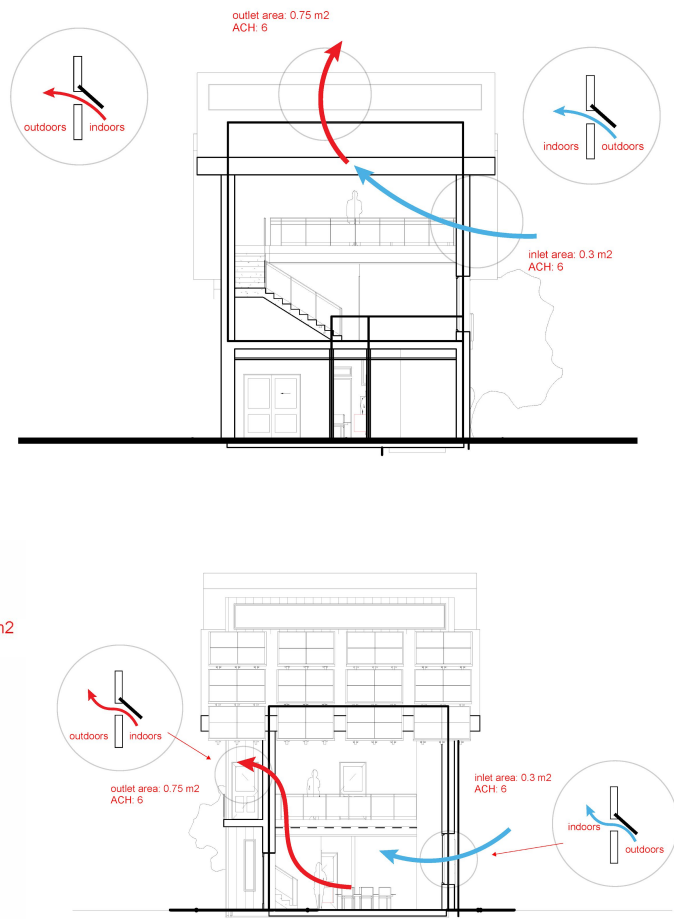
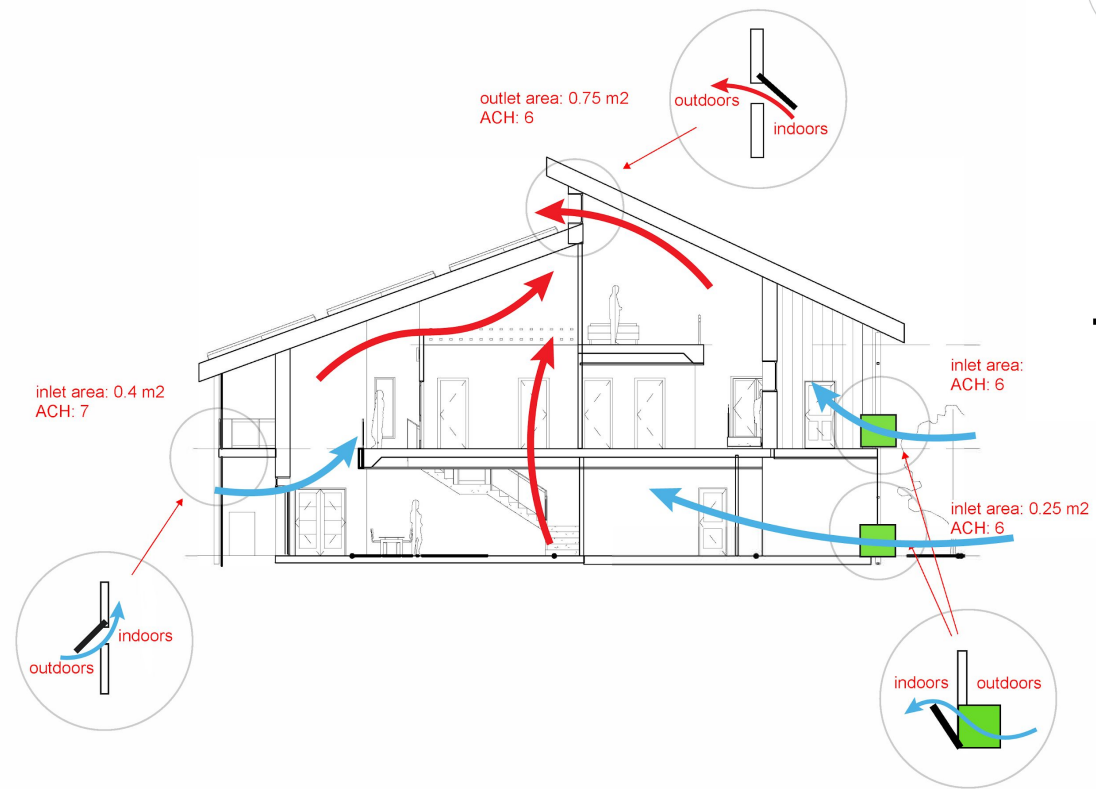


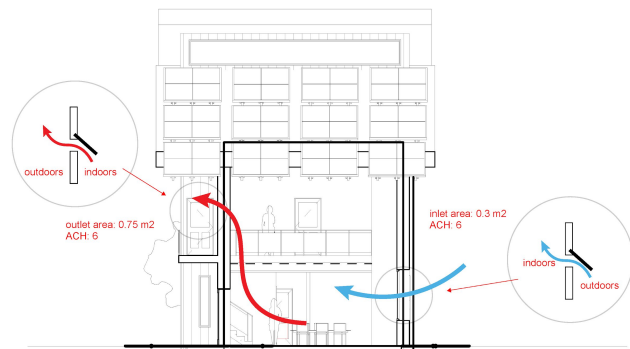
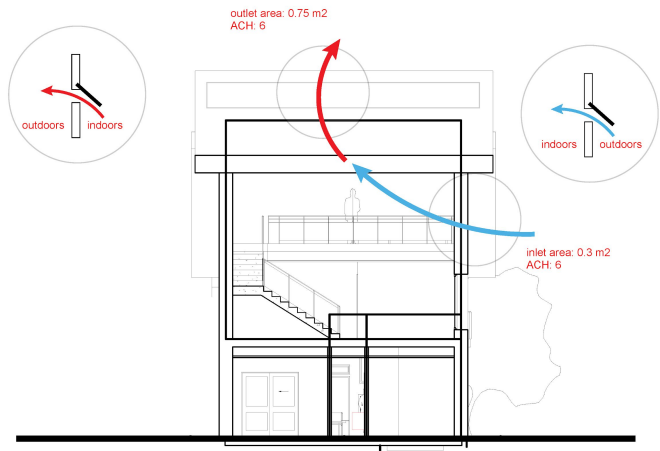
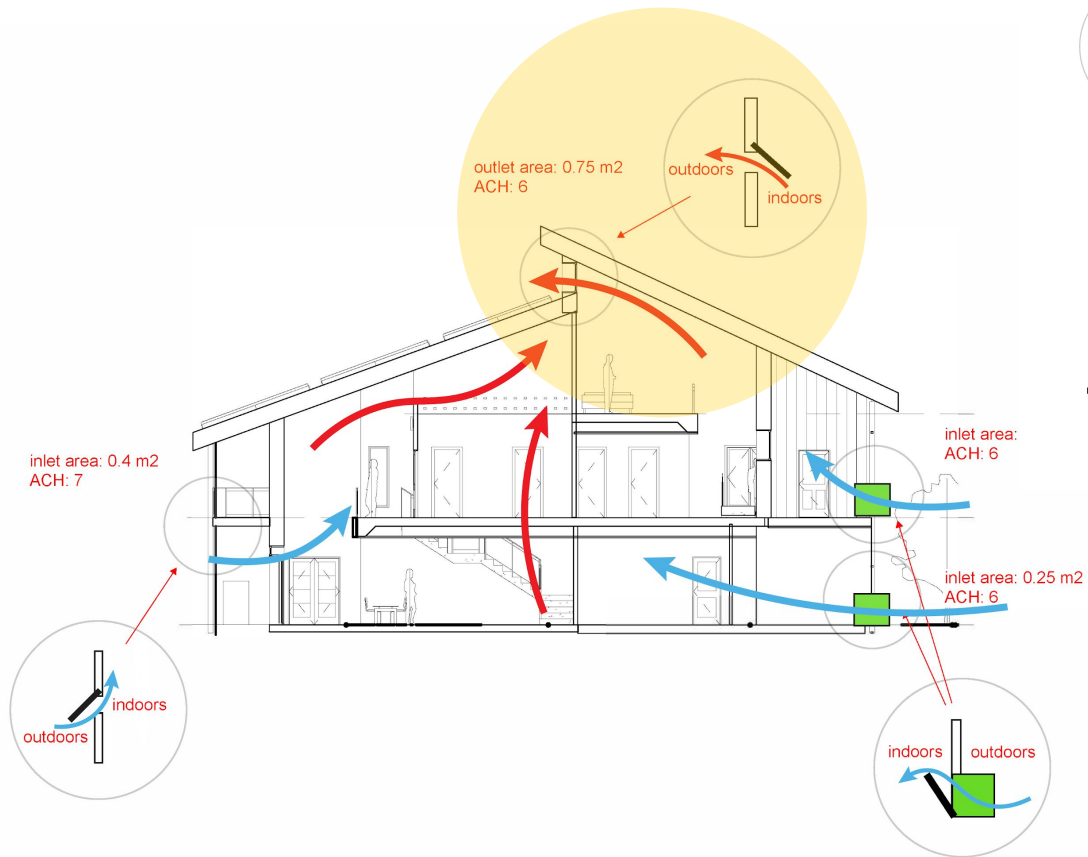
*Bedrooms in quiet and
low-traffic spaces*



