Project presentation for mid semester evaluation

on

Passive cooling system for the New Boys' Hostel

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Passive cooling system for the New Boys' Hostel

- <u>**Challenges**</u> **:-**
  - **High energy consumption of traditional air conditioning systems.**
  - **Need for maintaining indoor comfort in varying climates.**
  - **Reducing carbon footprint and operational costs.**

INTRODUCTION:

The high energy consumption, the need for maintaining comfort across varying climates, and the goal to reduce both carbon footprint and operational costs are major challenges in building design. The Earth Air Tunnel Heat Exchanger as well as water based cooling system, as a passive cooling solution, directly addresses these challenges by utilizing natural resources, offering energy savings, and enhancing environmental sustainability in multi-storey buildings.

1. **High Energy Consumption of Traditional Air Conditioning System:**

- Traditional air conditioning systems are energy-intensive, consuming large amounts of electricity to cool indoor spaces. In multi-storey buildings, this demand is even higher due to the increased volume and heat load from occupants, equipment, and external climate.
- Rising energy costs and growing energy demand put financial pressure on building operators, making energy-efficient solutions more attractive.
- Passive cooling methods, such as the Earth Air Tunnel Heat Exchanger (EATHE) as well as water based cooling system, can significantly reduce the reliance on energy-intensive air conditioning systems by using the earth's natural stable temperature to cool or pre-cool the air entering the building.

INTRODUCTION contd..

2. **Maintaining Indoor Comfort:**

- Climate variation requires constant HVAC adjustments.
- Earth Air Tunnel (EATHE) as well as water based cooling system stabilizes indoor temperatures using the earth's thermal inertia.
- Reduces need for artificial cooling/heating, improving comfort year-round.

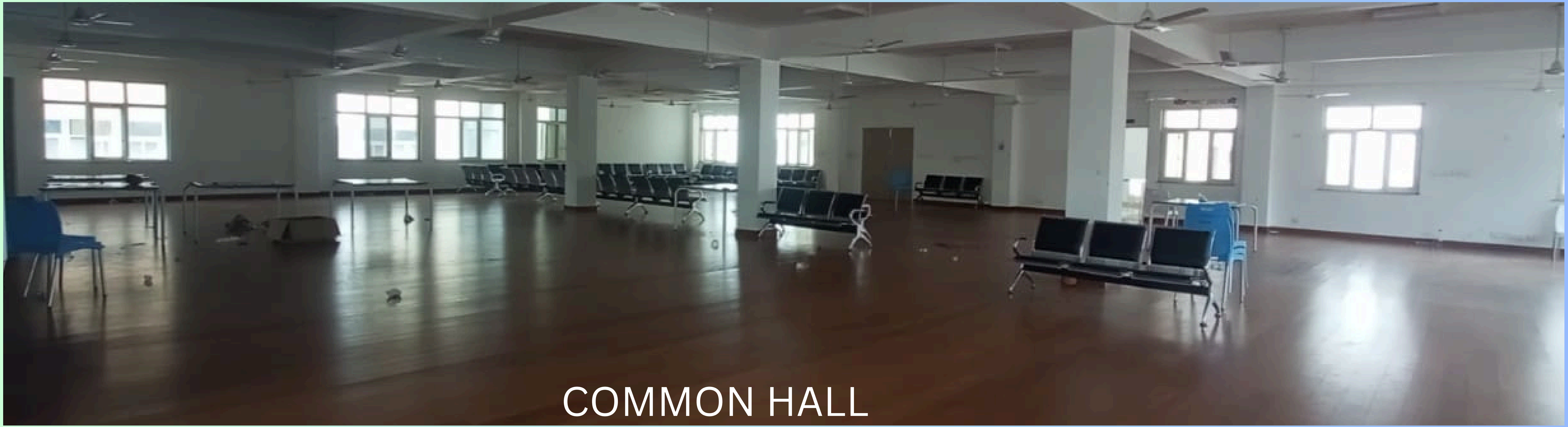
3. **Reducing Carbon Footprint & Costs:**

- HVAC systems contribute heavily to global carbon emissions.
- EATHE as well as water based cooling system reduces energy use, lowering emissions and supporting sustainability.
- Less maintenance and energy costs, especially beneficial for large buildings.

Energy Consumption In NBH Buildings:-

1. **HVAC** : Regulates temperature, air circulation, and ventilation across floors and rooms
2. **Lighting** : Energy used for 24/7 lighting in common areas, corridors, and rooms
3. **Water Heating** : High energy use for showers, kitchens, and laundry
4. **Security Systems** : CCTV, alarms, and safety systems run 24/7
5. **Electrical Appliances** : Devices like refrigerators, microwaves, and computers add to electricity use
6. **Elevators and Lifts** : Continuous power needed, especially during peak times
7. **Kitchen Facilities** : Shared kitchens/cafeterias consume energy with ovens, stoves, and dishwashers
8. **Cooling and Refrigeration** : Food storage units consume significant electricity
9. **Office Areas** : Computers, printers, and devices in offices contribute to energy use

