BUILT FOR THE NORTH

THE TEAM

Maggie Turmel

Specialized in project management and building structure.

Hannah del Rosario

Specialized in building energy and environment. Previous degree in Architectural Design and Environmental Studies.

Mihail Mihaylov

Specialization in building structure. Previous experience in the construction industry.

Youssef El Ouarat

Specialized in building structure and project management. Previous Computer science degree and IT professional experience.

Kishan Gandhi

Specialization in energy and environment with previous experience in mechanical and structural design.

Bruno Lee

Department supervisor at Concordia University.

Specialist in Building Energy Performance.

DESIGN PARTNERS

Dr. Bruno Lee

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Dr. Athienitis

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William Semple

Alejandro Cisnero

Daniel Baril

Samuel Dwore-Palmer

isofib

Homeland Hempcrete
Homes Built Better

B. PUBLIC PREFAB

HECO

Nunavut Housing Corporation
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Nunavut Housing Corporation

TIMBERHP
by GO LAB

cadwork

475 HIGH PERFORMANCE BUILDING SUPPLY

S COFFRAGES SYNERGY FORMWORK

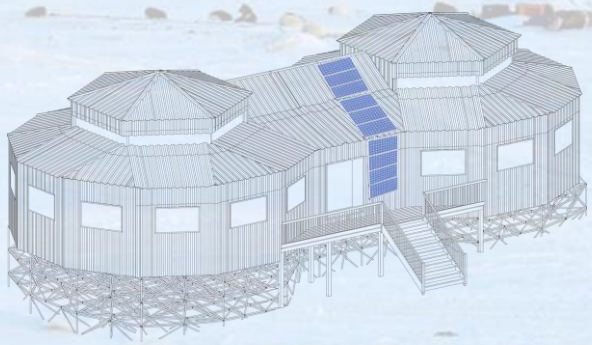
DESIGN GOALS

Offer affordable housing by minimizing building and shipping cost.

Eliminate thermal bridging.

Achieve an annual net-zero energy.

Design with respect of the local and historical culture of the Inuit community.



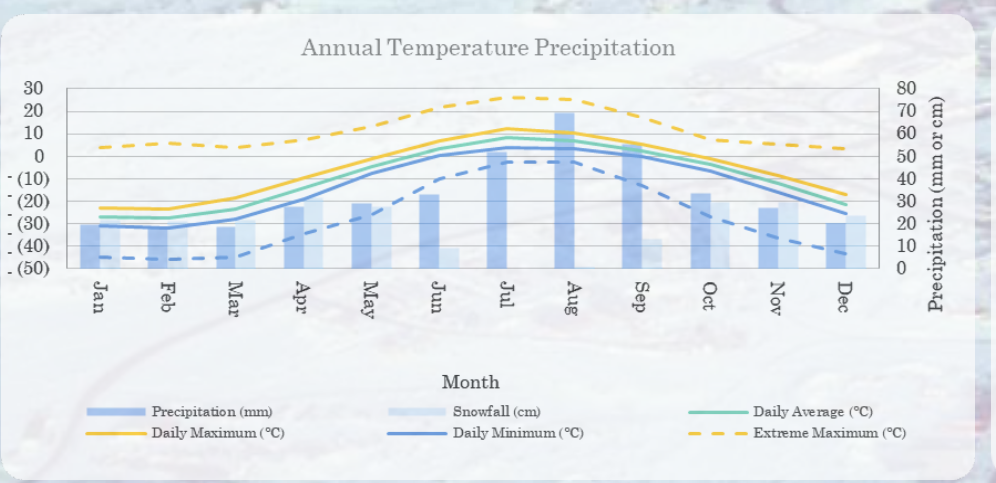
Design in accordance with Iqaluit's arctic climate

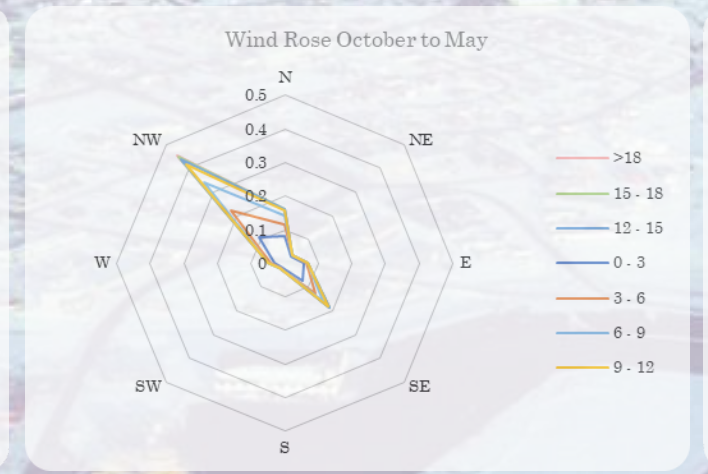
All natural or recycled materials. Zero synthetic Insultation materials.

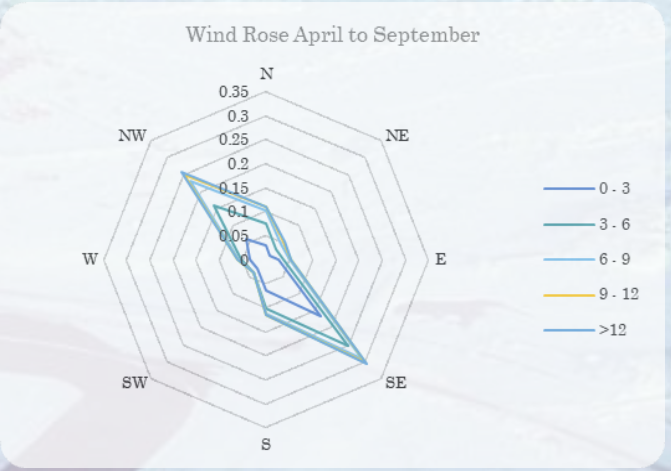
SITE AND WEATHER

Joamie Court,
Iqaluit, Nunavut
Lat. : 63° 44' 54.9996'' N
Long. : 68° 31' 10.9992’’ W

Temperature: -40°C – 12°C [-40°F - 54°F]
Daylight Hours: 4-21hrs
Average Winds: 6m/s [19. 7ft/s]







DEMOGRAPHICS AND HISTORICAL CONTEXT

DEMOGRAPHICS

7,429 Total Population

58.5% Inuit Population

42% Inuktitut Speaking

31 Average Age

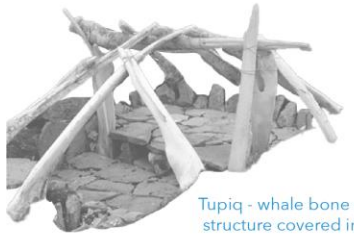
19% Population with Highschool Diploma

Housing Issue	Inuit Single Identity	Non-Aboriginal Identity Population
	Percent %	
Crowding	39.2	4.3
Home in need of major repairs	35.4	13.7

60% of Nunavummiut live in public housing

98% of which are Inuit

HISTORICAL CONTEXT



Tupiq - whale bone or drfit wood structure covered in hydes .

"Eskimo mother and baby standing in front of crude shack at Igloolik, April 1958. The baby has nothing on below the waist yet the temperature is 10° below zero. Does this mother appreciate the effect of this temperature on the baby?"

Rigid-Digit House

Interior damage

Peeling paint

Igloo - used in winter while hunting along ice flows. Lined igloo in hydes to block air.

Matchbox House

Overcrowded home.

Pre-1940s

The igloo, the Inuit's most permanent housing, was in a state of imperenance, on ice.

Qarmac
- sod house

1950s

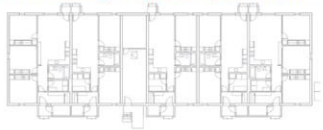
High incidence of respiratory desiease, post-WWII, from exposure to new illnesses.

The "Eskimo Mortality and Housing" report balmed mortality on housing conditions which ignited the housing policies imposed on Inuit communities.

1960s-Present

Implementation of government housing. Imported design from the South, inadeqaute for climate and culture.

Northern Housing Corporation, 2019 model



Housing Crisis

Housing shortage of 3800 units and 35% of existing houses in need of repair.

To properly addess housing issues - necessary to consider traditional Inuit practices.

Broken windows taped and covered in plastic

Windows won't close

ARCHITECTURE

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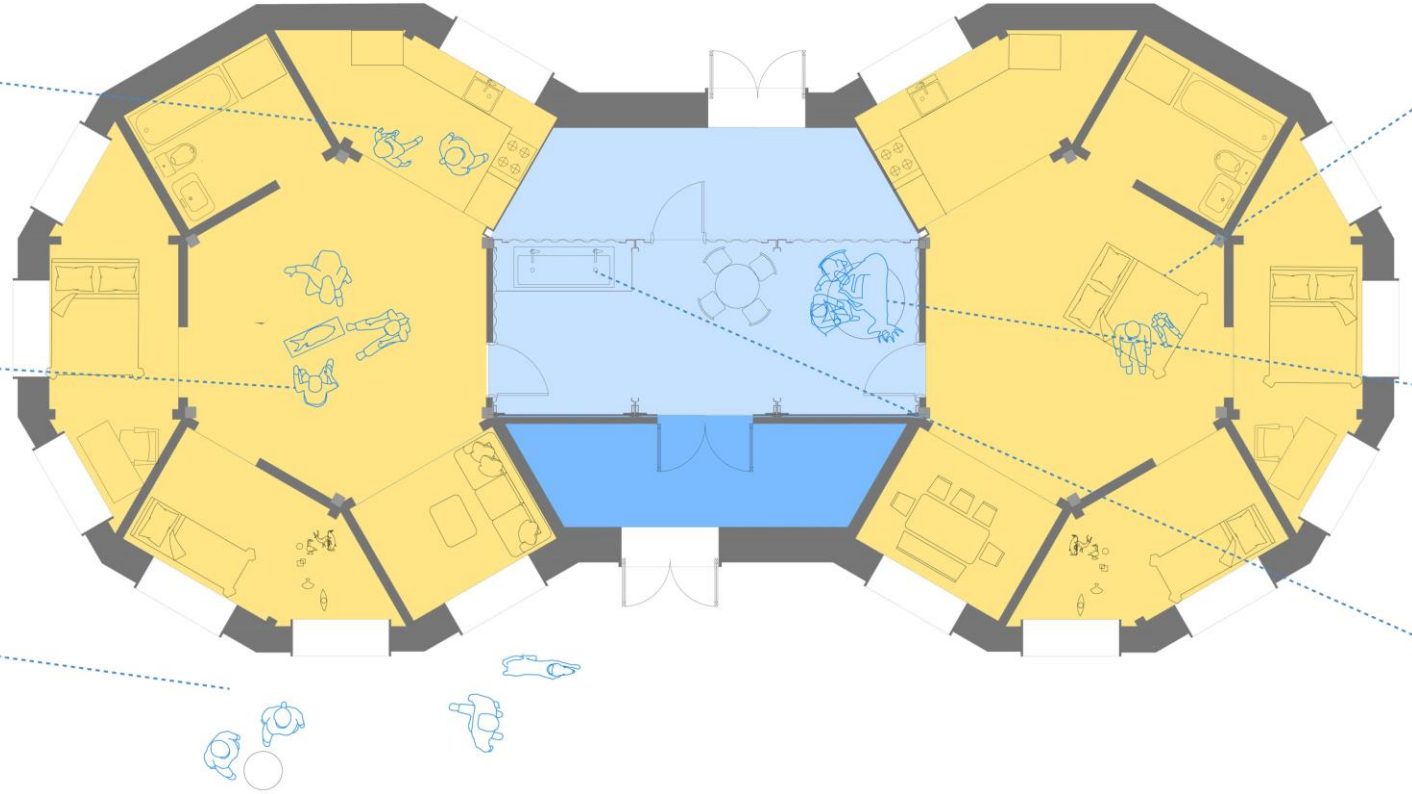


Cold Space
- Outerwear storage
- Entrance

Cool Space, 5°C (41F)
- Mechanical room
- Sewing room
- Hide preparation
- Meat processing

Warm Space, 21°C (70F)
- Kitchen
- Bathroom
- Flexible Living Space

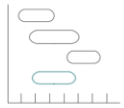
ENGINEERING

ENGINEERING

Prefrabricated Envelope

Reduced Timeline

- 10-20% Reduction in Site Time
- Construction Year Round
- Reduced Skilled Labour on Site