*Open-plan
living spaces*

*High-levels of natural
lighting & ventilation*





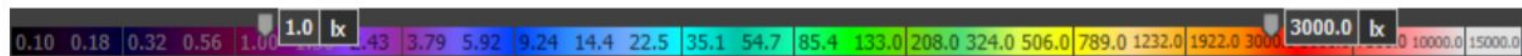
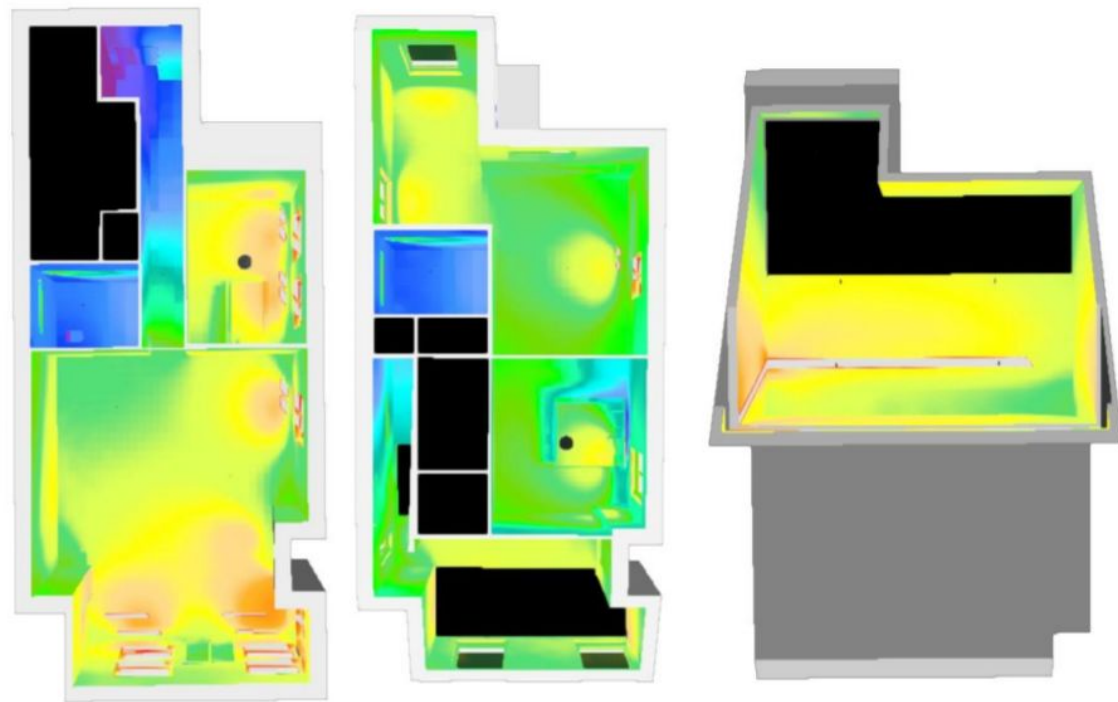


Figure 18: Summer Solstice natural lighting (left to right: floor plans 1-3, N direction top of page)



Local, natural & healthy materials.



Cross-laminated Timber

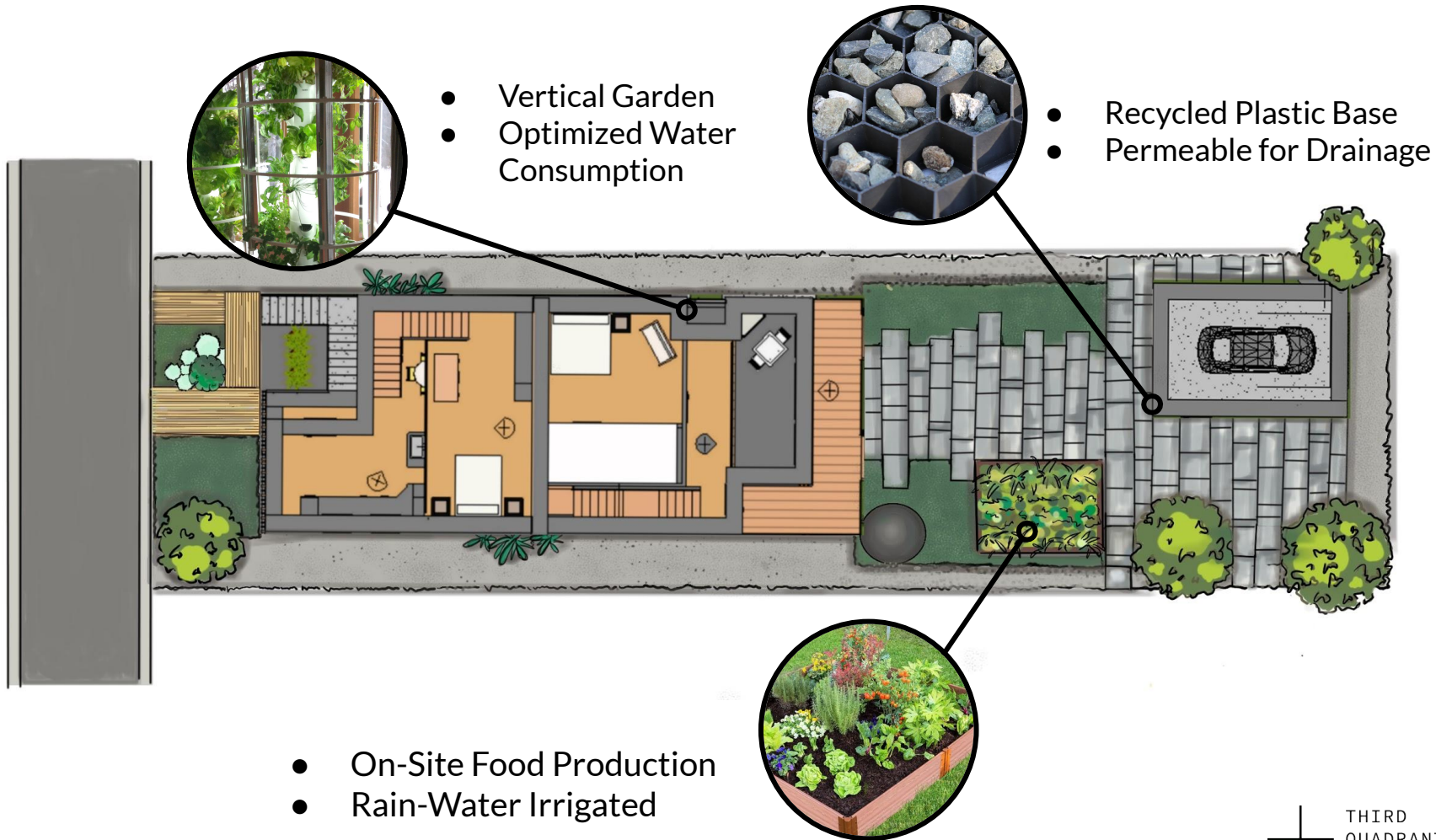


Wood Fibre insulation

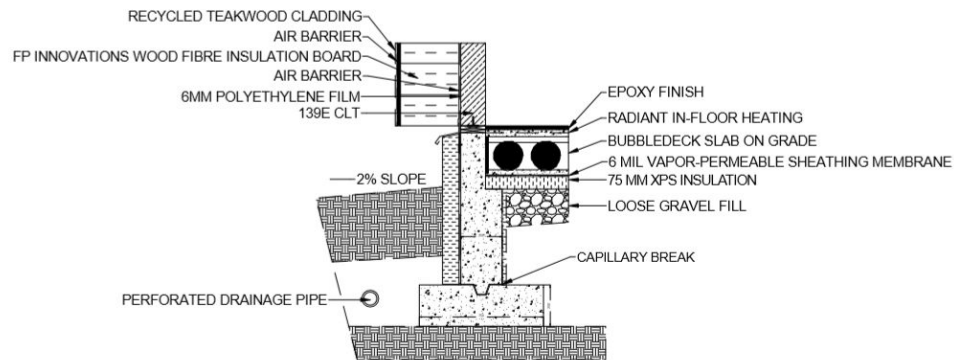
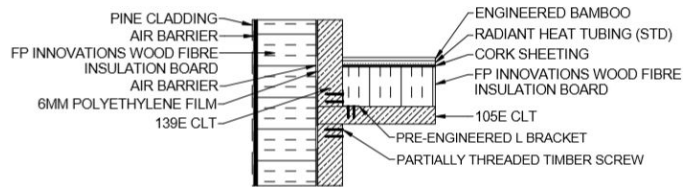
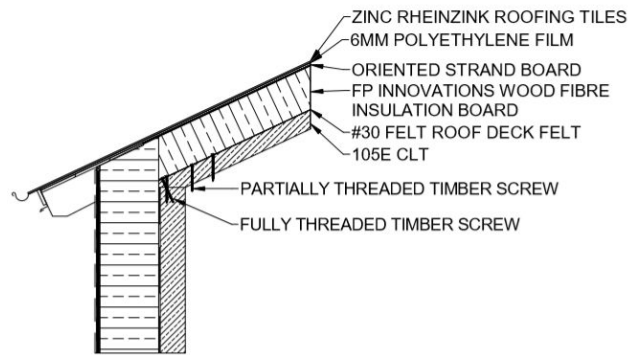