Location Sites:-



Location Sites:-

TOP VIEW

SIDE VIEW

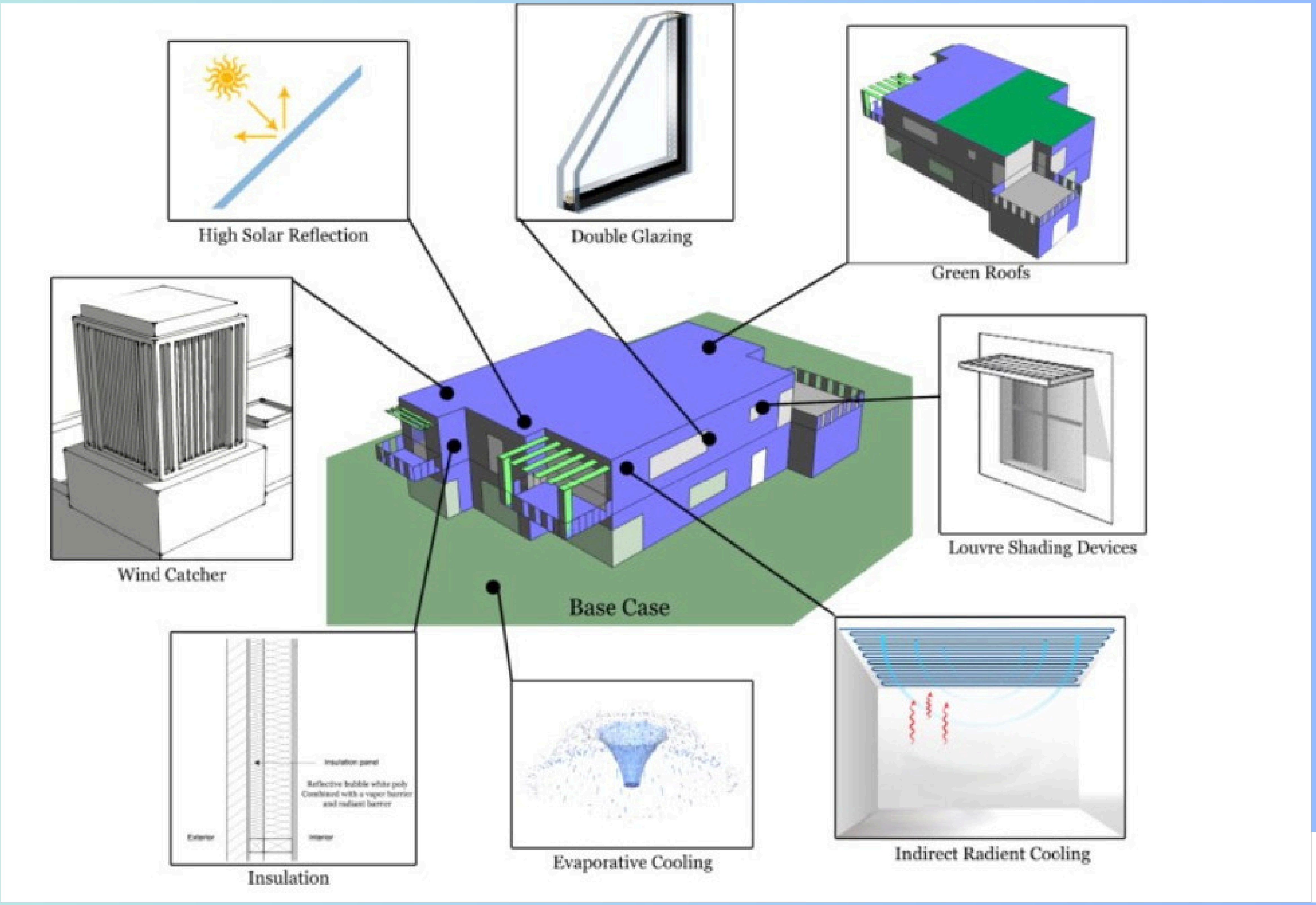
TYPES OF PASSIVE COOLING TECHNIQUES :

Definition:

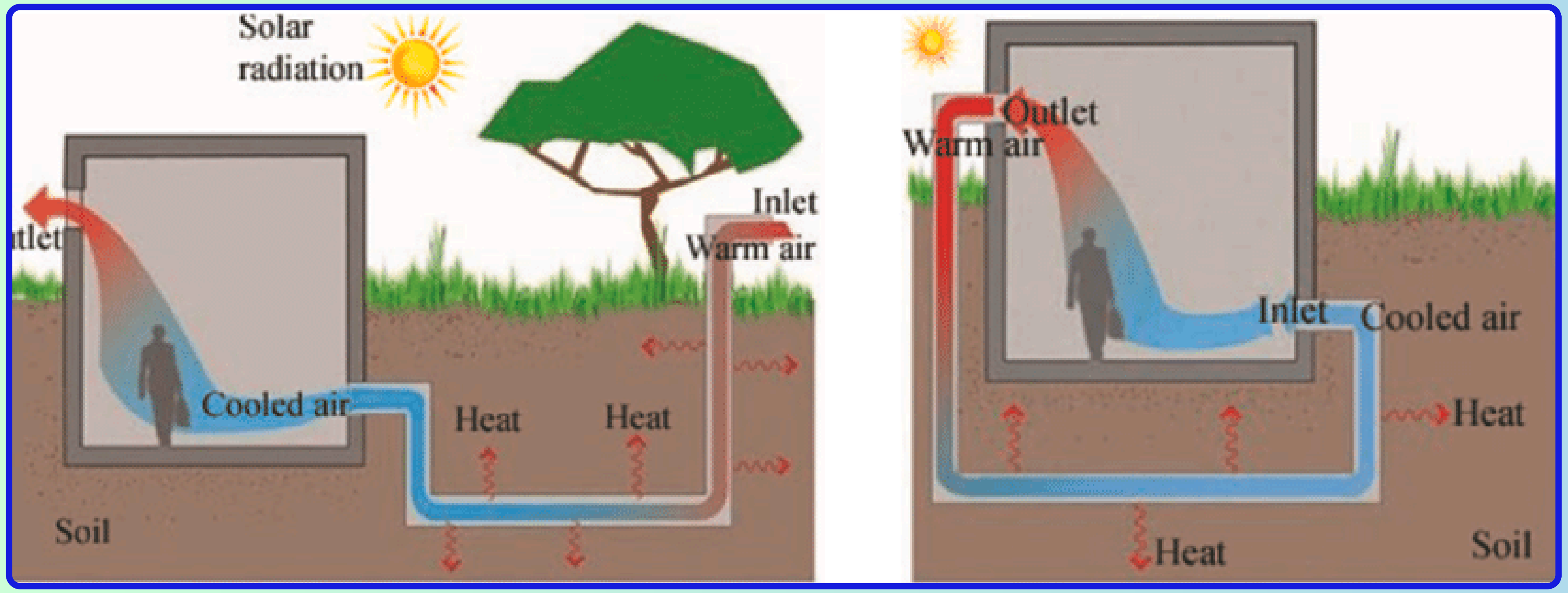
Passive cooling uses natural processes to regulate indoor temperatures without mechanical systems.

Types of Methods:

1. Earth Air Tunnel Heat Exchanger (EATHE): Underground air cooling system.
2. Integrating harvested rainwater into a passive cooling system.



EARTH AIR TUNNEL HEAT EXCHANGER (EATHE):-