Controlled Environment

- Reduce Built in Moisture
- Ensure Precision

High Quality

- Ensure Precision of Continuous Envelope Layers

Waste Optimization

Cost Certainty

Construction Process

Step 5 - Roof Panel

- I-Joist Roof Panels

Step 4 - Attach Wall Panels To Structure

- C-Joist Wall Panels

Step 3 - Structure

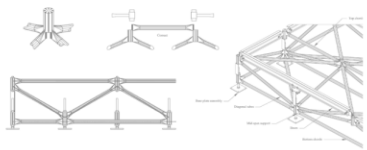
- 10ft Shipping Containers
- Timber

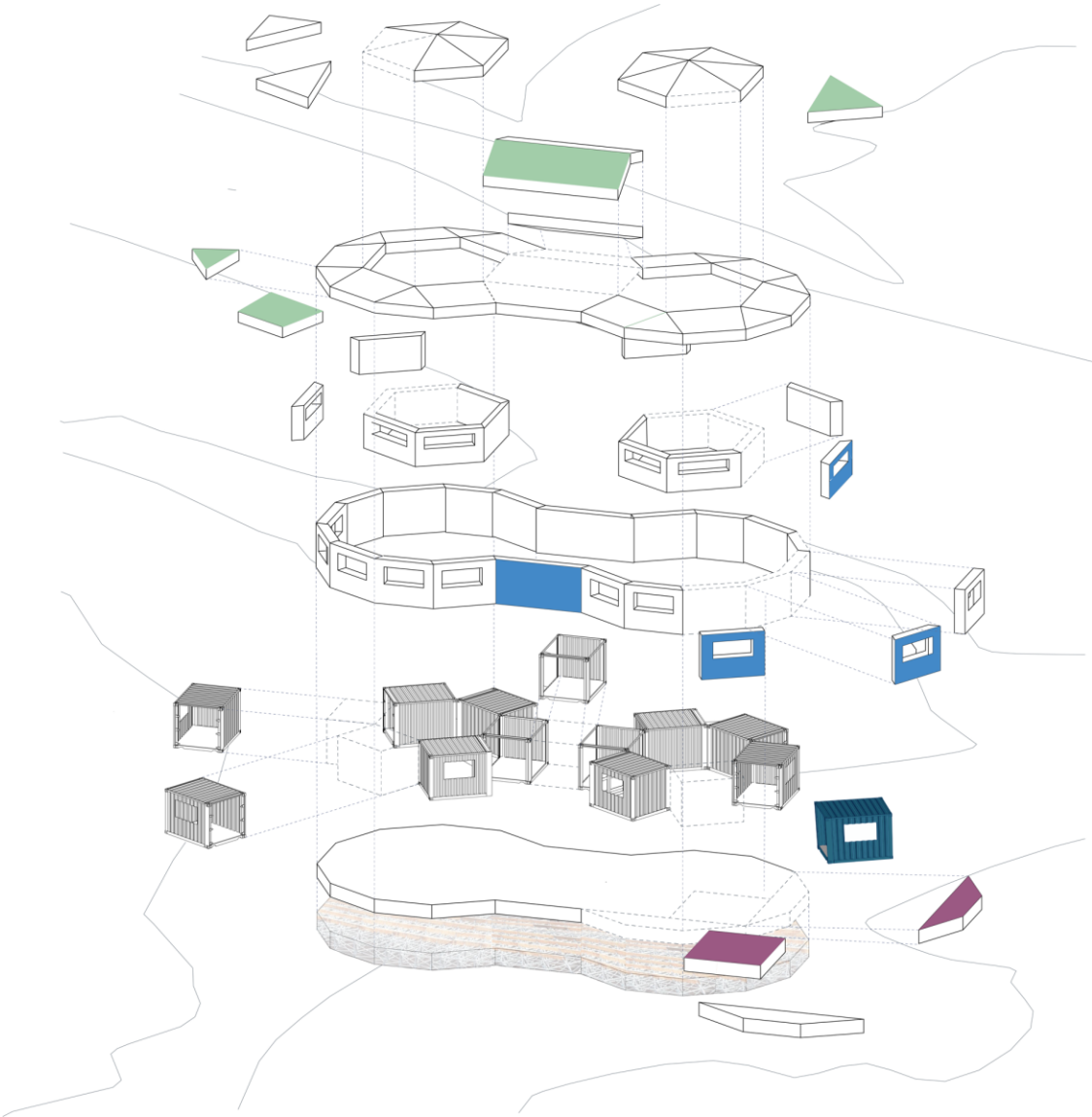
Step 2 - Floor Panels

- I-Joist Floor Panels

Step 1 - Place Foundation

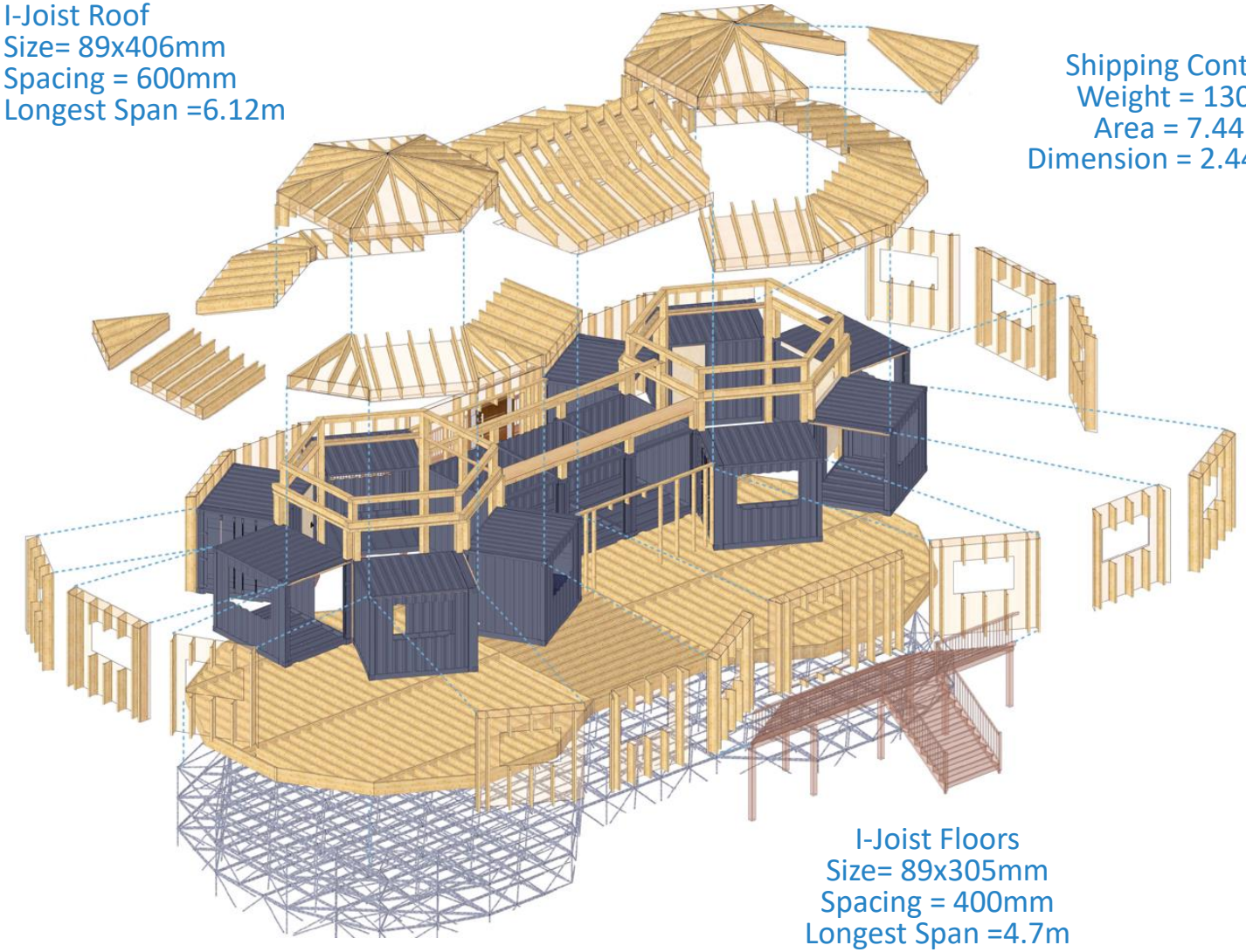
- Multipoint Frame





ENGINEERING

I-Joist Roof
Size= 89x406mm
Spacing = 600mm
Longest Span =6.12m



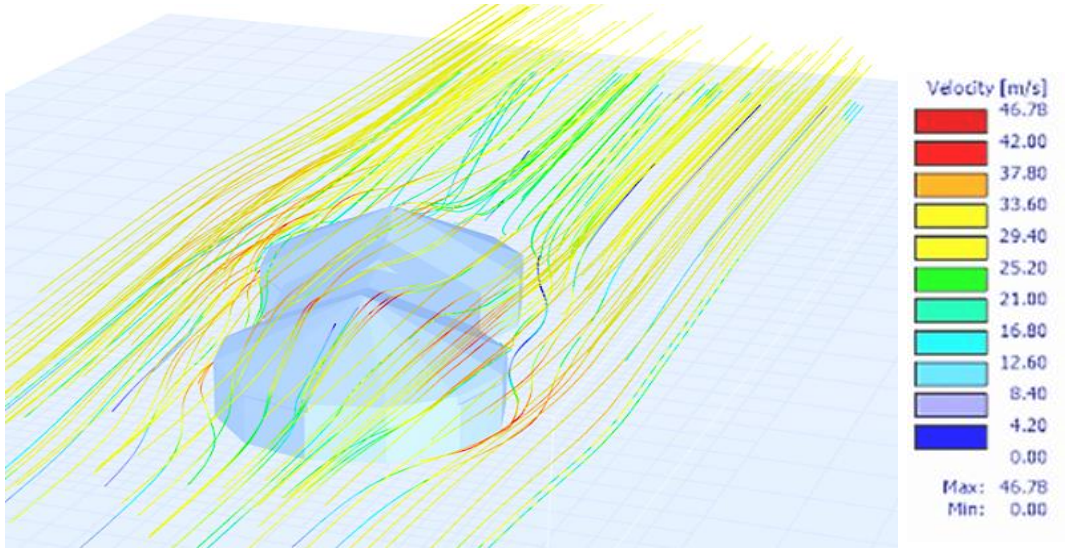
Shipping Container
Weight = 1300 kg
Area = 7.44 m^2
Dimension = 2.44x3.05m

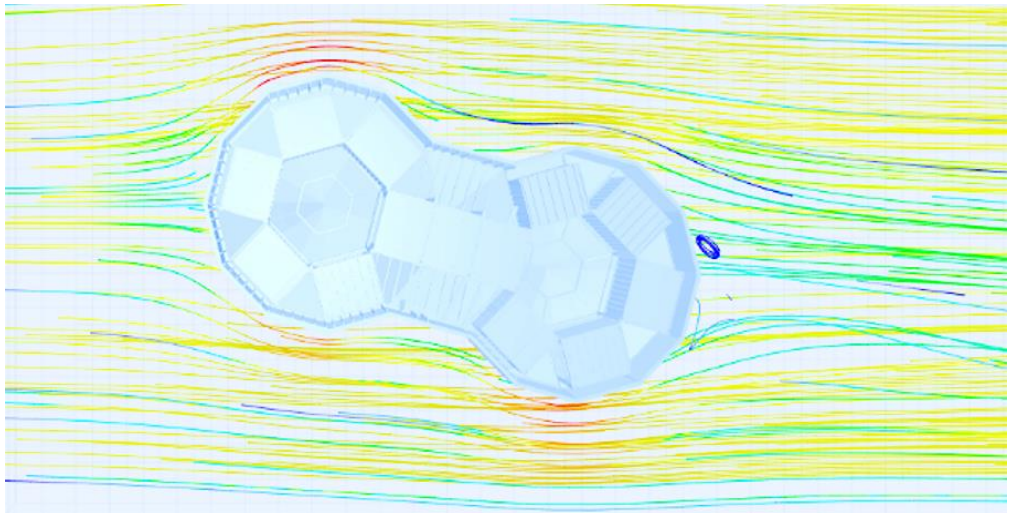
I-Joist Floors
Size= 89x305mm
Spacing = 400mm
Longest Span =4.7m