*Recycled Oyster Shell
Countertops*

LANDSCAPE



STRUCTURE



Earthquake Resilience

CLT

- Improved performance given its strength, flexibility, and lightweightedness

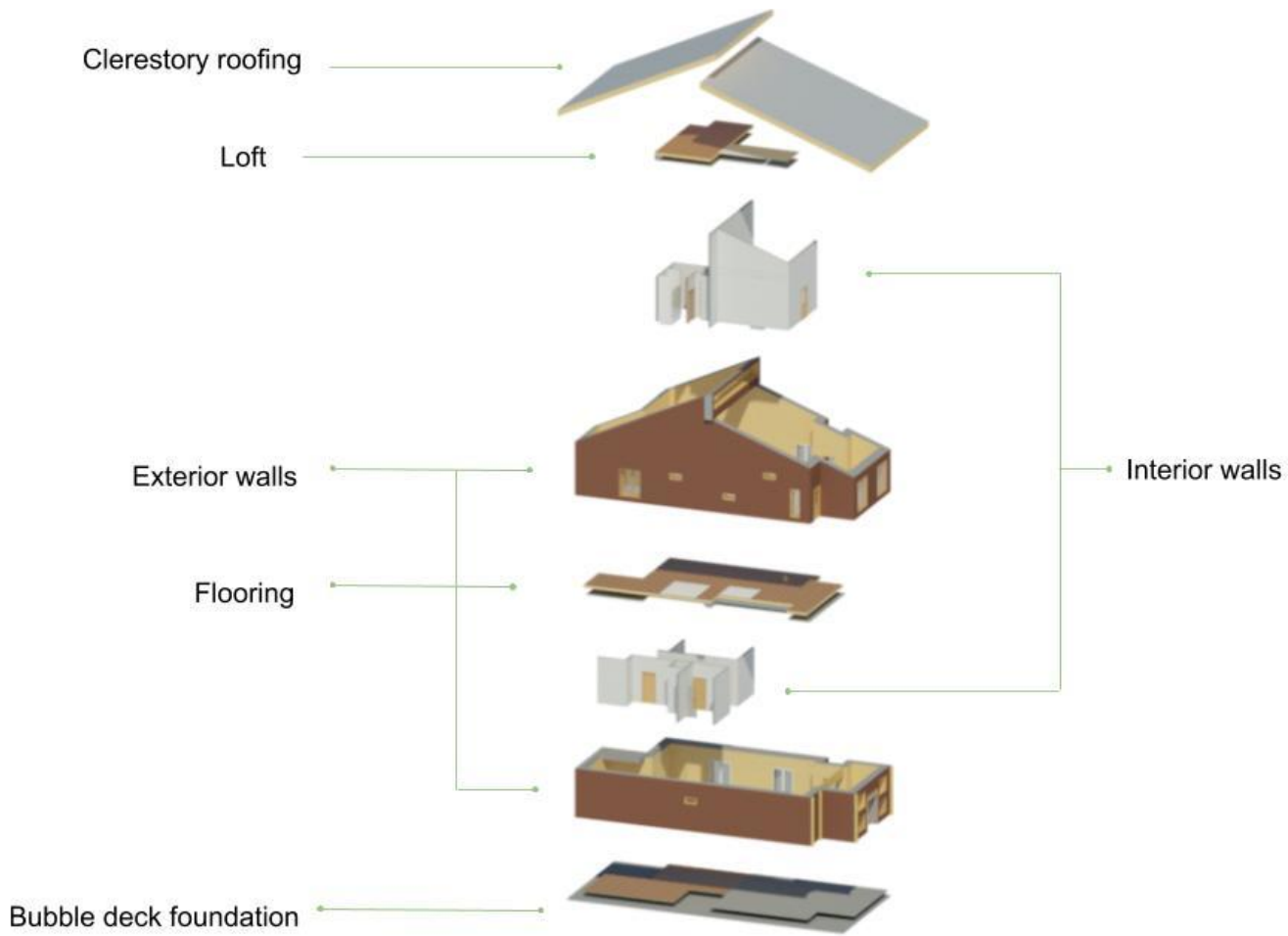
Bubbledeck slab on grade

- Reduces earthquake loads

Tie downs

- Resist lateral seismic loads

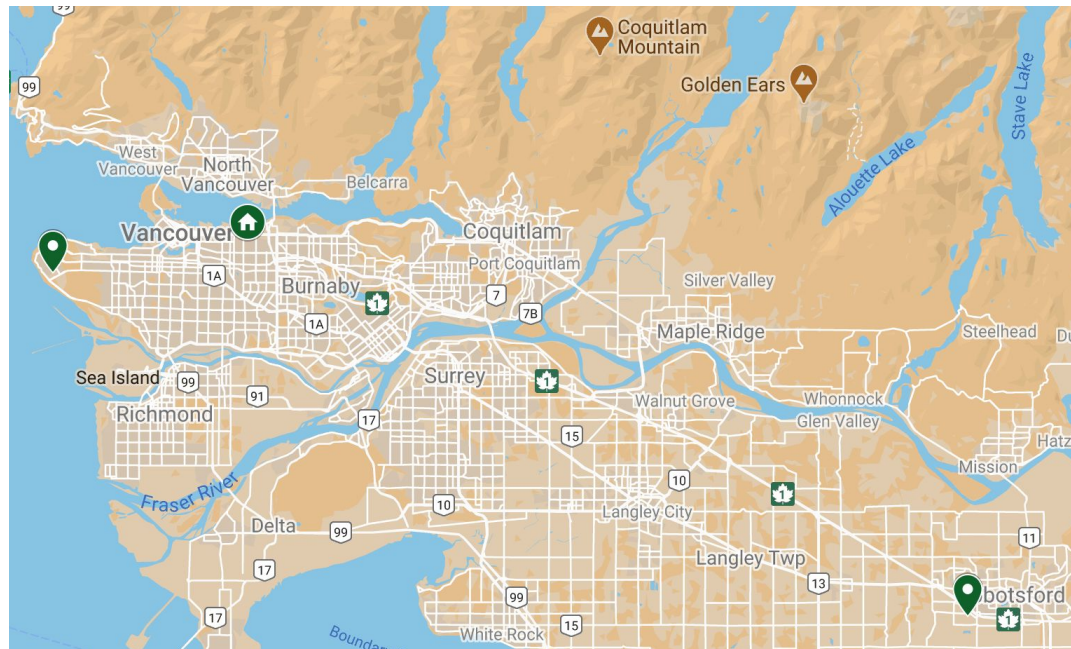
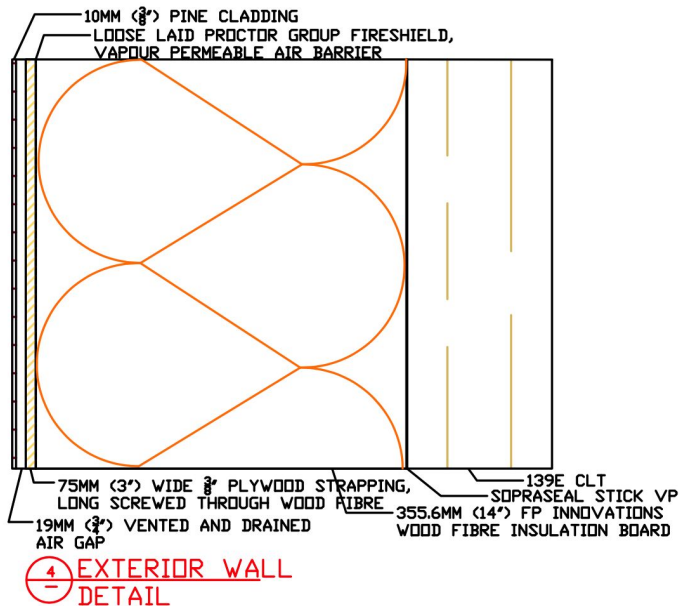
CONSTRUCTION



BUILDING ENVELOPE

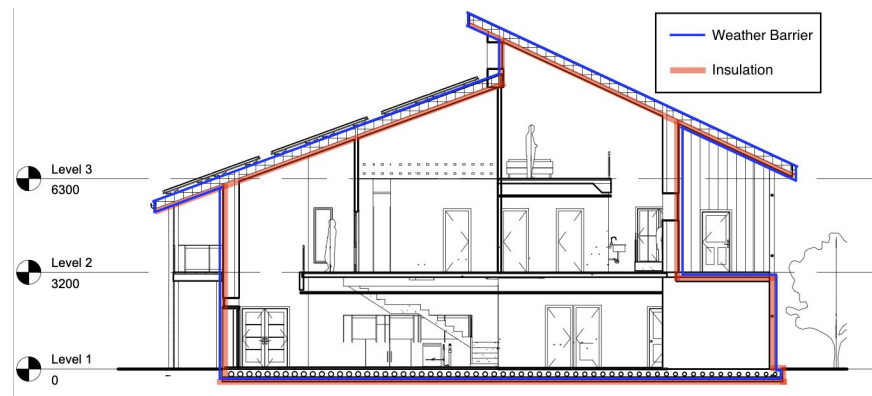


Hyperlocal. Carbon-Sequestering. High Performing.





- Vancouver's biome is classified as a temperate rainforest
 - High levels of rainfall
 - High relative humidity
 - Below 0C (32F) temperatures in the winter
- This biome poses challenges regarding:
 - Condensation
 - Mold
 - Wetting
 - Freeze-Thaw
- Used Passive House Canada for thermal minimums
- Conducted humidity analyses to assure mold free enclosure



Section	Passive House Min	Solis House R-Value
Roof	60	60
Exterior Wall	40	60
Slab/Ground Floor	30	49

Table 1: Passive House Canada R-Values VS Our Calculated R-Values



Relative Humidity and Temperature Models

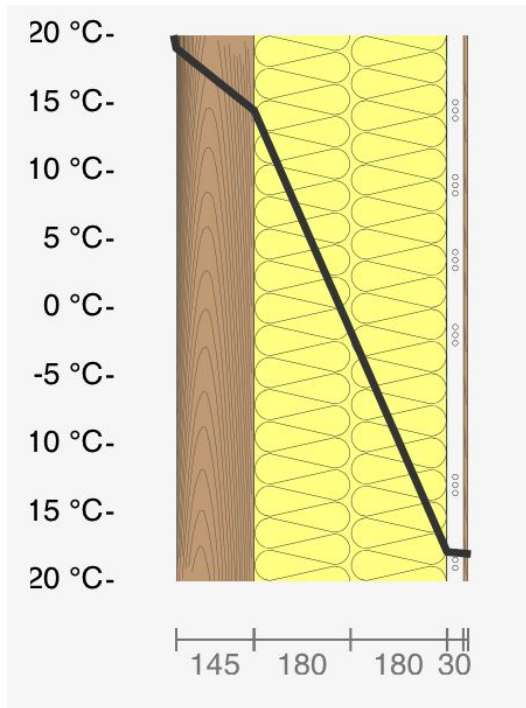


Figure 1: Ubakus temperature gradient model through our exterior wall section. -18°C exterior and 19°C interior temperatures

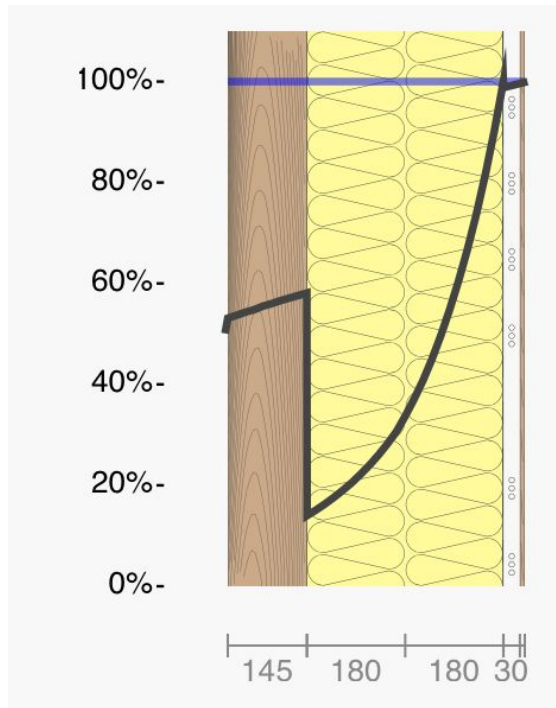


Figure 2: Ubakus Relative Humidity model through our exterior wall section. 100%RH exterior and 50%RH interior conditions