A system of underground pipes that pre-cool ventilation air before it enters the building.

Operation:

Air temperature decreases from 46°C (ambient) to 26°C (outlet).

The system relies on the stable temperature of the ground.

Performance:

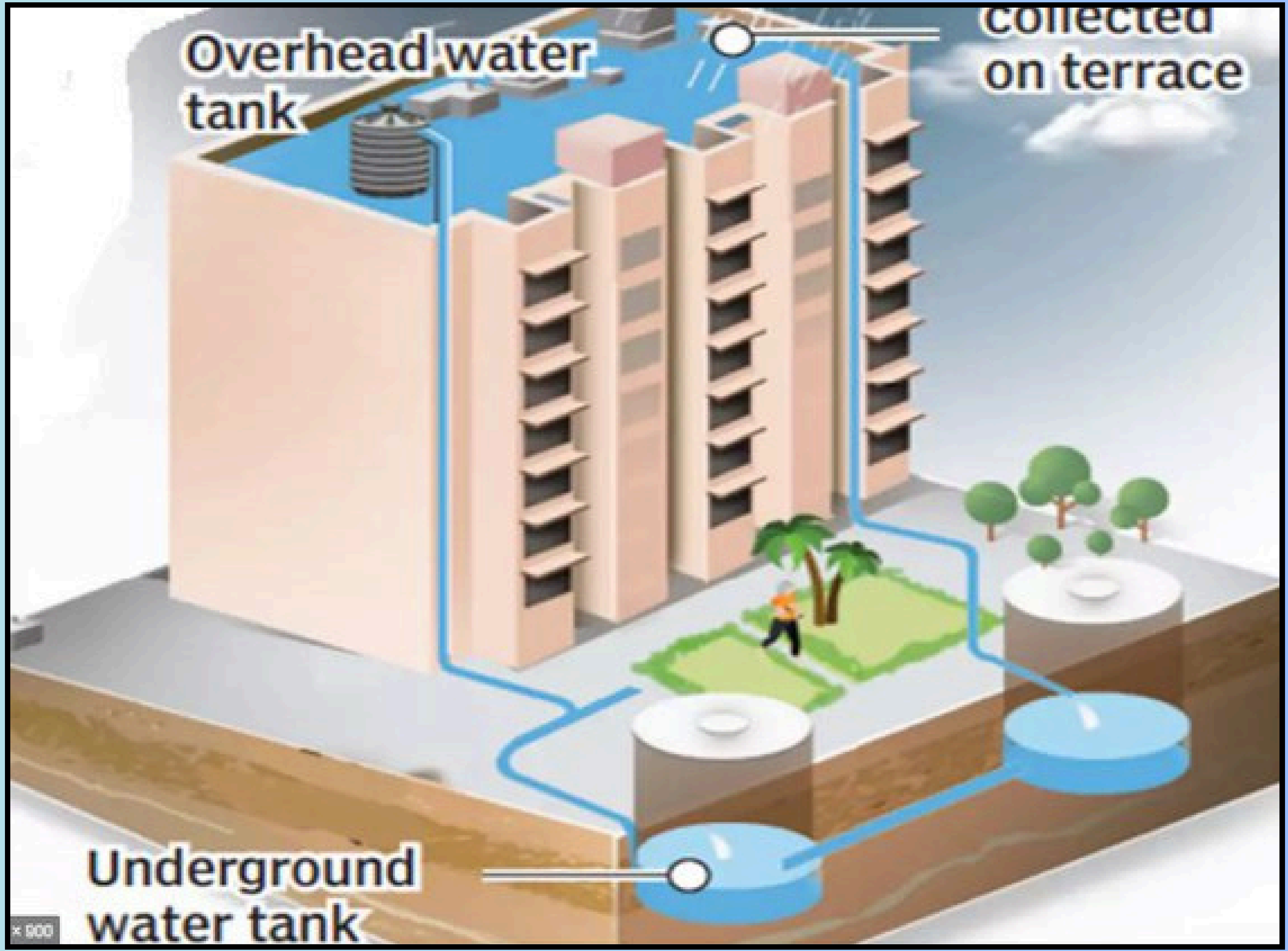
Effective with 16 pipes.