Multipoint Foundation

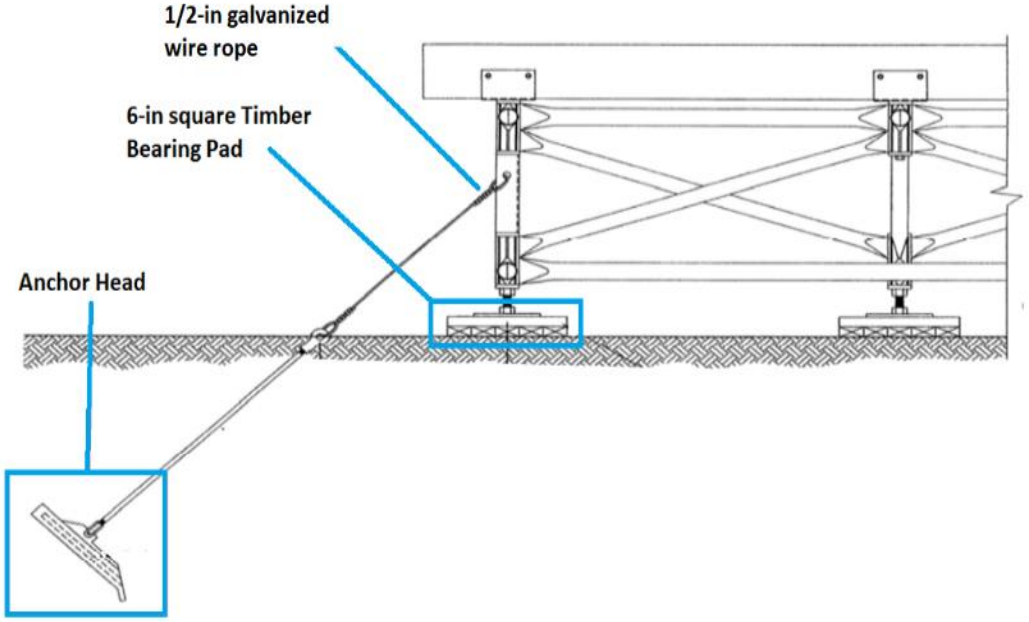
- Ideal for unstable soil such as permafrost ground
- 10ft x 8ft containers can support 900kN.
- 13 containers in the assembly
- Reduced assembly time.
- No skilled worker or heavy equipment required

ENGINEERING





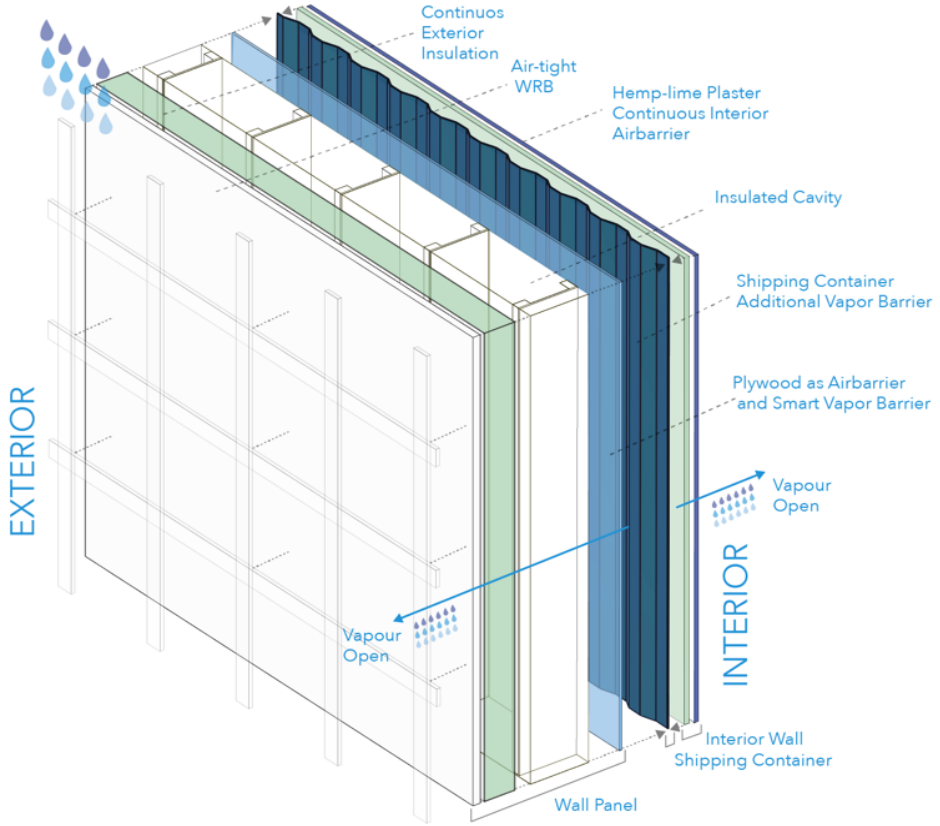
- **30% Less Wind Load Than a Typical Building**
- **Anchorage System to Prevent Structure Tilting**



DURABILITY & RESILIENCE

DURABILITY & RESILIENCE

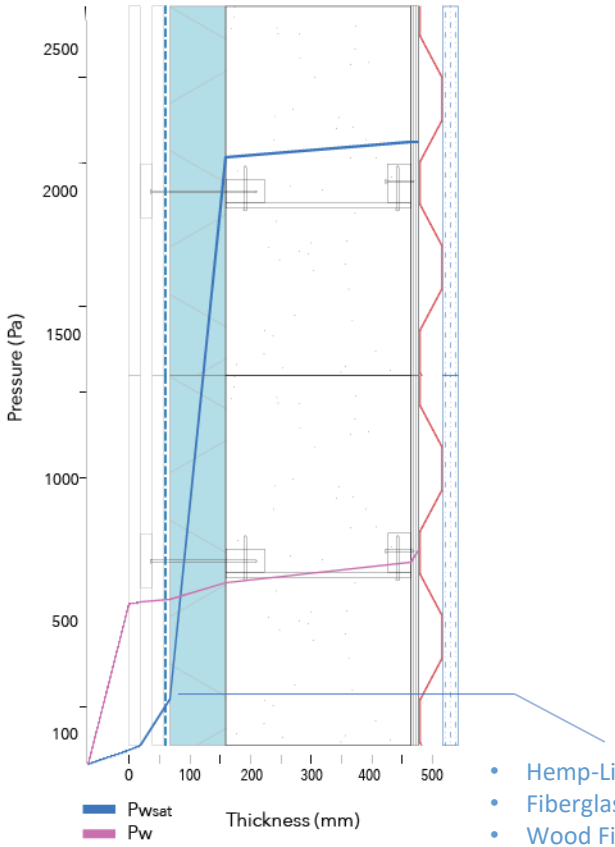
Envelope Composition



R-Value Wall: 52.68 [9.29 W/m^2]
R-Value Roof: 61.83 [10.89 W/m^2]
R- Value Floor: 46.06 [8.11 W/m^2]

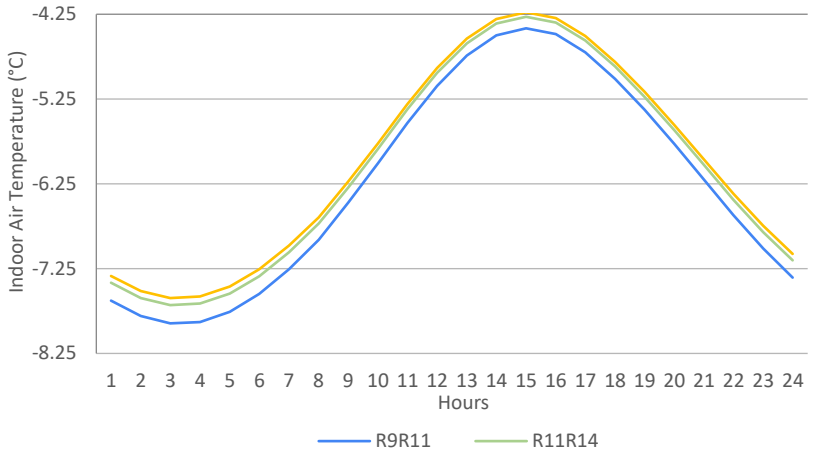
DURABILITY & RESILIENCE

Condensation Check

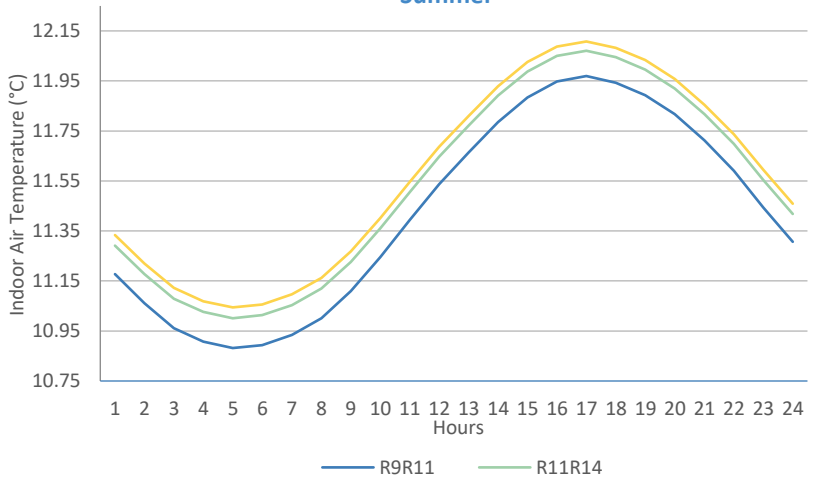


- Hemp-Lime Plaster 1”
- Fiberglass Lath
- Wood Fiber Insulation 1“
- Shipping Container
- Plywood 5/8”
- C-joist, 12”, with Cellulose Insulation 24"o.c.
- Wood Fiber Insulation 3”
- Mento Plus Air Barrier
- Horizontal and Vertical Furring 2x3/4”
- Vertical Metal Cladding

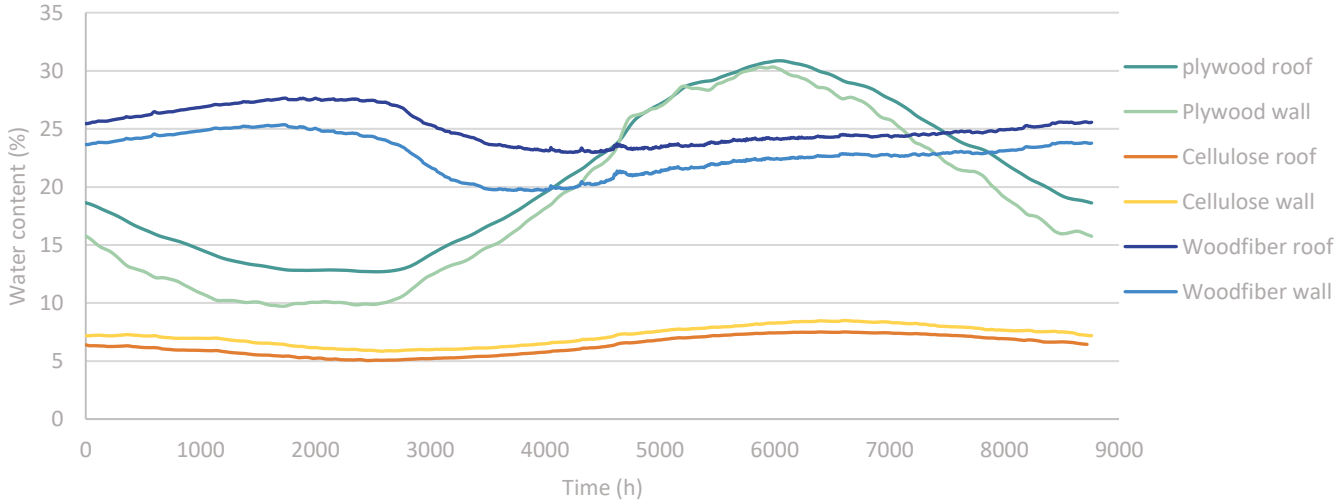
Wall and Roof Insulation Impact on Indoor Air Temperature Winter



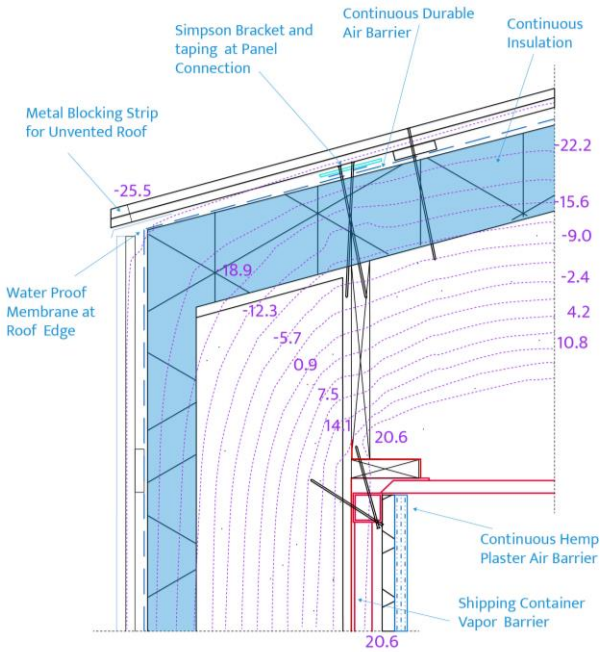
Wall and Roof Insulation Impact on Indoor Air Temperature Summer