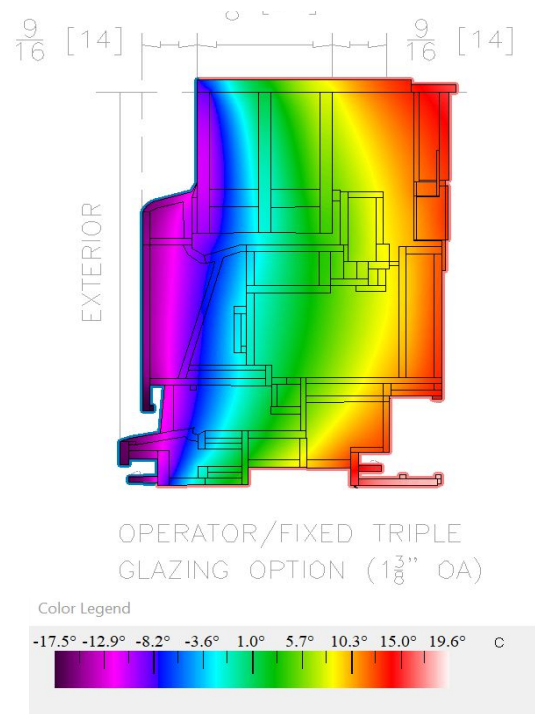


Figure 3: Therm temperature gradient model of a typical triple glazed, fiberglass framed window

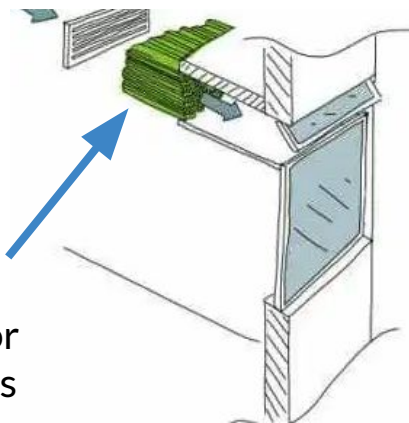
ACOUSTICS



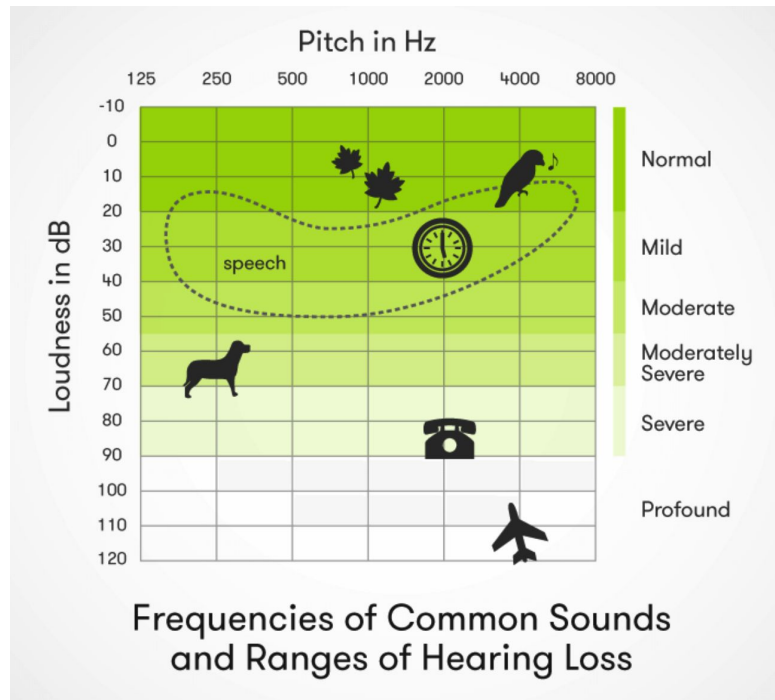
Natural, carbon sequestering materials used for acoustic insulation