Provides significant cooling with reduced energy consumption.

INTEGRATING HARVESTED RAINWATER INTO A PASSIVE COOLING SYSTEM :-

Rainwater-Fed Cooling Coils

- Coils or pipes filled with harvested rainwater are embedded in or attached to the walls or ceiling.
- Rainwater flowing through these coils absorbs heat from the surrounding surfaces, which lowers the indoor temperature.
- Implementation: Install coils in direct contact with the building's structure or within a water-circulating system.



WORK PLAN :- 7th SEM

- Do survey of New Boys' Hostel to find its dimensions and specifications and collection of the data
- Creating a 3 D model of building using the E-Quest software and calculating cooling load.
- Designing of Earth Air Heat Exchanger system for increasing the comfort inside the dining hall of New Boys' Hostel

WORK PLAN :- 8 th SEMESTER

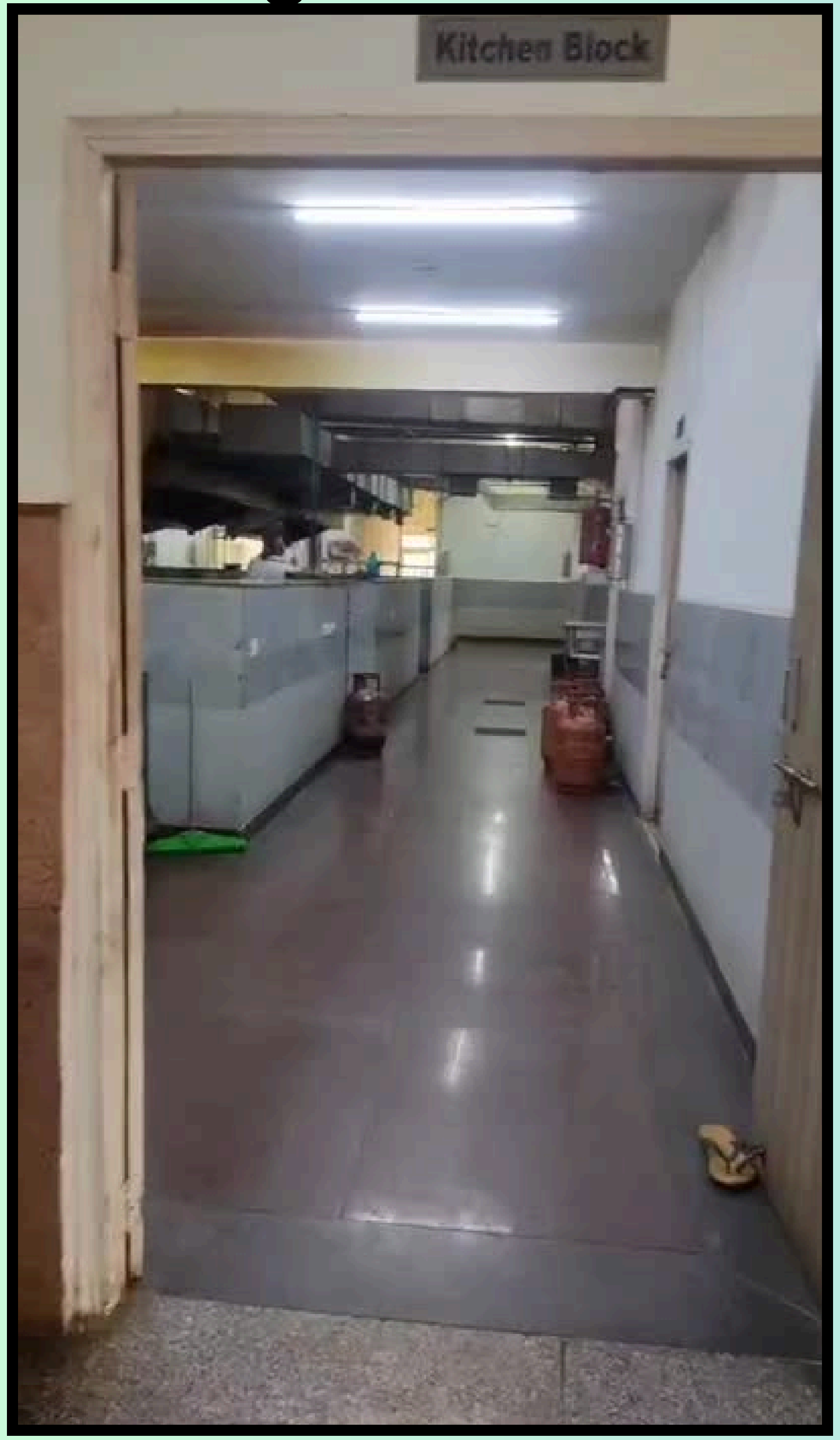
- To design a underground rainwater harvesting tank for the New Boy’s Hostel.
- Supply the stored rainwater (at nearly 20 degree celsius) to the cooling coils of the student’s room of NBH building as per cooling load.
- To cool the warm water coming from fan coil units from the room by using evaporative cooling system for recirculation of water.
- Accessing economic feasability and reduction in carbon emissions .