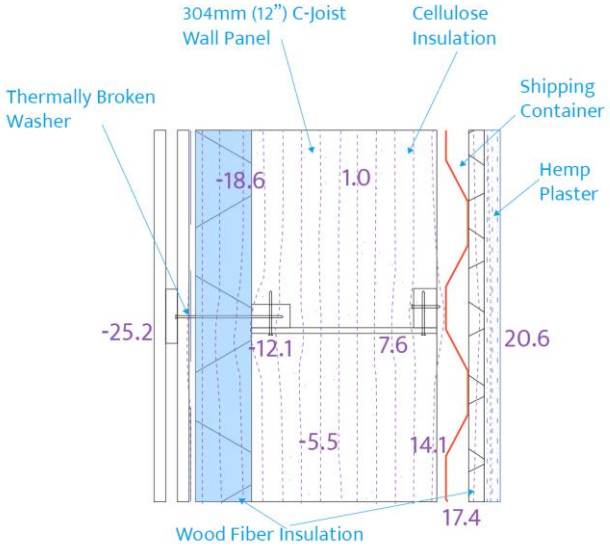


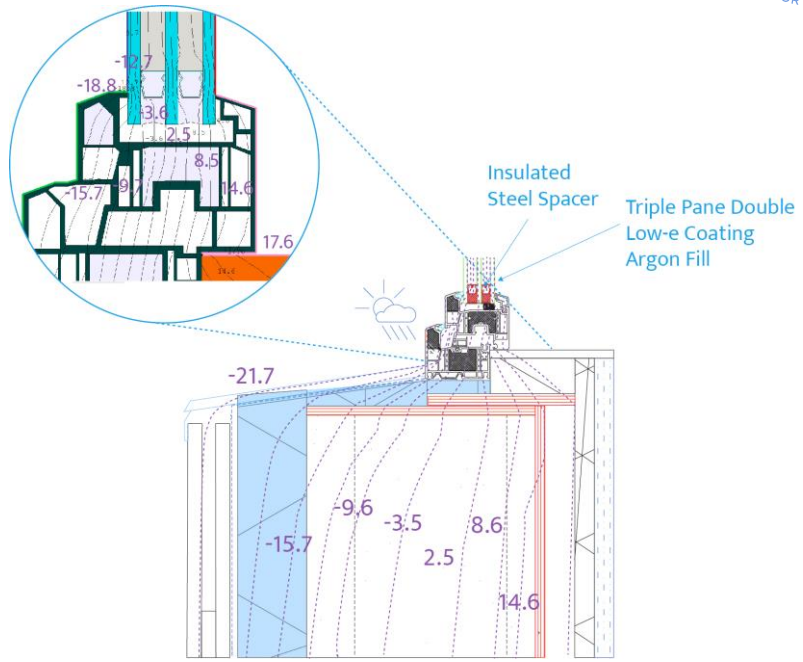
Water content in critical layer of the assembly according to time

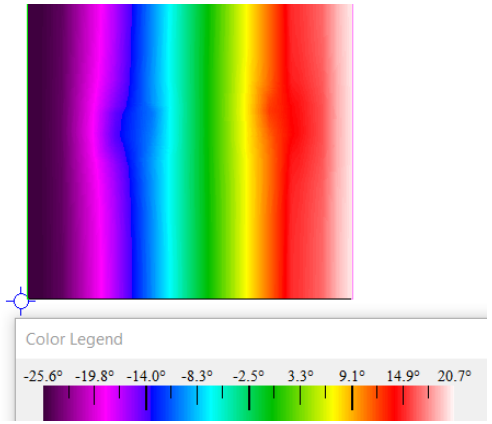


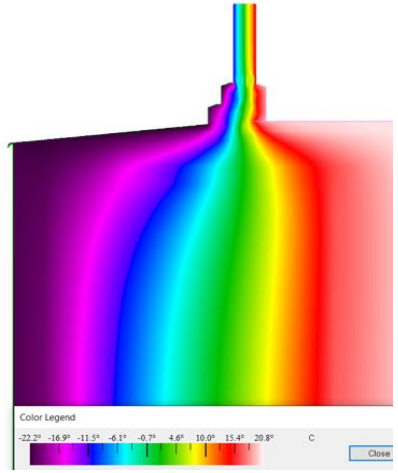
DURABILITY & RESILIENCE









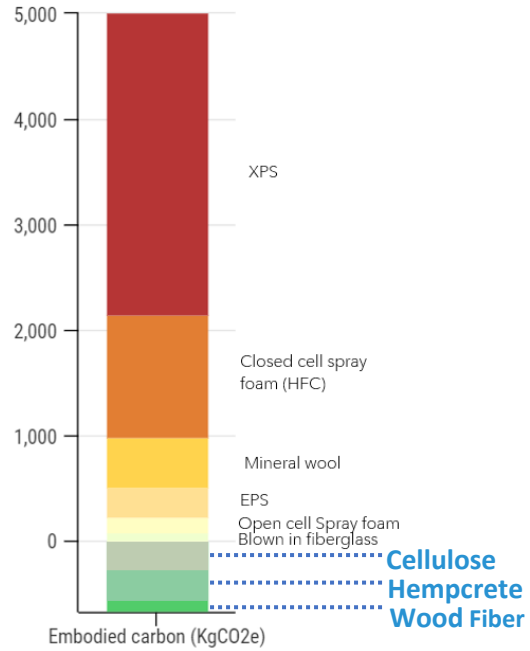


EMBODIED CARBON

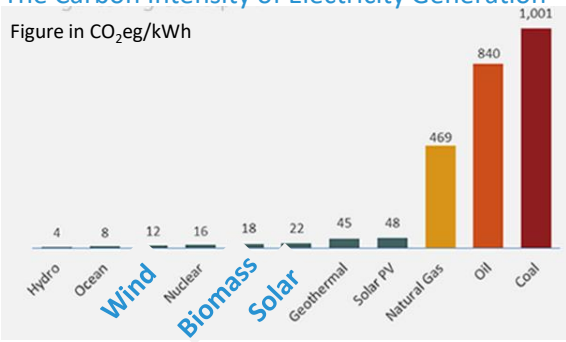
EMBODIED CARBON

Material Sources

Material Embodied Carbon



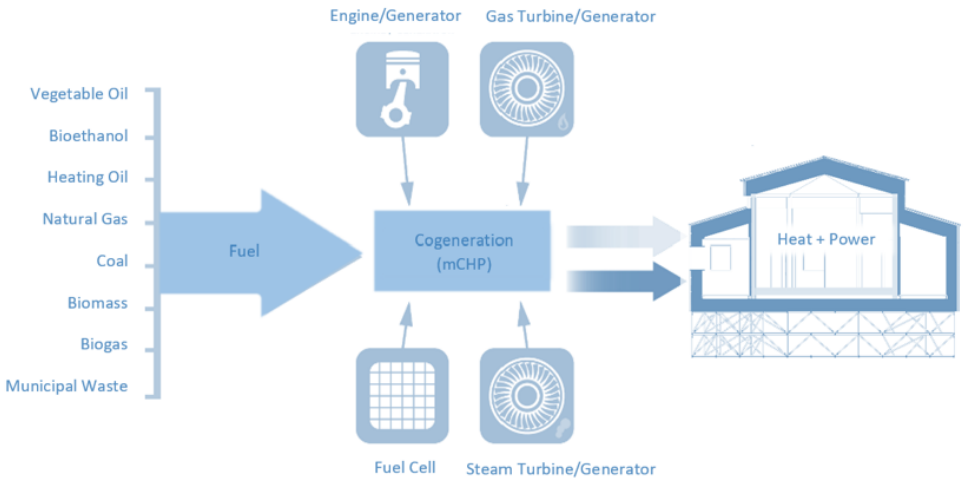
The Carbon Intensity of Electricity Generation