Acoustic Performance of Partitioning Elements

- Int Wall: 58STC²
- Ext Wall: 52STC³
- Floor: 55STC and 51IIC⁴



Honeycomb sound attenuators used for ventilation openings

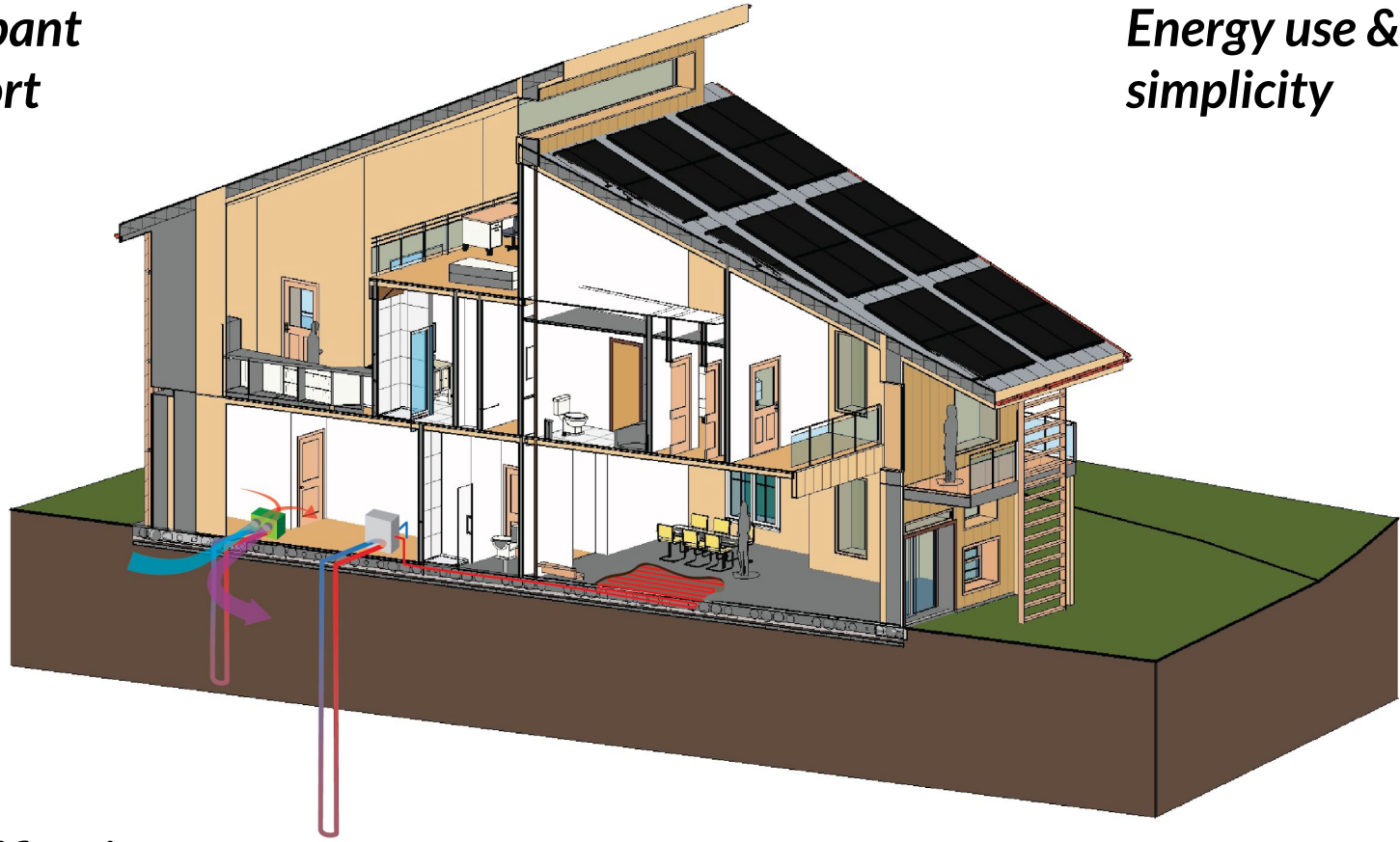


MECHANICAL SYSTEMS

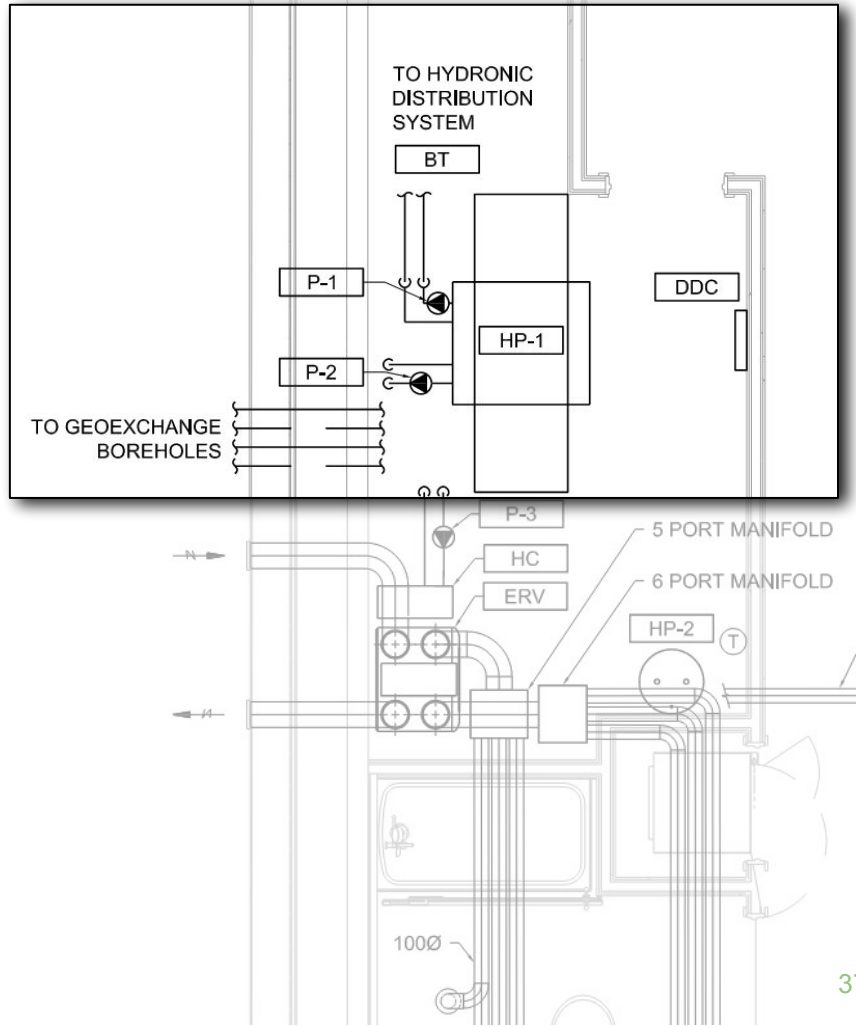


*Occupant
comfort*

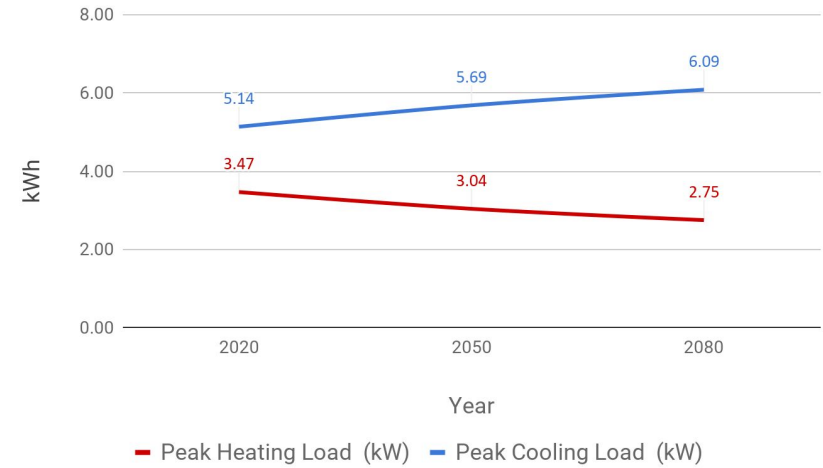
*Energy use &
simplicity*



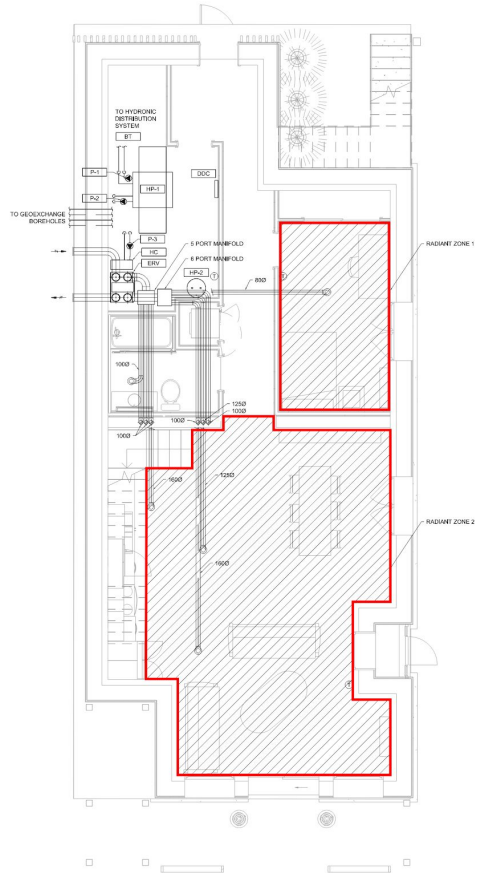
*100%
electrification*



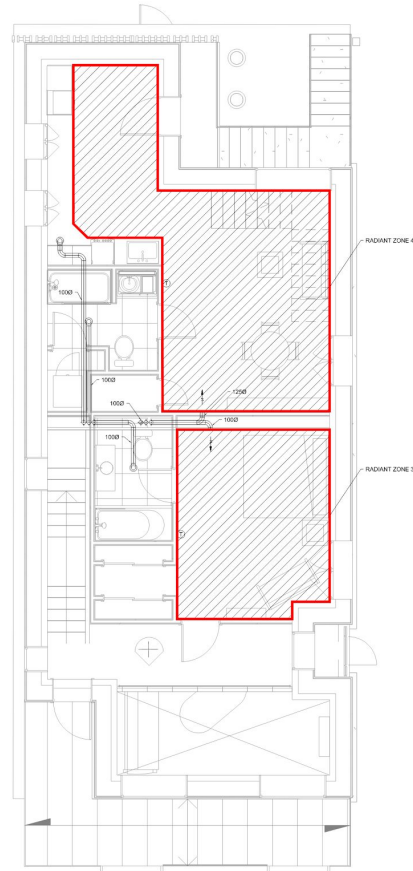
Peak Heating & Cooling Loads



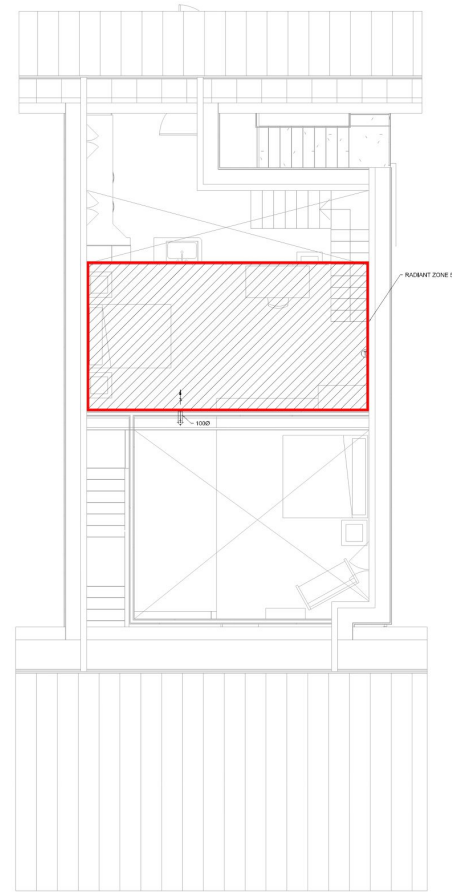
- 6.75 kW Ground Source Heat Pump sized for peak future cooling load
- 120m vertical borehole sized for peak future heat rejection



LEVEL 1 HVAC



LEVEL 2 HVAC



LEVEL 3 HVAC

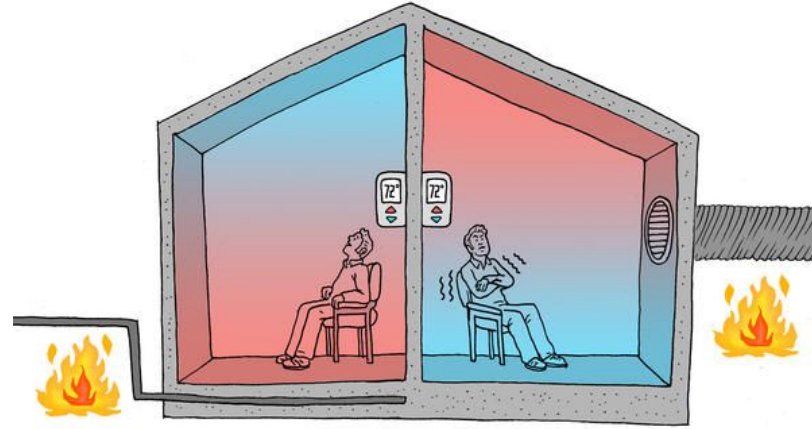


Figure 1: Ideal temperature profile

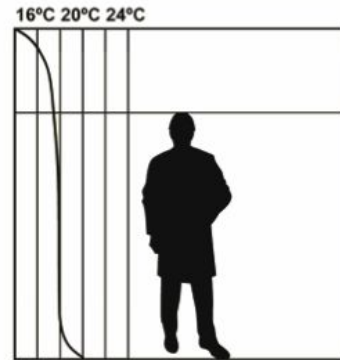


Figure 2: Profile for underfloor heating

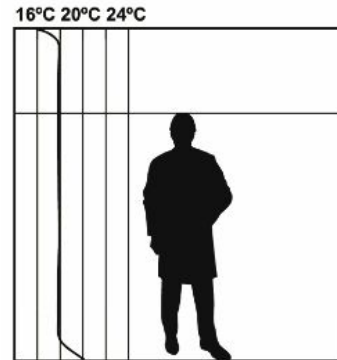
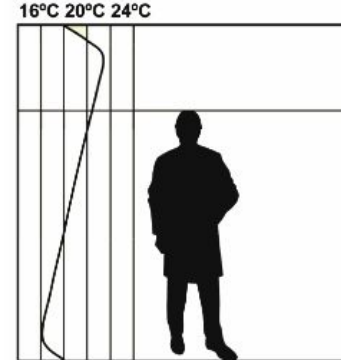
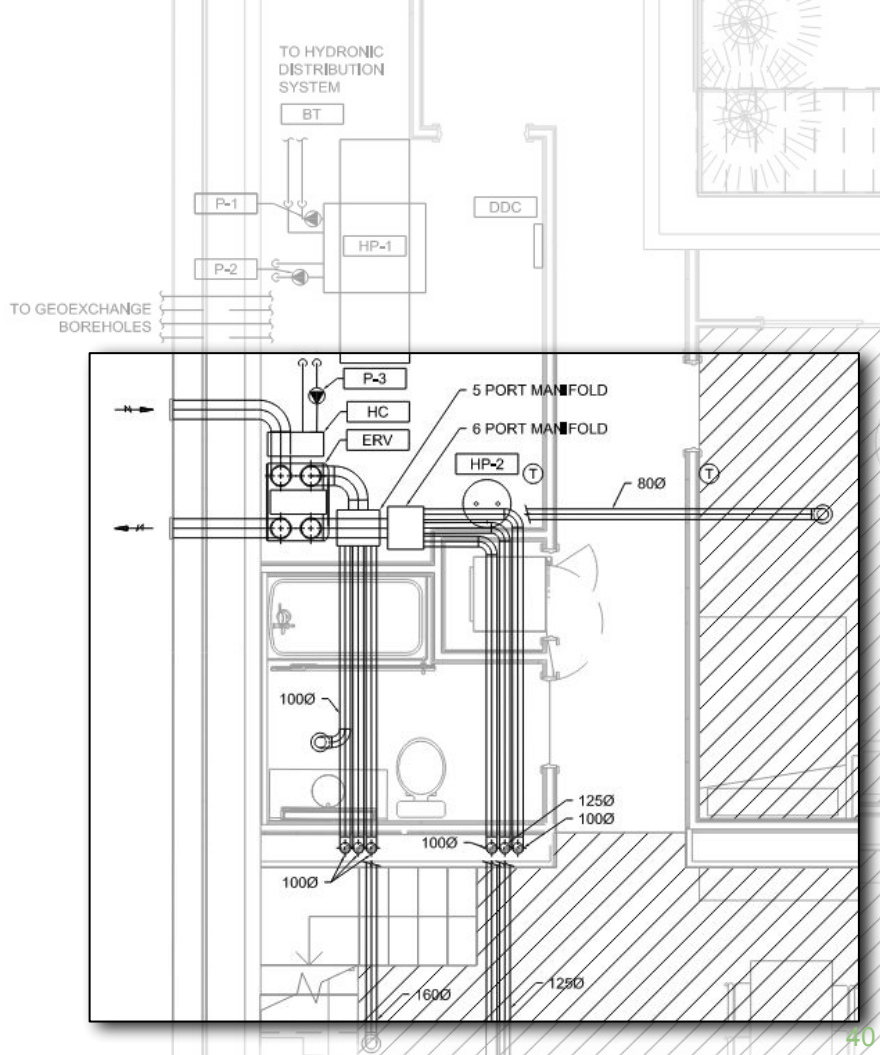