NBH BUILDING SPECIFICATIONS

No. of floor	13
No. of Room per floor	26
Floor to Floor Height	9.56 ft
Floor to Ceil Height	9 ft
Orientation of Block	South-West
Room Dimension	11 X 8.5 X 9 ft^3
Window Dimension	3.8 X 3.5 ft^2
Door Dimension	6.4 X 3 ft^2

Survey

Dining Area of NBH



Site to Install EATHE

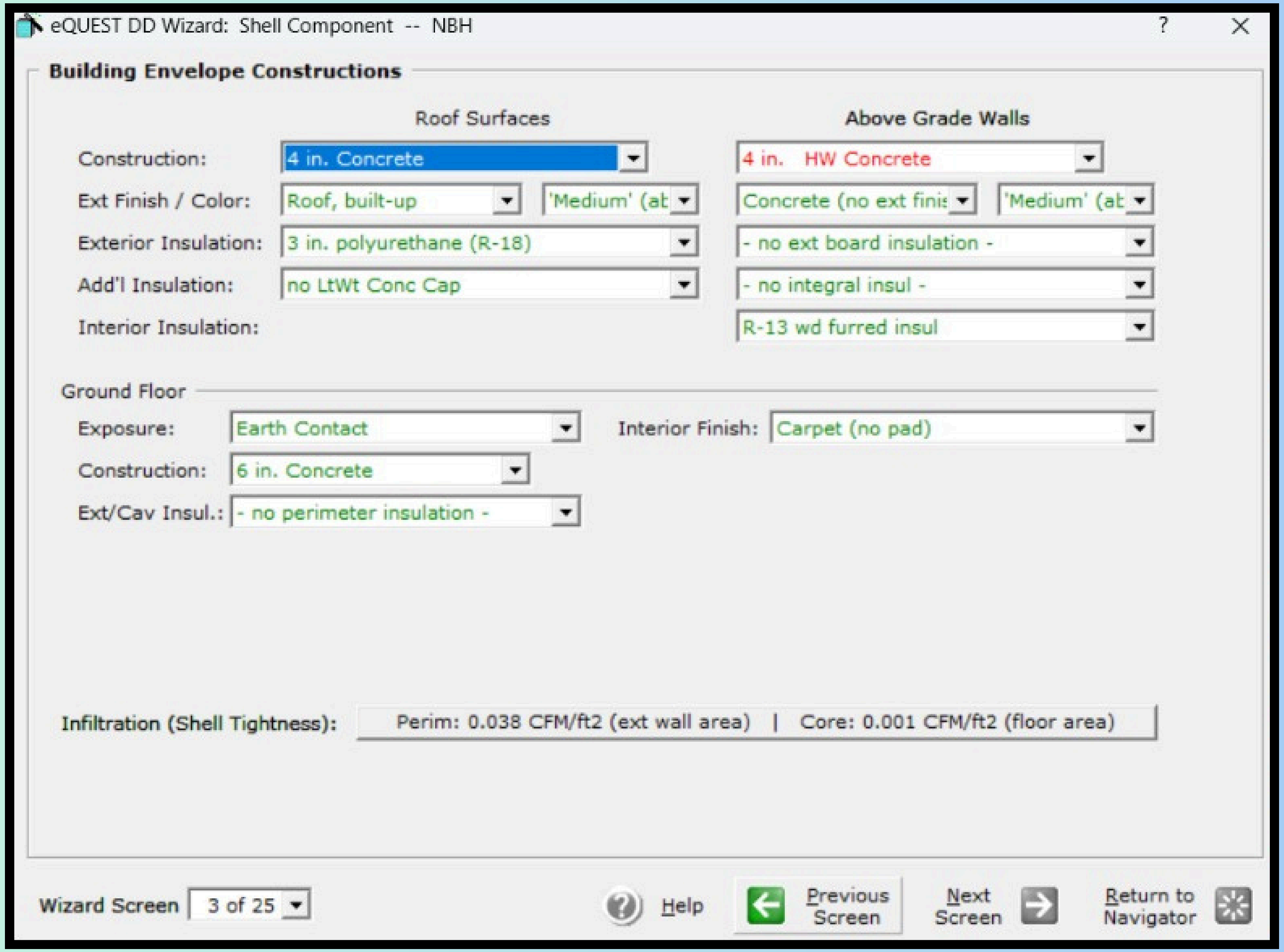
Room in NBH

eQUEST SIMULATION INPUT

Building Footprint

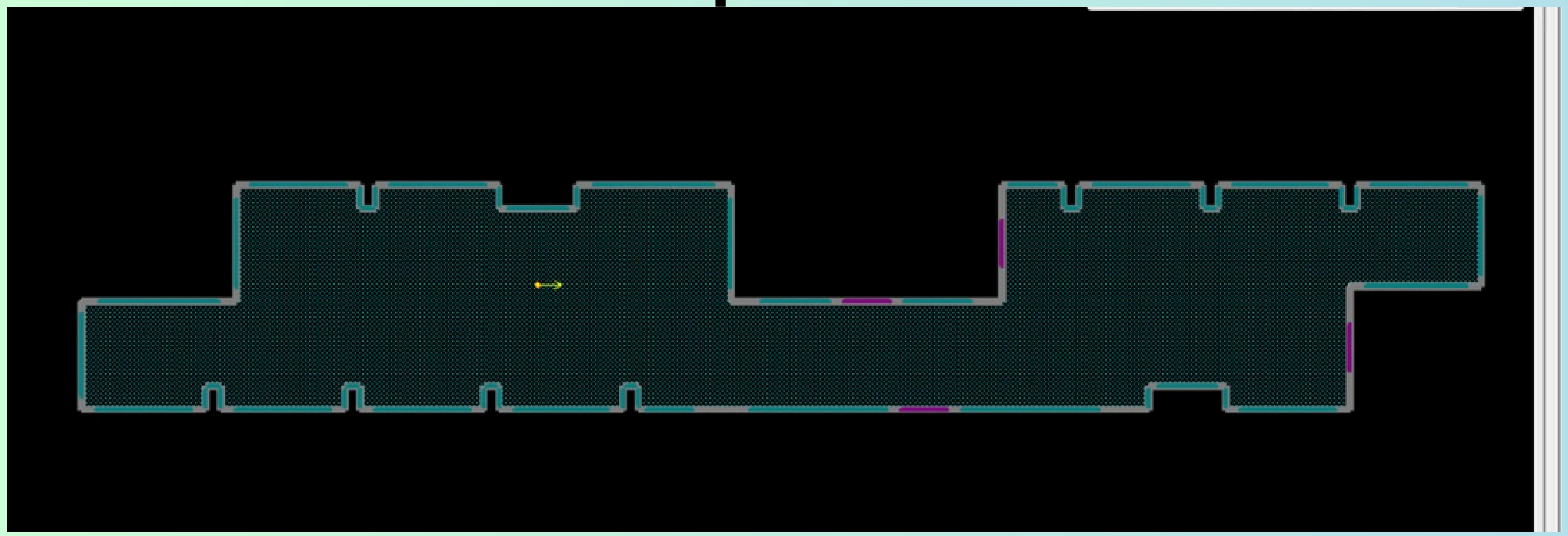
Cooling System	FCU(Fan Coil Unit)
Weather Data	IND_UP_Allahabad-Bamrauli.AP.424750_ISHRAE2014
Operating Schedule	Monday-Sunday(14x7)
Construction Roof	Concrete 4 inch
Building Orientation	South-West