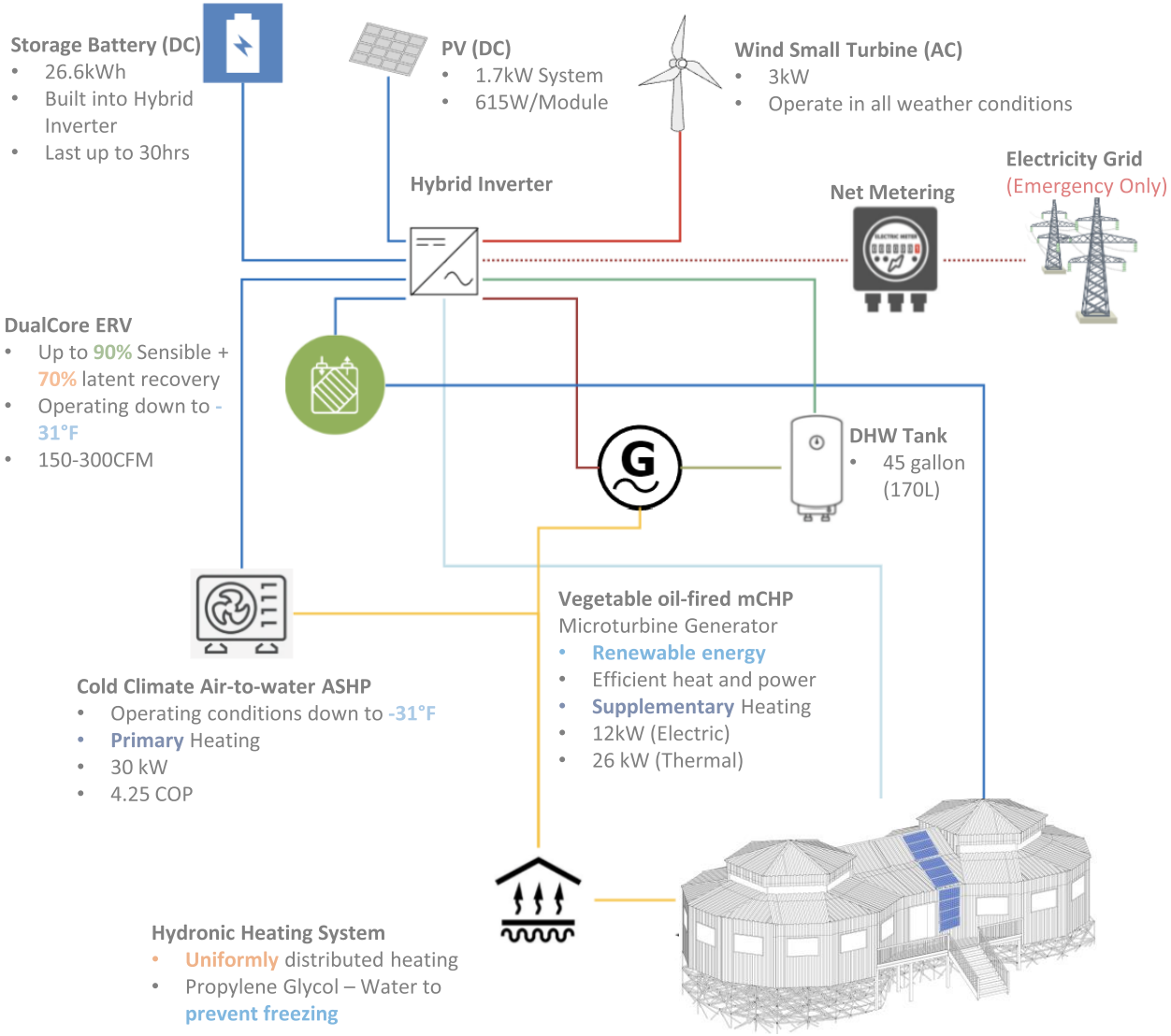


COMFORT & ENVIRONMENTAL QUALITY

COMFORT & ENVIRONMENTAL QUALITY

Hybrid Power and Heating System





Reduced energy demands

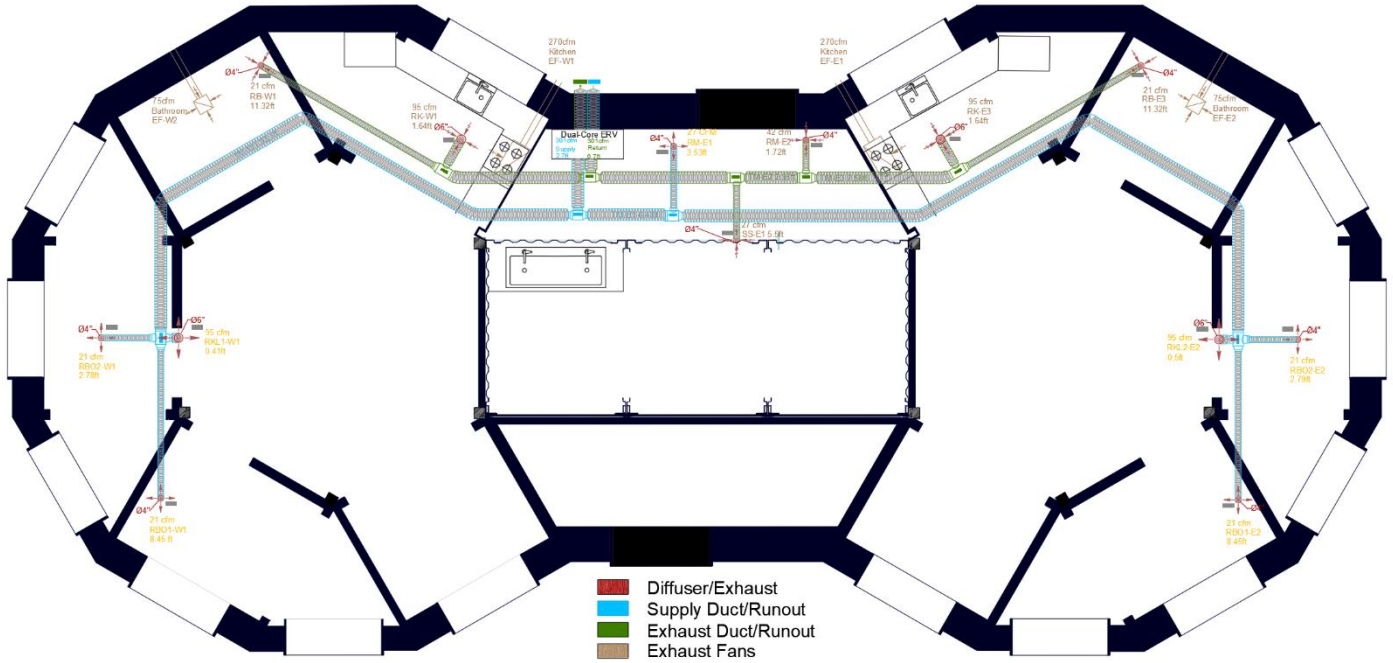
Reduced GHG by 30% annually

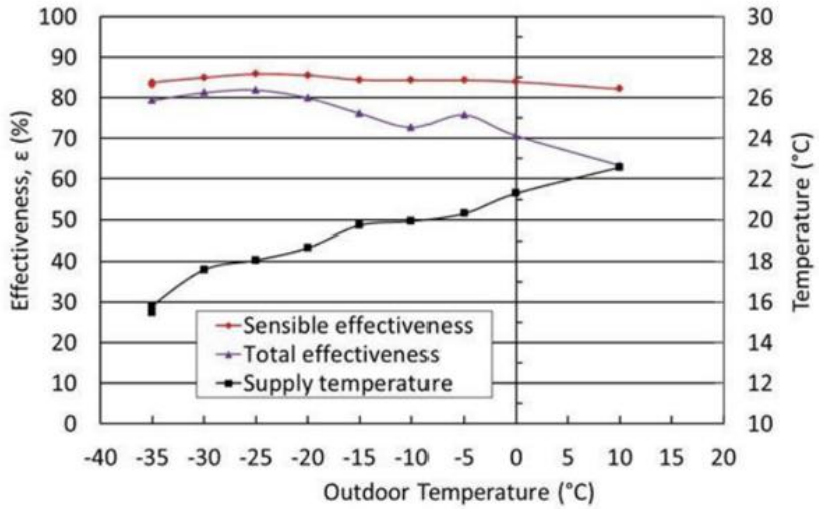
On site energy generation

Up to 90% energy efficient

COMFORT & ENVIRONMENTAL QUALITY

Mechanical Ventilation: DualCore ERV





DualCore ERV
Tempeff
RGSP 450
150-300 cfm

Diffuser and Grille
Imperial Premium
Round Air Diffuser
4-6"

Bathroom Exhaust Fan
AirKing
ASHRAE 62.2. Approved
75 cfm

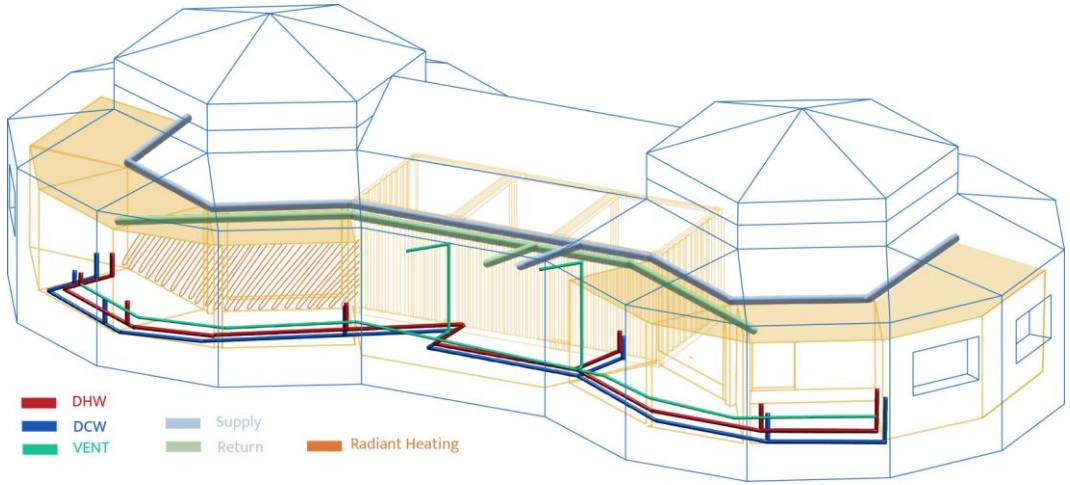
Kitchen Range Hood
AirKing
ASHRAE 62.2. Approved
270cfm

Flexible Ducting (PVC)
Polyvent 660
6000 CFM

- Exceeds ASHRAE 62.2 recommendation for ventilation
- Operates below -35°C without reducing thermal performance based on Nunavut Case Study
- Demand Controlled Ventilation to increase energy efficiency
- Connected to CO2 sensors
- Preheat Coil for outdoor air

COMFORT & ENVIRONMENTAL QUALITY

Plumbing & Hydronic In-Floor Heating



Valves
Aqua-Dynamic Brass Full Port Ball Valve, Assorted Sizes

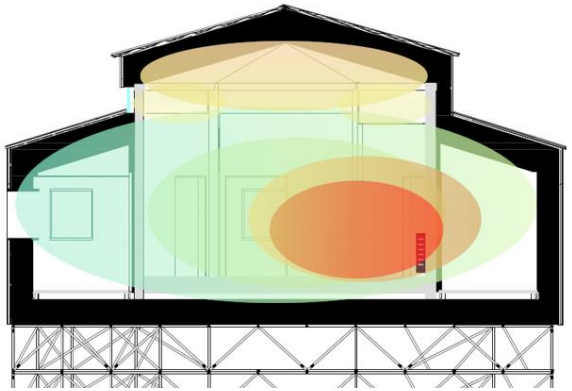
Sinks
Blanco 402067-PRECIS U1 Low Divide Undermount Sink, SILGRANIT, Cinder

Pipes
System 15® PVC DWV

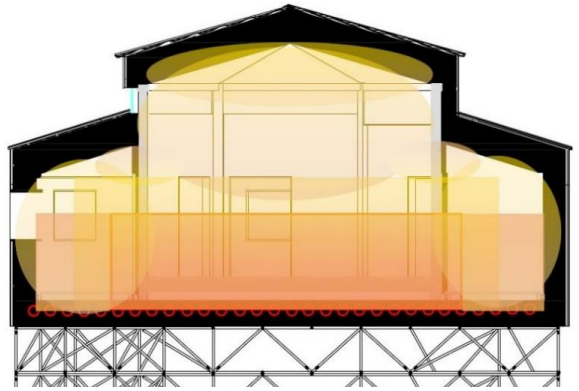
Conservation of water:
E Touchless Electronic Faucet With Temperature Control Lever

Design information	
Piping Span	0.3 m (11.8in or 12in)
Pipes diameter	0.5 in
Fluid	50% Propylene Glycol
Best material	Schedule 80 PVC or PEX

Traditional Central Heating

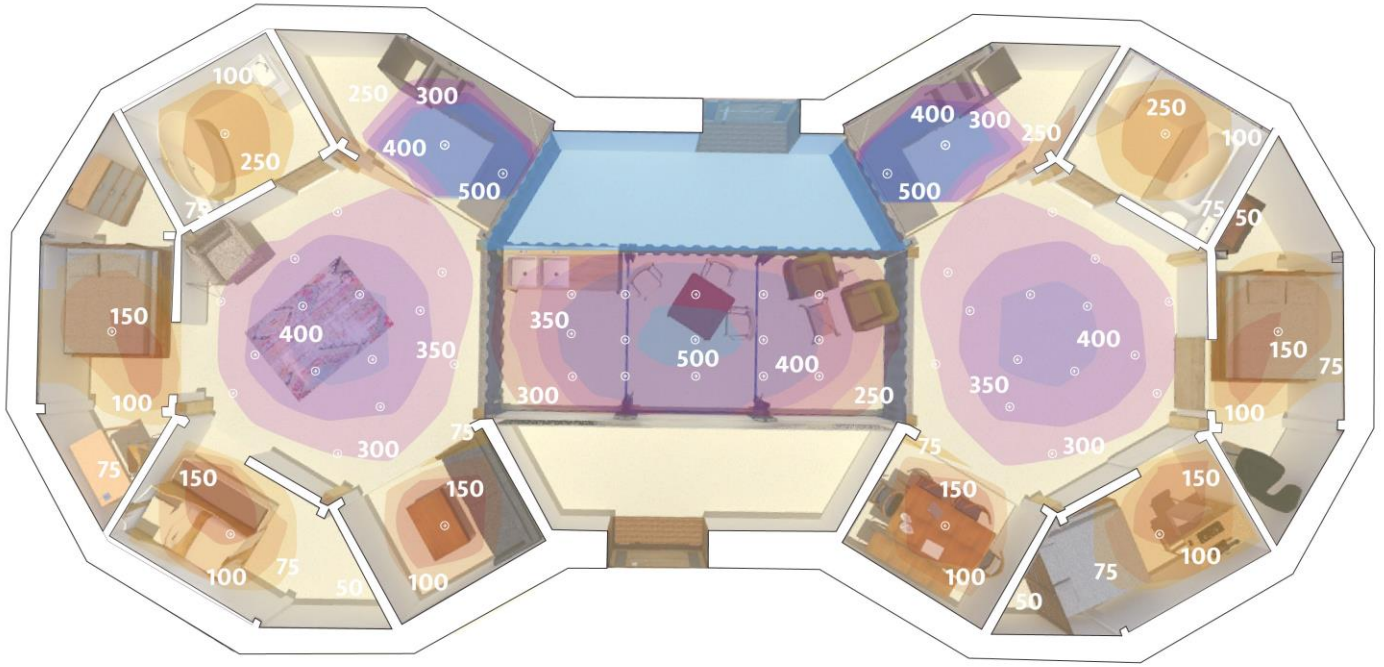


Hydronic In-Floor Heating



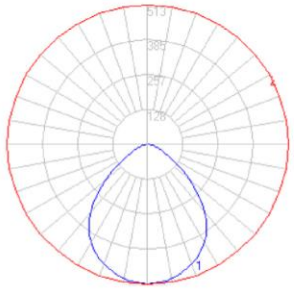
Thermal Zones	Temperature °C [°F]	Relative Humidity (%)
West Bedroom Office 1	22.2 [72.0]	42.7
West Bedroom Office 2	21.8 [71.3]	43.4
West Bathroom 1	21.4 [70.4]	44.3
West Kitchen and Living Space	21.9 [71.3]	55.5
East Bedroom Office 1	22.2 [71.9]	42.2
East Bedroom Office 2	21.8 [71.2]	42.9
East Bathroom 1	21.3 [70.4]	44.4
East Kitchen and Living Space	21.8 [71.3]	55.8

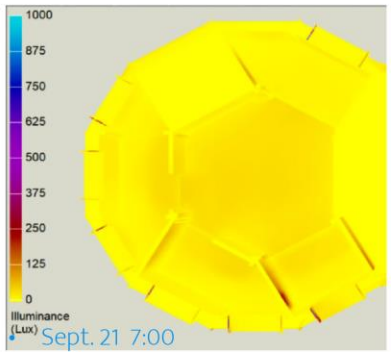
Daylight and Lighting

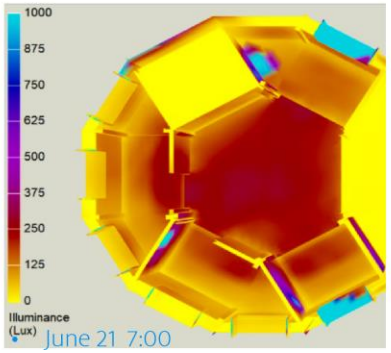


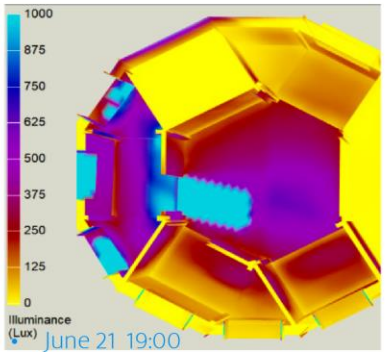
Copper Lighting Solutions

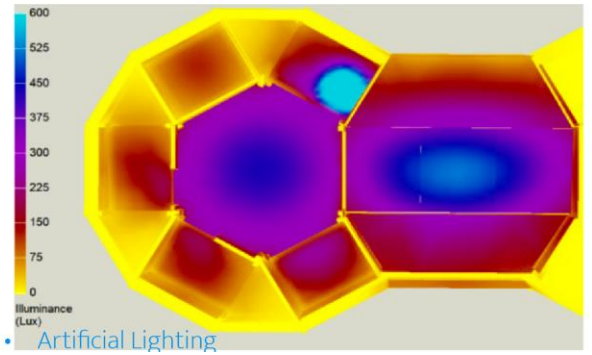
- Array of High Lumen LEDS, 100W
- Luminaire Efficiency Rating (LER) 100
- Max 513.3 Candela at 0H 0V
- 1000 Lumen
- 3000K CCT
- 90CRI