Figure 4: Profile for convector heating

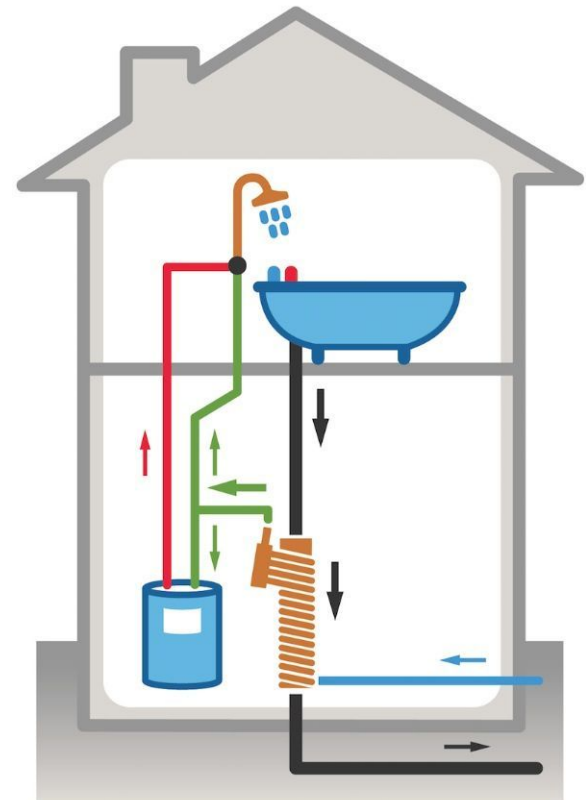
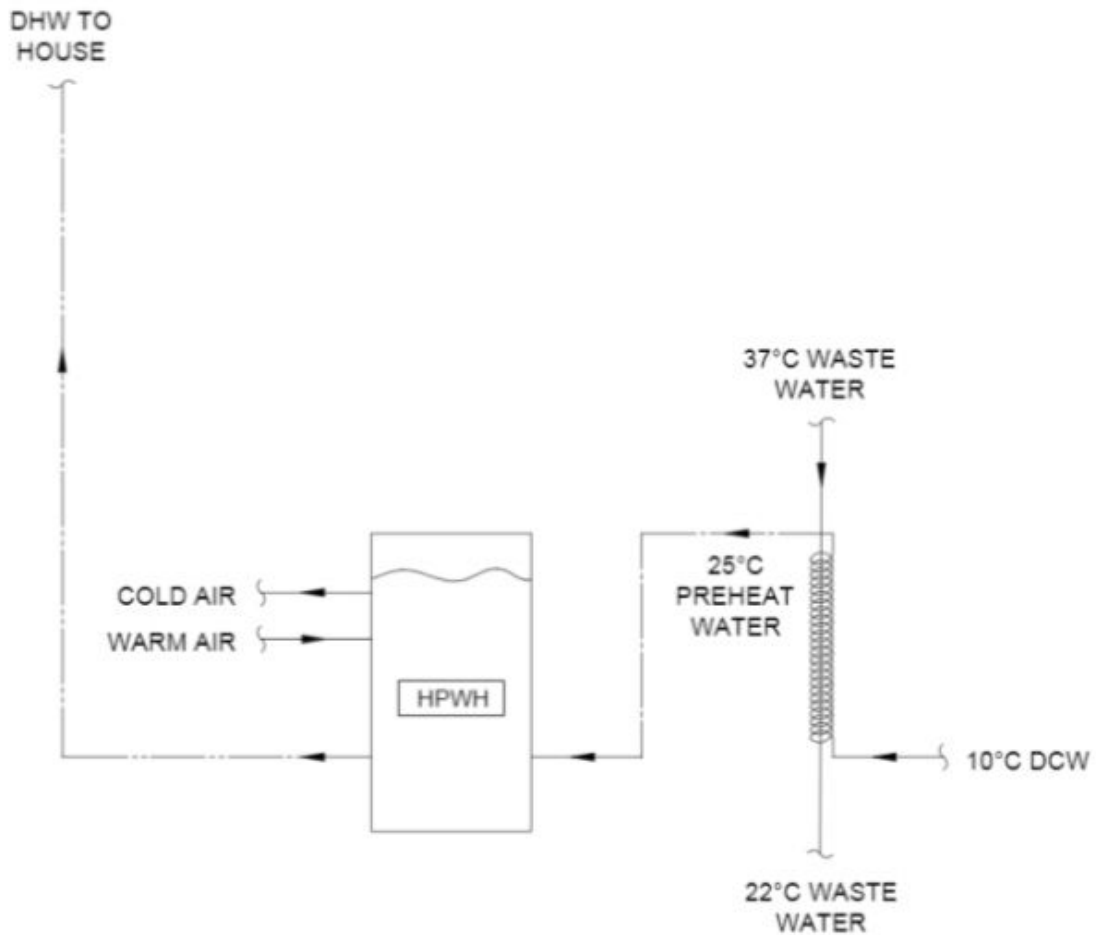




Ventilation

Tag	Location	Service	Flow Rate (L/s)	
			Standard	Boost
ERV	Main House Mech Room	Whole Home	115.50	149.99

WATER SYSTEMS



- Cold Water
- Hot Water
- Pre-Heated Water
- Drain Water



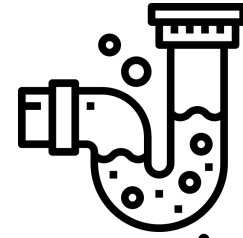
REDUCE



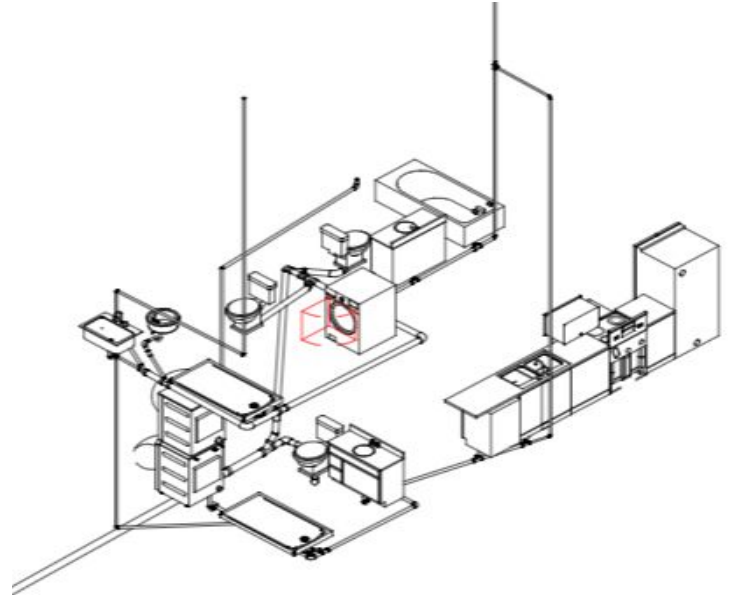
water

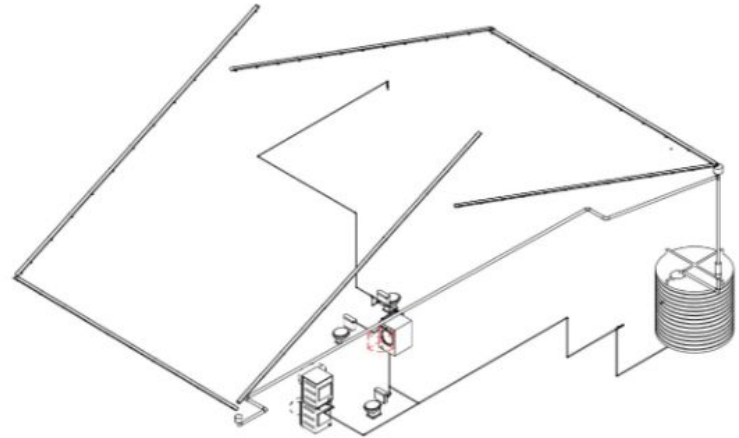
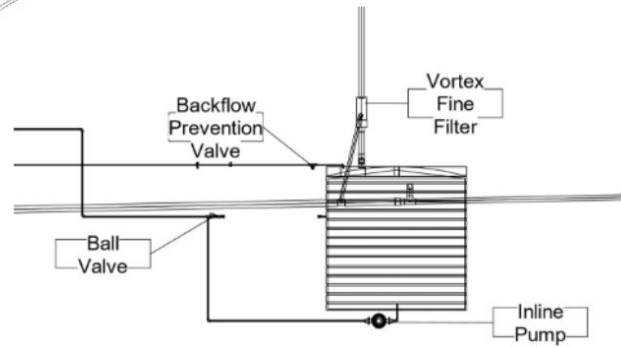
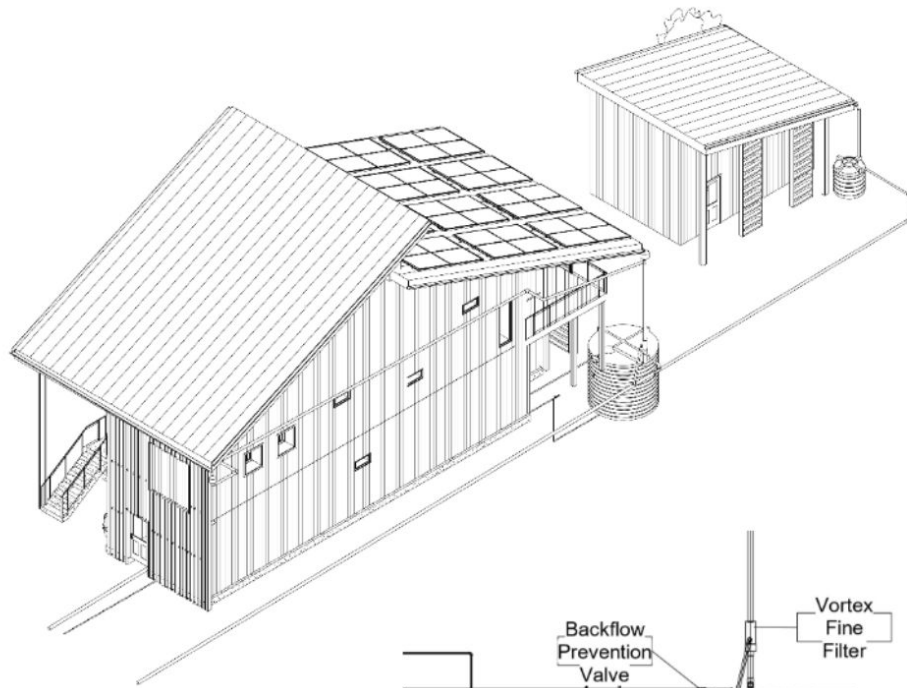