OCCUPANT EXPERIENCE

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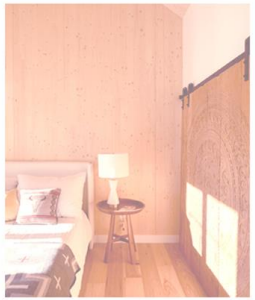
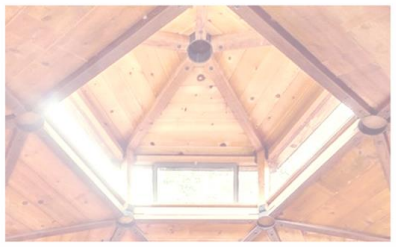
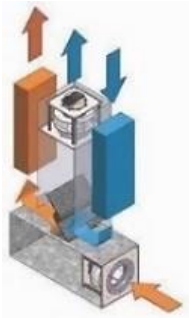


Relative humidity and air quality challenges



DualCore ERV
Tempeff RGSP 450
150-300 cfm

Hemp Plaster
Interior Finish
and Thermal Mass


OCCUPANT EXPERIENCE

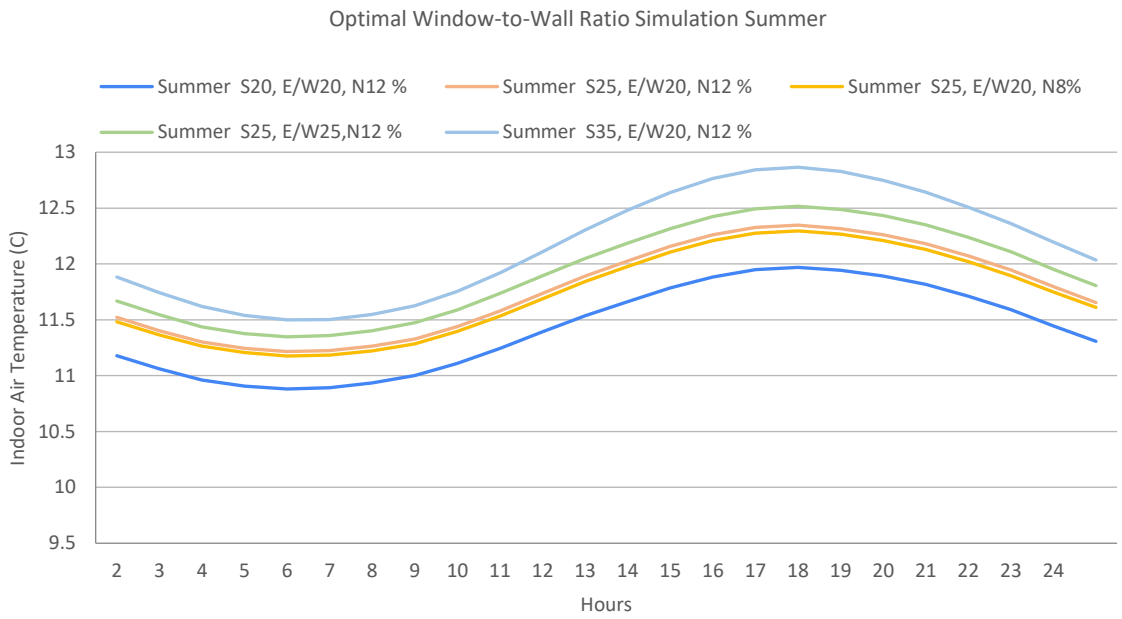
OCCUPANT EXPERIENCE

OCCUPANT EXPERIENCE

INTEGRATED PERFORMANCE

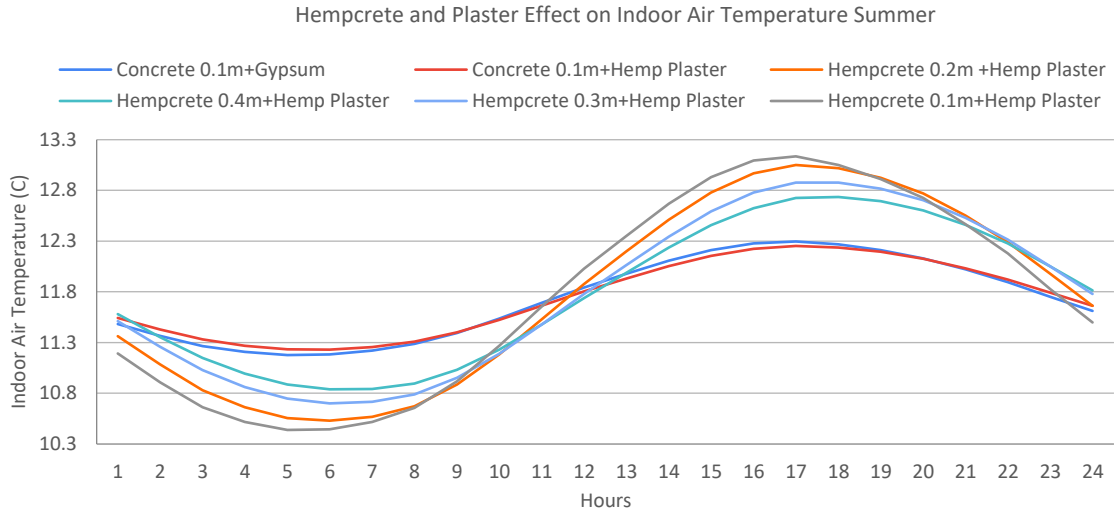
INTEGRATED PERFORMANCE

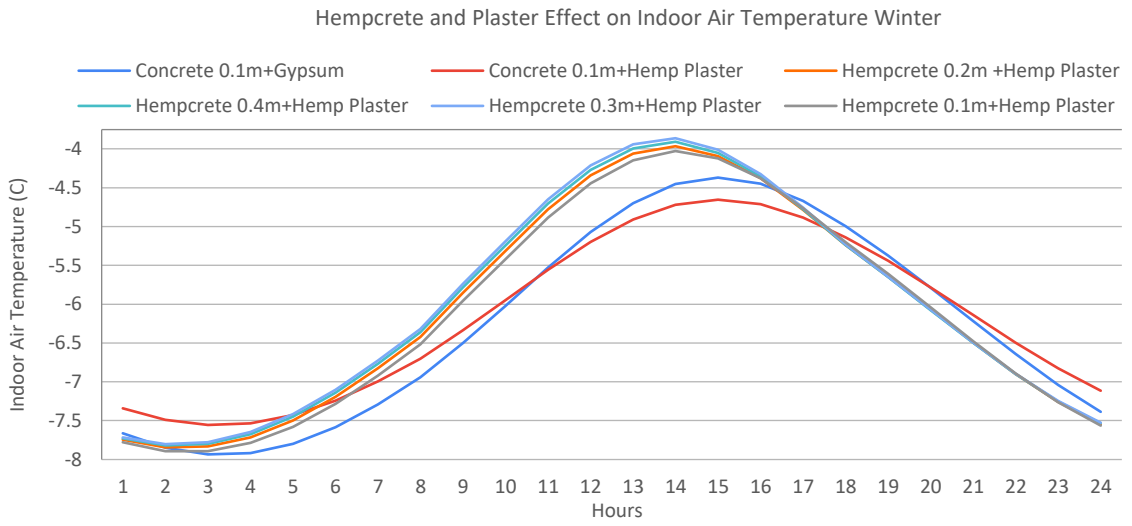
Window to Wall Ratio



Case	South WWR	E & W WWR	North WWR	Peak Heating Load (kW)	Design Heating Load (1.25) {kW)
1	20	20	12	21.07	26.34
2	25	20	8	21.01	26.26
3	35	20	12	21.15	26.44
4	25	25	12	21.04	26.30

Thermal Mass





INTEGRATED PERFORMANCE

SD3 Small Wind Turbine

- Continuous energy generation + storage during winter
- Northwest independently mounted (6m)
- Self-regulating blades to improve efficiency
- Withstand up to 70m/s wind speeds
- High performance in all weather conditions.
- SD6 used in Antarctica
- Designed for northern Canadian climates

INTEGRATED PERFORMANCE

CanadianSolar HiKu7 Mono PERC

- Monocrystalline solar cells to maximize efficiency per area on south wall/roof
- Capture up to 24hrs of sunlight during peak summer
- Heavy snow load up to 5400 Pa + wind load up to 2400 Pa
- Up to 20.5 % module efficiency
- Designed for northern Canadian climates

INTEGRATED PERFORMANCE

CanadianSolar EP CUBE Energy Storage

- Smart Gateway + Hybrid Inverter + Battery Storage
- Prioritize and manage energy without interruption
- Battery storage provides up to 30 hrs of power.
- Stable overall performance and longer service life lithium batteries

ENERGY PERFORMANCE

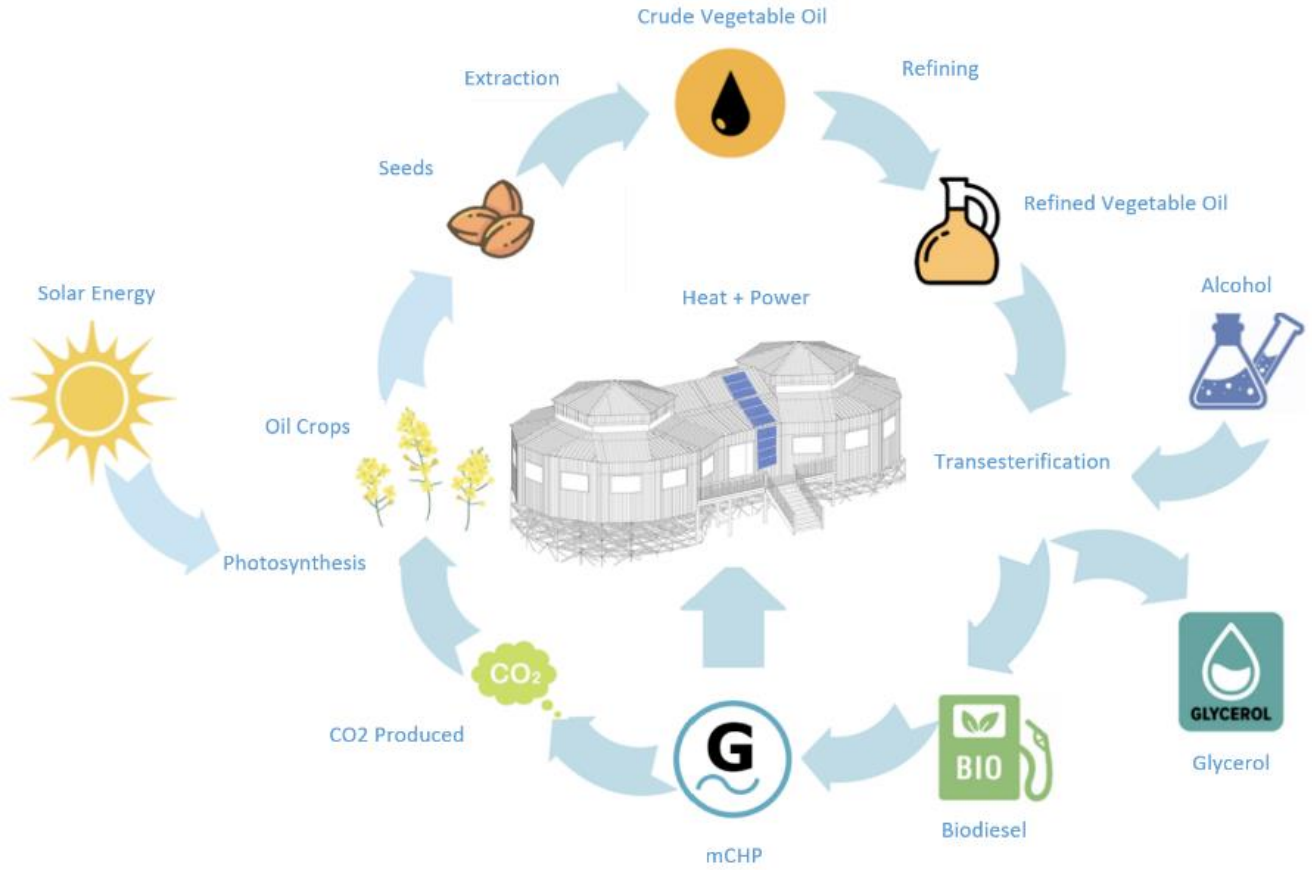
ENERGY PERFORMANCE

Renewable Energy Design

UP TO 90% REDUCTION IN LIFECYCLE GHG EMISSIONS COMPARED TO FOSSIL DIESEL

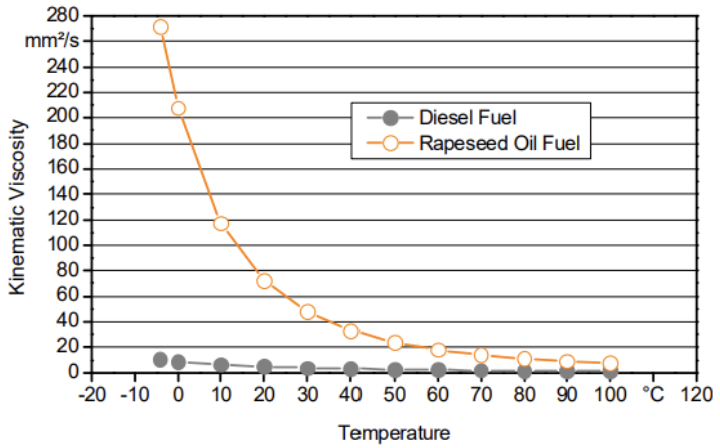
CARBON-NEUTRAL RENEWABLE CANOLA OIL BIOFUEL