power



materials





ELECTRICAL SYSTEMS



Lighting power density (LPD):
1.57 W/sqm

Lighting Controls:

- Manual control
- Daylight harvesting
- Vacancy sensing

Lighting Control Zones:

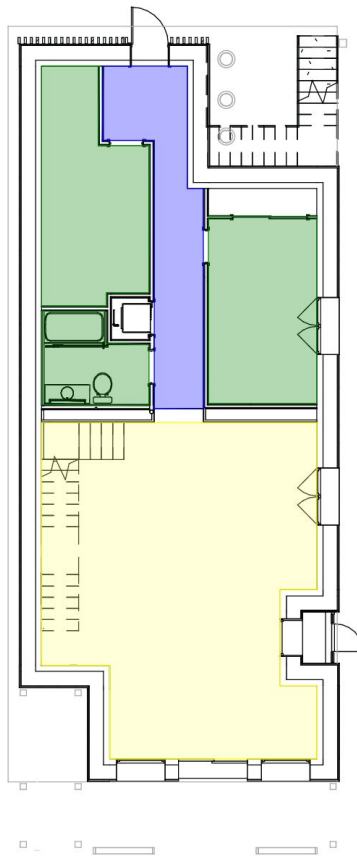
Zone 1:
Primary ON/OFF: Manual Switch

Zone 2:
Primary ON/OFF: Manual Switch
Secondary OFF: Daylight (Photocell) Sensor

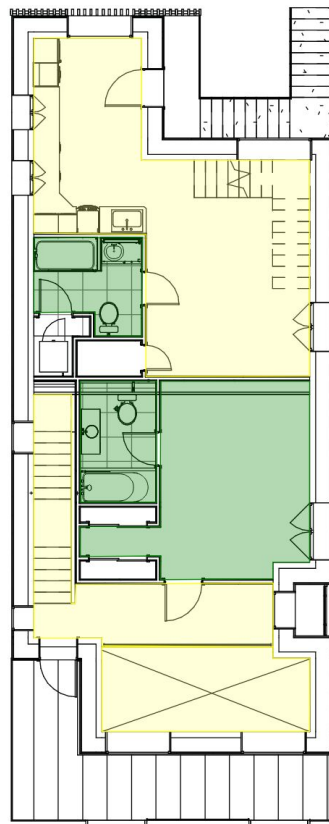
Zone 3:
Primary ON/OFF: Manual Switch
Secondary OFF: Occupancy Sensor



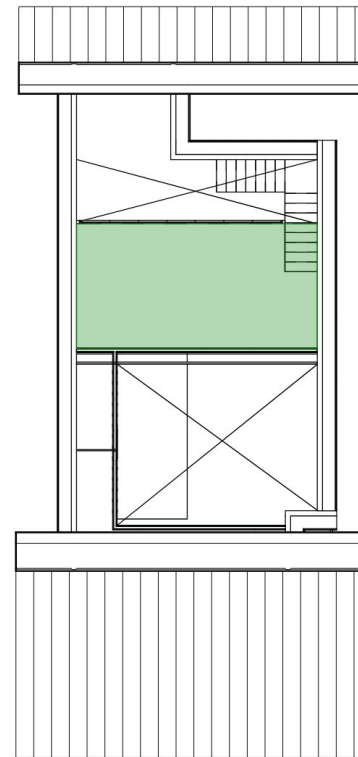
LEVEL 1



LEVEL 2



LEVEL 3





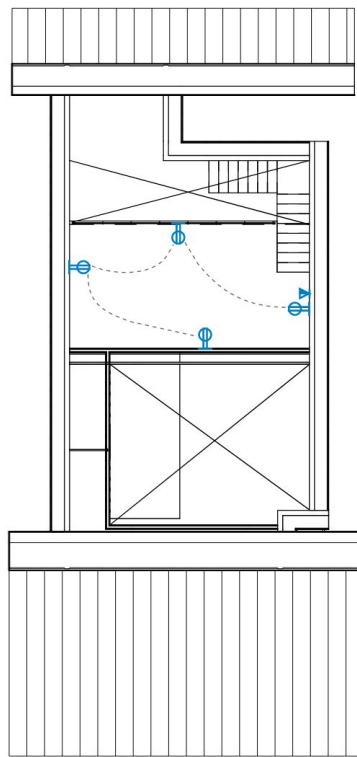
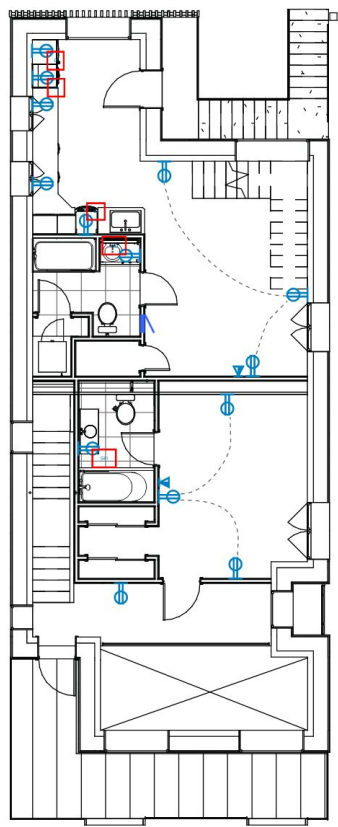
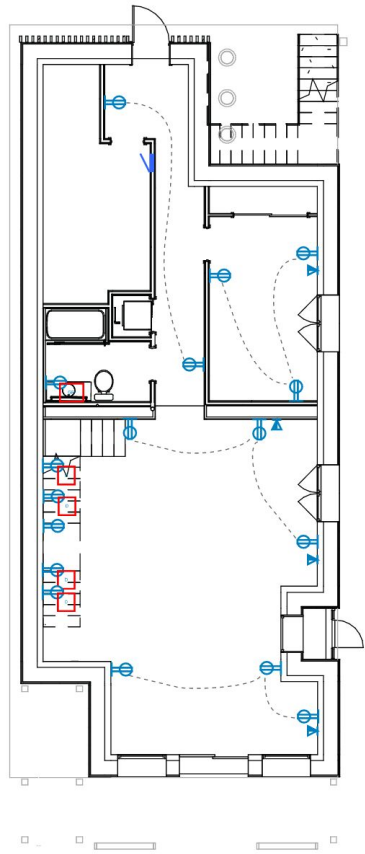
LEVEL 1

LEVEL 2

LEVEL 3

POWER & COMMUNICATIONS SYMBOL LEGEND

-  SMART DUPLEX RECEPTACLE
-  DEDICATED RECEPTACLE
-  GFCI DUPLEX RECEPTACLE
-  ELECTRICAL PANEL
-  DATA/TELEPHONE COMBO OUTLET



ENERGY PERFORMANCE



Energy Performance Metrics



Est. Energy Consumption: **8,000 kWh/yr**

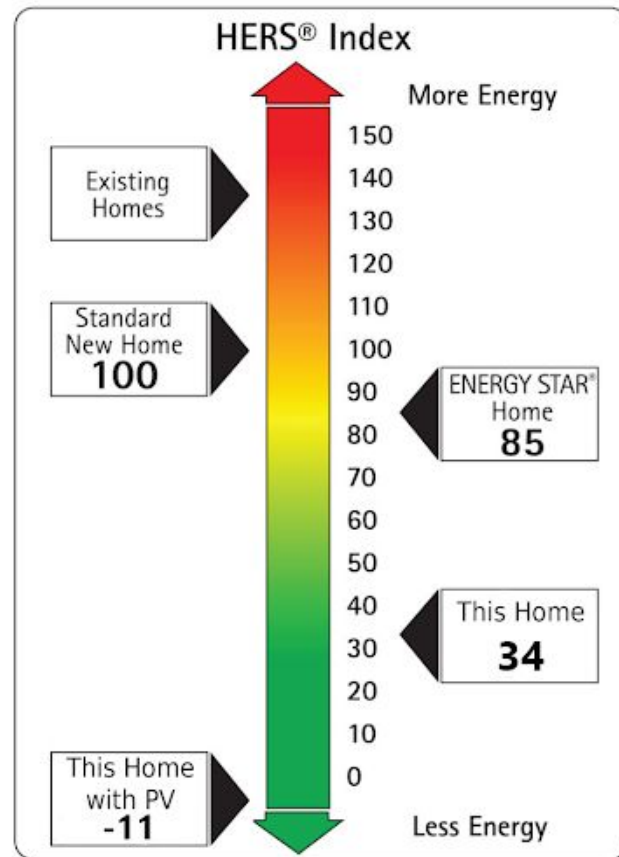
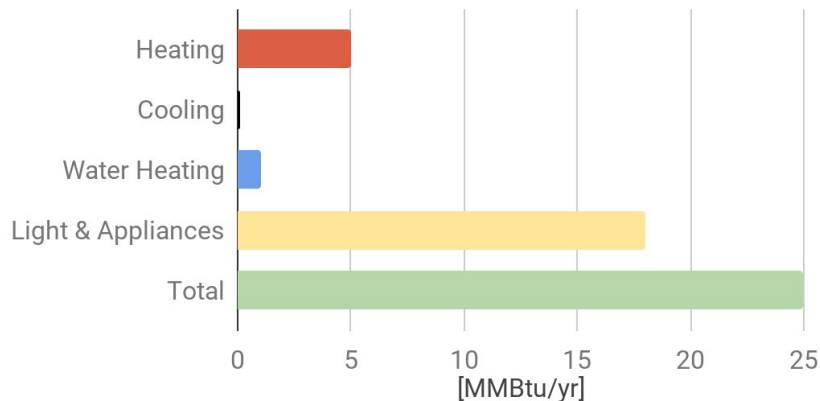


EUI: **48.34 kWh/m²**



Est. Utility Bill: **\$240 CAD/yr**

Estimated Annual Energy Consumption



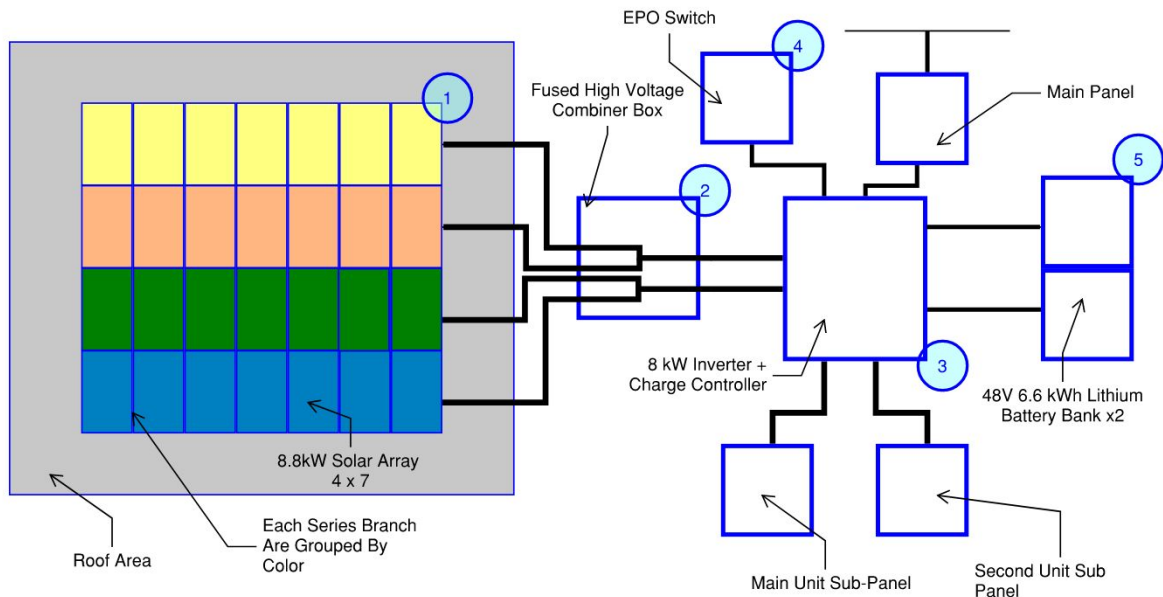


Energy System Metrics

Nameplate Capacity: **8.8 kW**

Expected Yearly Output:
8,600 kWh

Battery Size: **13.2 kWh**



Index	Item	Brand Name
1	Solar Panel	Canadian Solar CS3K-315MS > 315 Watt
2	Combiner Box	Midnite Solar MNPV12-250
3	Inverter/Charge Controller	FLEXpower Radian 8 kW with 2x flexmax 100 charge
4	Shutdown Switch	IMO FireRaptor Shutdown Switch for FRS-01
5	48V Battery Lithium Ion Battery	Discover Battery 260AH 48VDC w/ Xanbus 13,200 Wh (2)

FINANCIAL FEASIBILITY



Vancouver Housing Market



2nd least affordable

- Avg 2 storey: \$2.3million



Sunrise-Hastings: **Land Cost** -
\$150-200/sqft



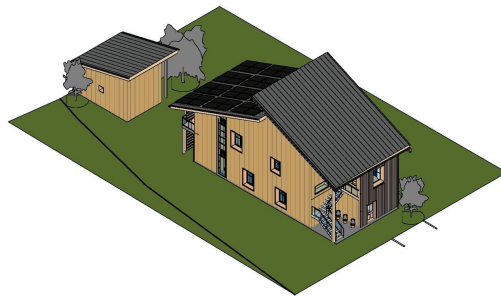
Average home debt to income ratio

- Canada: 177%
- Vancouver: 208%

Rental Unit = Passive Income

- Offsets homeownership costs
- Provides increased density low volume market

Solis House



Construction
Costs

\$389,012.47

Total Cost
\$1,739,012.47

\$1,350,000.00

*Land Value
at Market Rate*

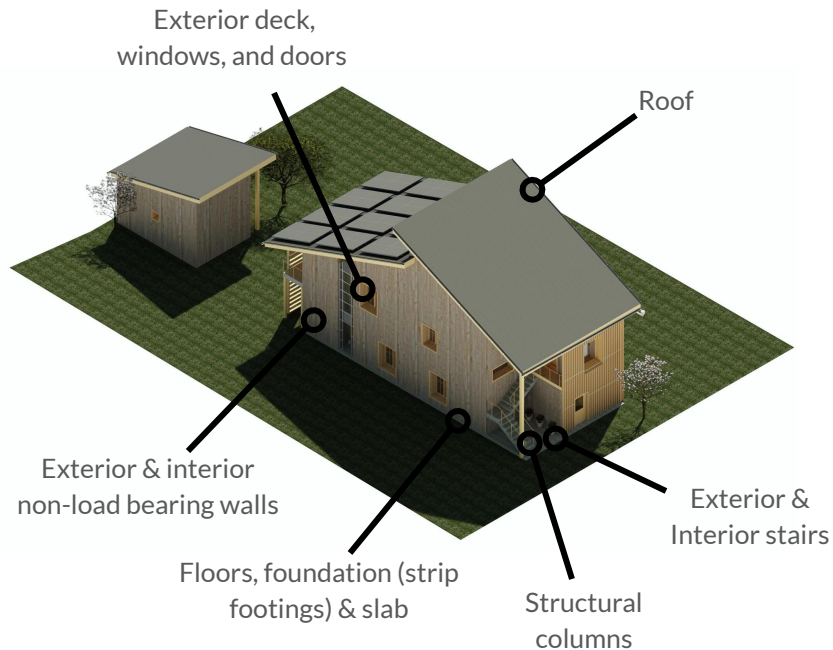
Mortgage

20% down payment	\$347,802.49
Remaining Capital	\$1,391,209.98
Average mortgage payment (25 yr - 5 yr 2.44% fixed IR)	\$6,191.00
Homeowner Debt to Income Ratio	47.93%

EMBODIED CARBON



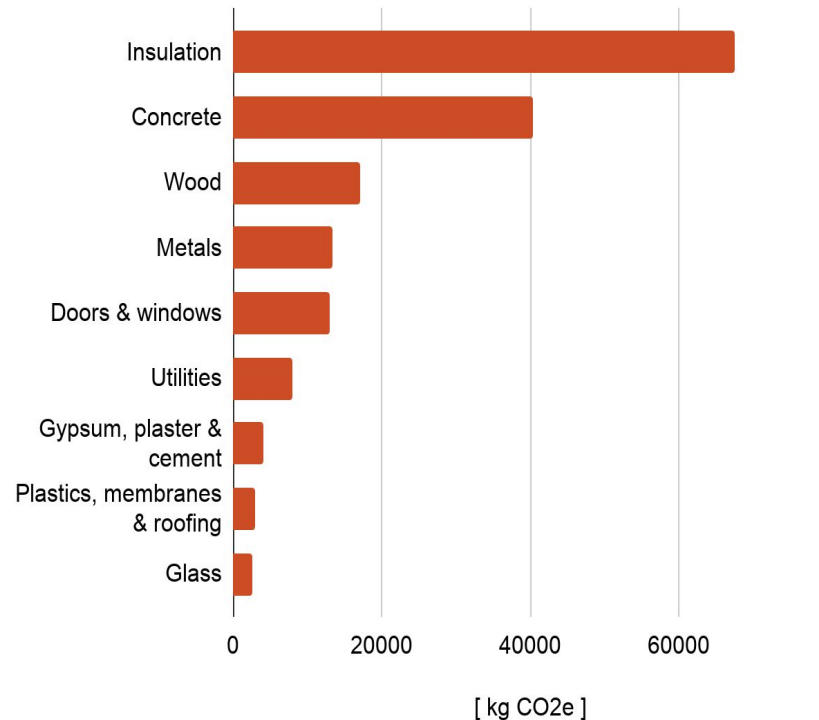
LCA Scope: 100 years



Trade-offs

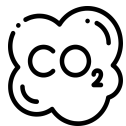
High levels of insulation balance low operational emissions

Global Warming, kg CO₂e - Resource Types





Embodied Carbon Impacts



169 Tons CO₂e

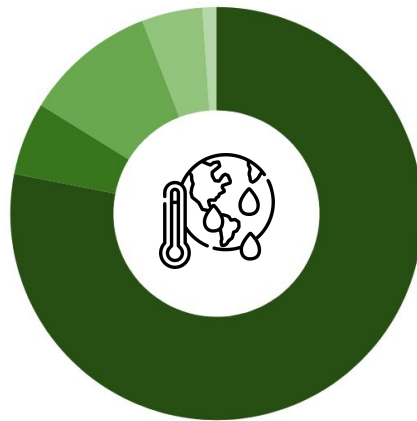


8 kg CO₂e / m² / yr



\$12,868.85 CAD
social cost of carbon

Global Warming (kg CO₂e) - Life-cycle stages



● A1-A3 Materials ● A4 Transportation
● B1-B5 Maintenance and replacement ● B6 Energy ● C1-C4 End of life

INNOVATION



MATERIAL SELECTION

- Recycled Plastic Honeycomb
- BubbleDeck Slab on Grade
- Oyster Shell Composite
- Cross-laminated Timber
- Wood Fibre Insulation

SELF SUFFICIENCY

- On-site Energy Production
- Rainwater Harvesting

ONSITE FOOD PRODUCTION

- CityBeets Community Garden Partnership
- Indoor Vertical Greenhouse





***Thank
you.***

- Solis House -



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