COOKING OIL RECYCLING FOR MCHP



ENERGY PERFORMANCE

Waste Vegetable Oil for mCHP



Source of Waste cooking oil	Quantity
Annual use of canola cooking oil per restaurant	12000lb (1458gal/5520L)
15 Iqaluit restaurants	83 000L (21926 gal)
A single family of 4	1.5L/month (0.4gal/month)
Canola oil/person	4.5L/year (1.2gal/year)
Waste cooking oil from Iqaluit population of 8000	36 000L/year (9510gal/yr)
Total estimated recovered waste cooking oil from Iqaluit	119,000L/yr (31437gal/yr)

AT LEAST 17 BUILT FOR THE NORTH HOUSING UNITS

REDUCE THE COST OF EXPORTED FUEL

LOCAL USED COOKING OIL RECYCLED

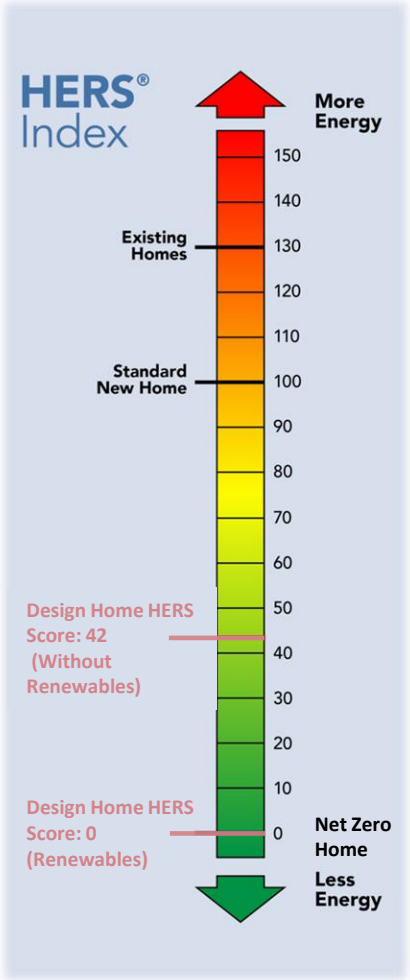
ENERGY PERFORMANCE

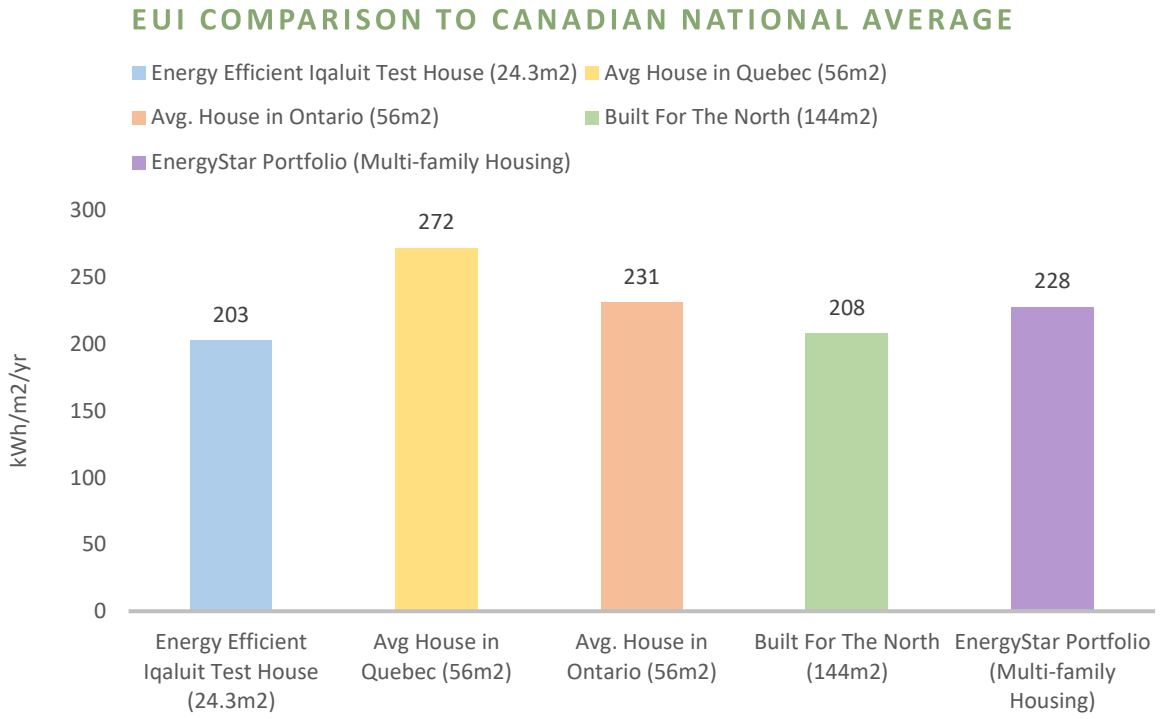
DESIGN HEATING LOAD:
20KW
(68,243 BTU/HR)

HEATING DEMAND:
34,503 KWH/YR
(117,729 KBTU/YR)

SITE ENERGY:
234 KWH/M2
(74 KBTU/FT^{2}YR)

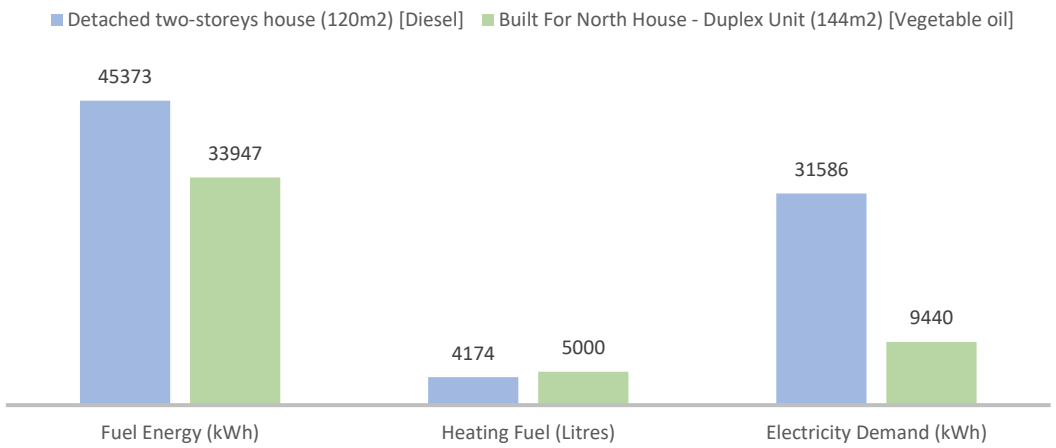
SOURCE ENERGY:
208 KWH/M2
(66 KBTU/FT^{2}YR)



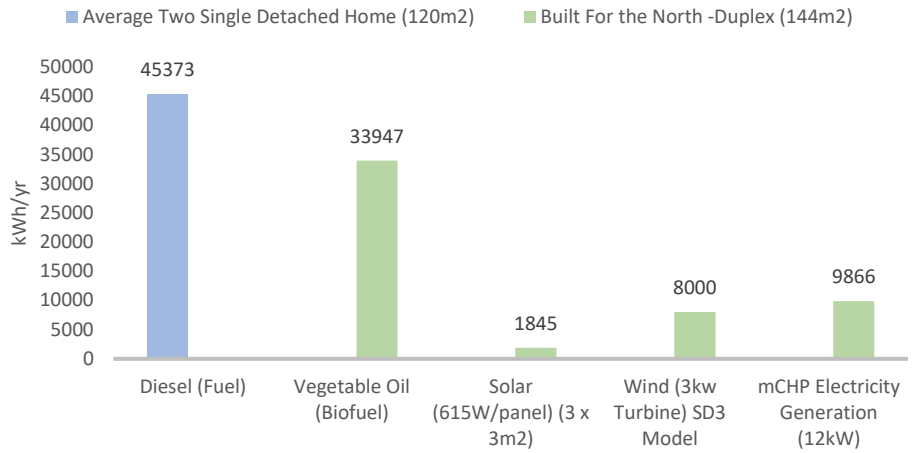


ENERGY PERFORMANCE

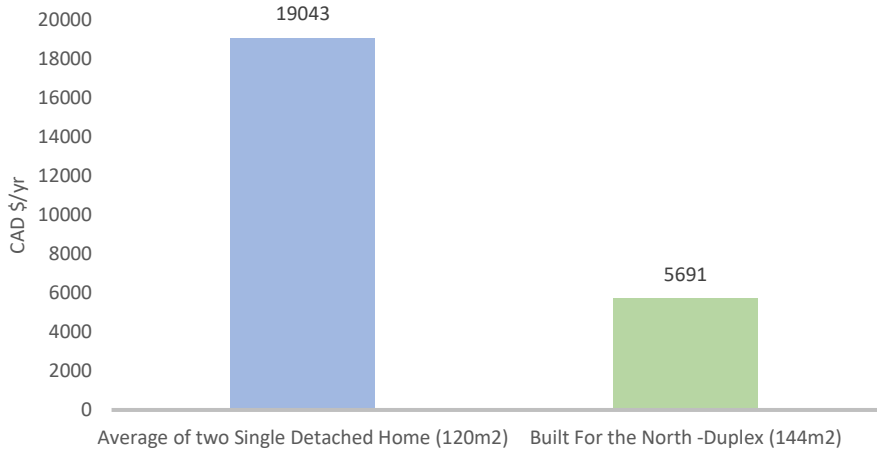
BASELINE ANNUAL ENERGY CONSUMPTION COMPARISON FOR IQALUIT NEW HOMES



TYPICAL IQALUIT HOME ANNUAL ENERGY SOURCE COMPARISON

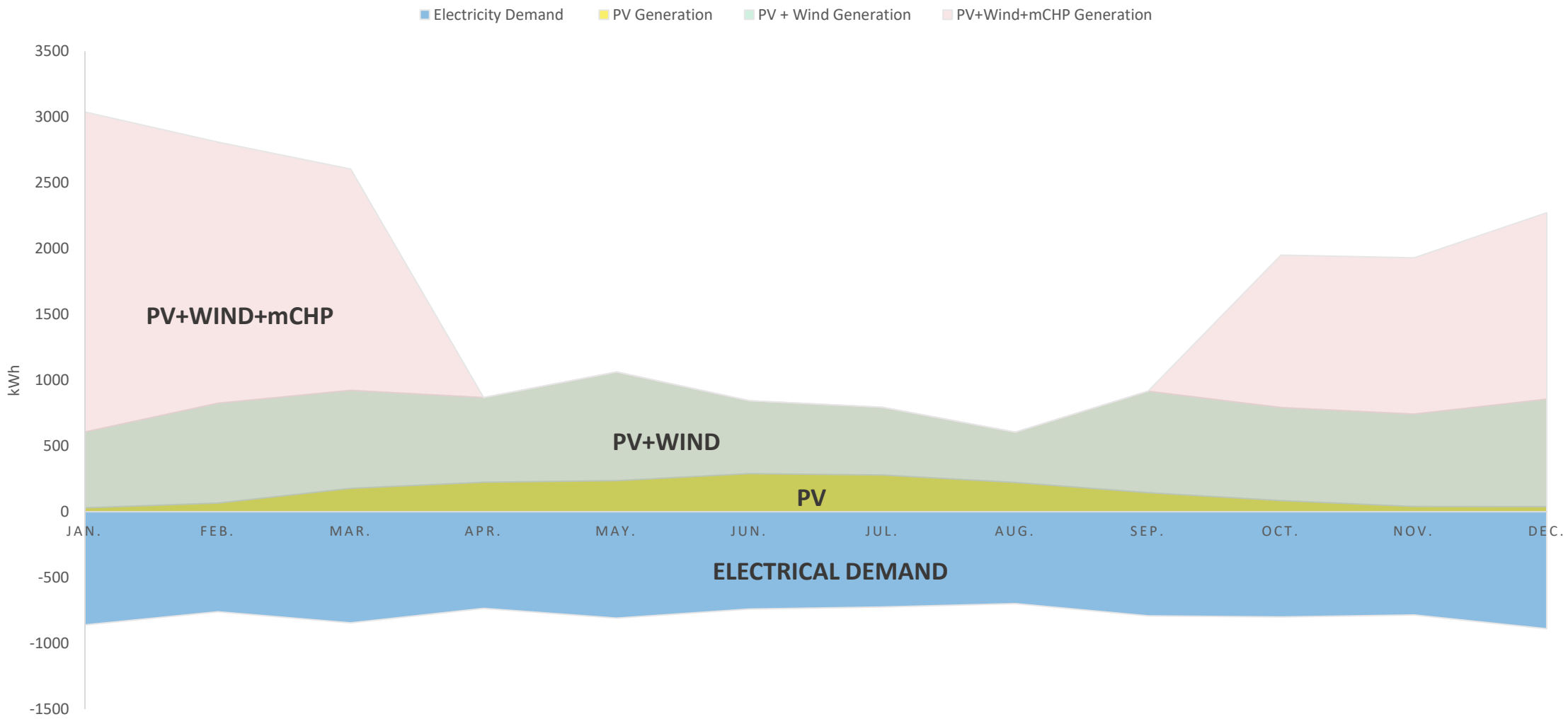


AVERAGE ANNUAL COST IF CONNECTED TO GRID

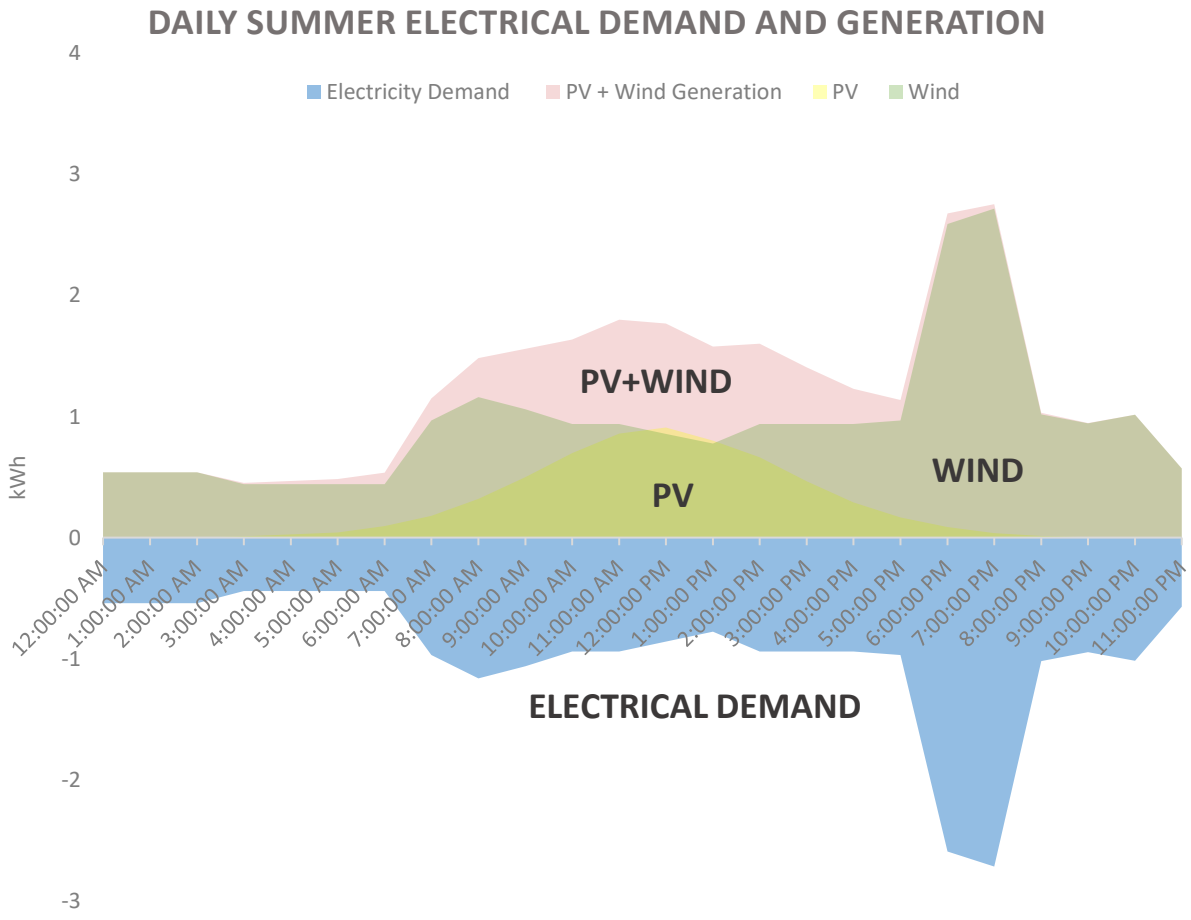


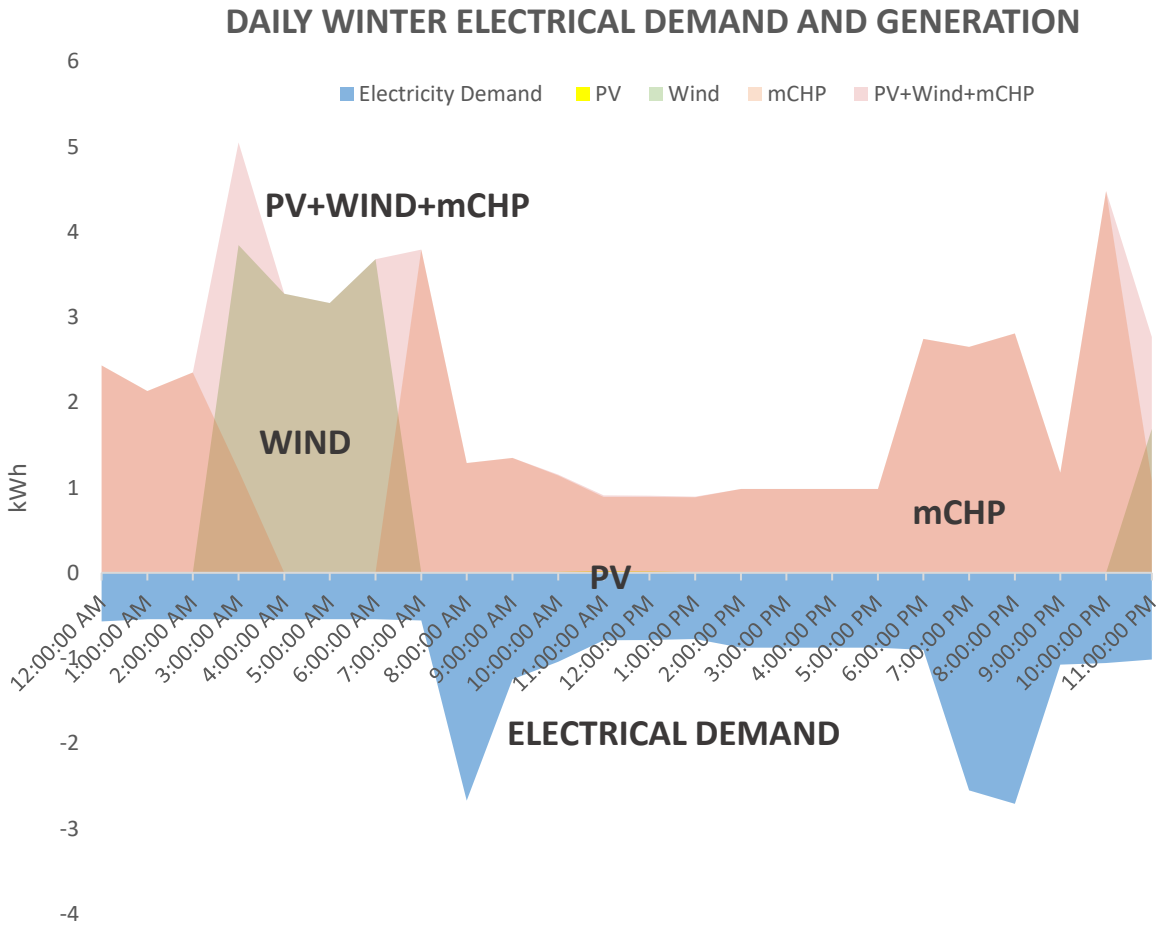
ENERGY PERFORMANCE

MONTHLY ELECTRICAL DEMAND AND PV+WIND+MCHP GENERATION



ENERGY PERFORMANCE





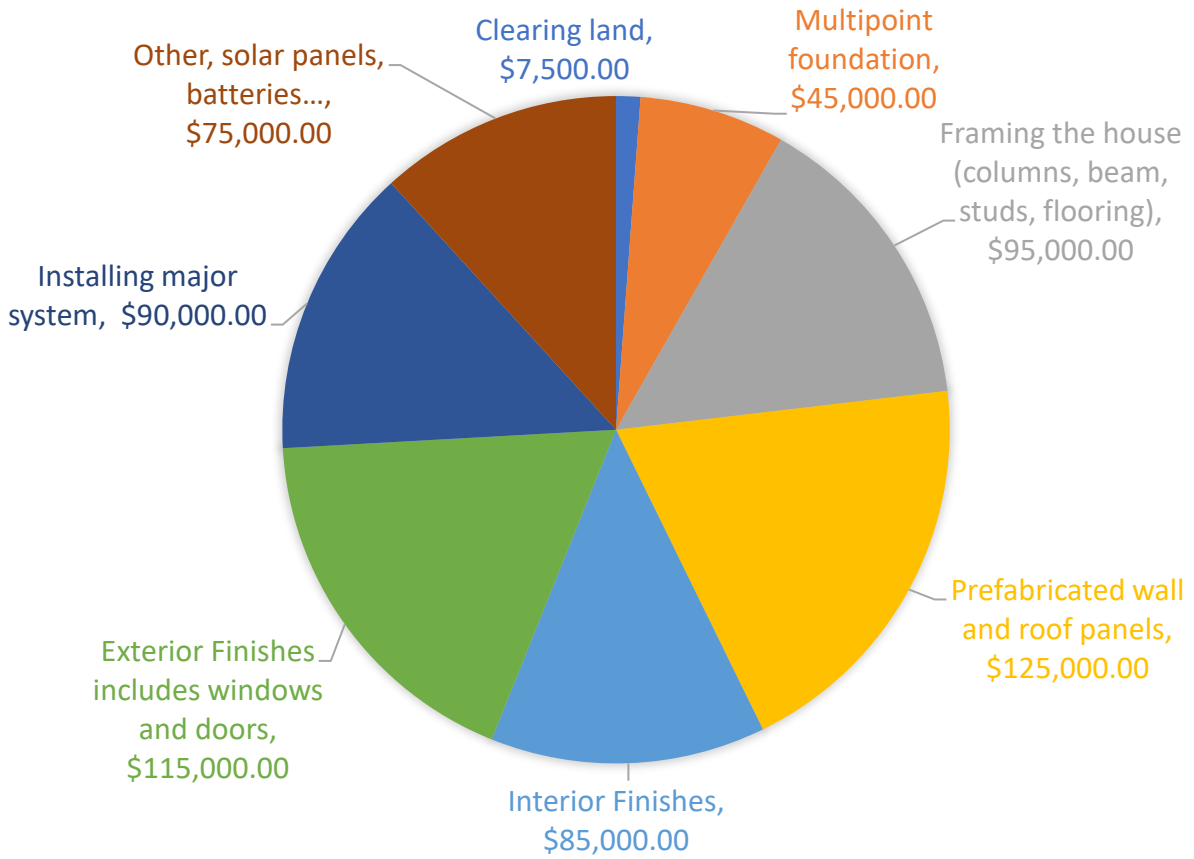
MARKET ANALYSIS

MARKET ANALYSIS

Issue		Solved by
Social/Cultural	→	Architecture
Feasibility	→	Engineering
Extreme Climate	→	Durability & Resistance
High Carbon Footprint	→	Embodied Carbon
Fossil fuel Dependence	→	Clean and renewable energy
Quality of Life	→	Occupant Experience
Housing Optimization	→	Integrated Performance
Energy Consumption and Waste	→	Energy Performance
Socioeconomic barriers	→	Market Analysis

MARKET ANALYSIS

Total Construction Cost: $632,250



	Annual Grid Savings ($)	Payback Period for $36,225 Renewable Energy Investment (Years)
Government Residential ($0.9339/kWh)	8814.15	4.1
Non-Government Residential ($0.6152/kWh)	5422.46	6.7

Thank you

Any Questions?