eQUEST INPUT

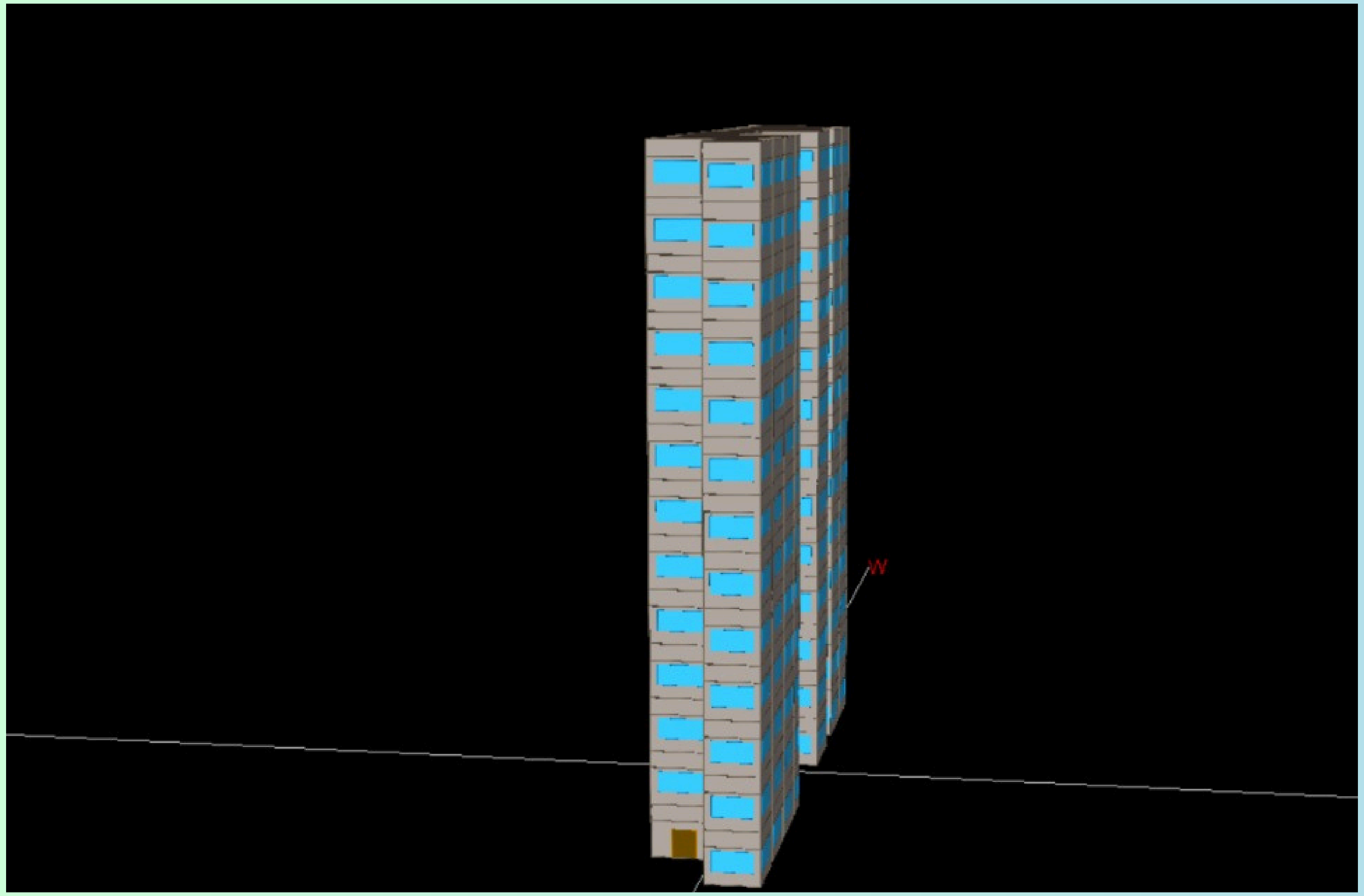


MODEL OF NBH BUILDING MADE USING eQUEST

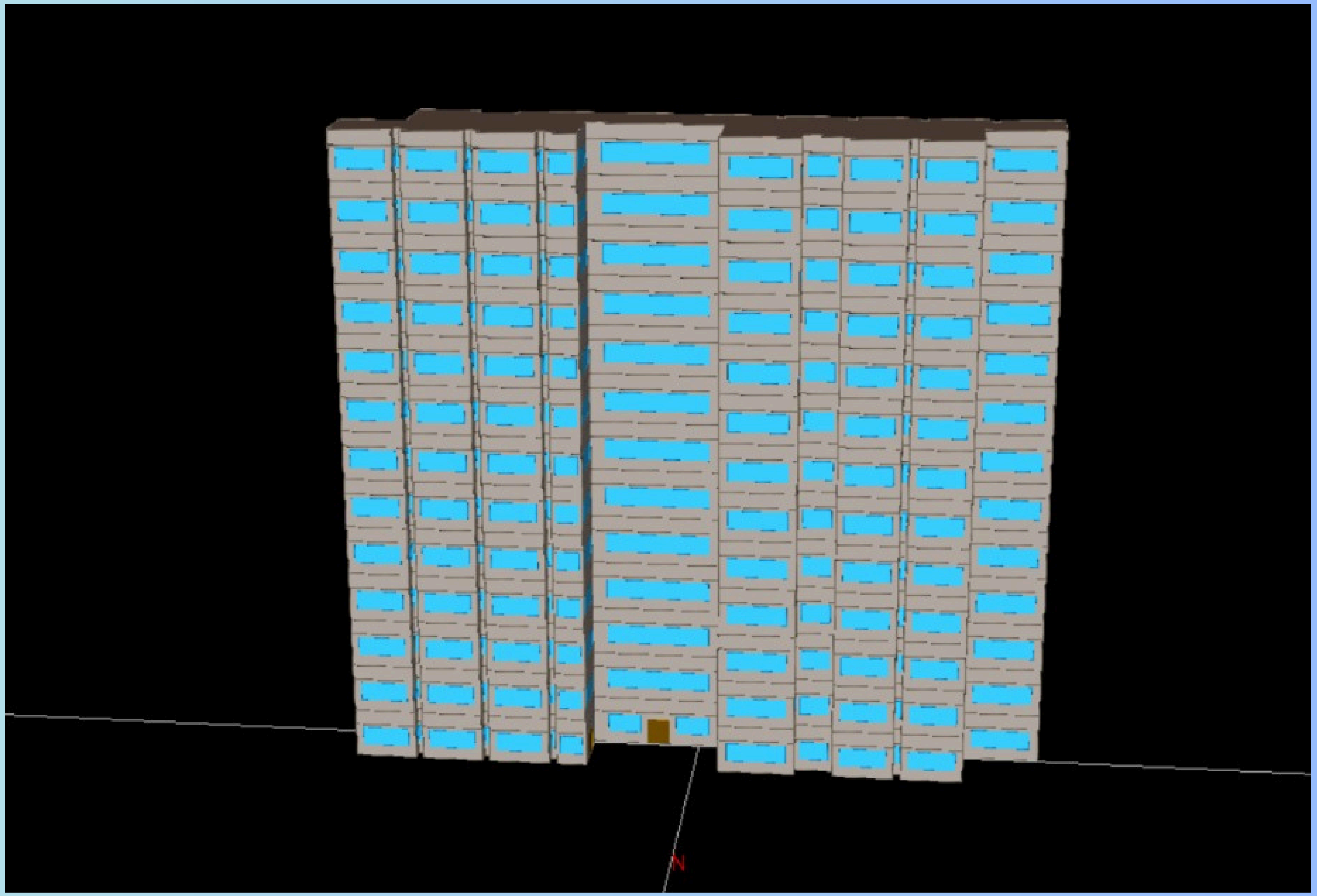
Top View



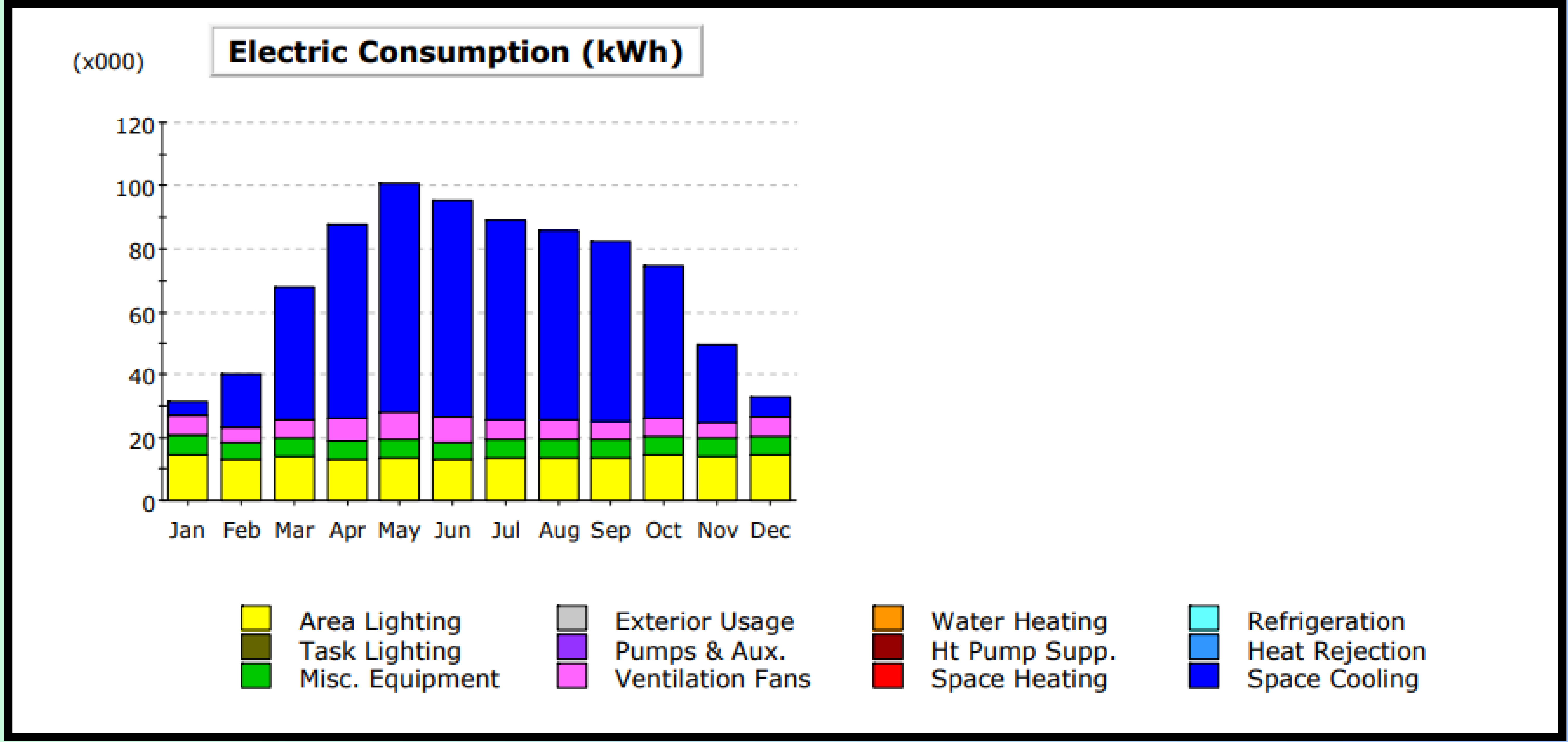
Side View



Front View



eQuest Output Electric Consumption(KWh) for NBH:



eQuest Output Electric Consumption for NBH:

Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	4.13	17.06	42.38	61.62	72.71	68.95	63.66	60.23	57.31	48.77	25.25	6.49	528.57
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	6.65	4.97	5.68	7.40	8.91	8.06	6.54	5.92	6.08	5.52	4.73	6.01	76.47
Pumps & Aux.	0.06	0.00	-	-	-	-	-	-	-	-	-	0.01	0.08
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	5.79	5.23	5.81	5.60	5.80	5.59	5.79	5.81	5.58	5.80	5.60	5.76	68.18
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	14.69	12.97	14.04	13.14	13.33	12.85	13.30	13.62	13.52	14.47	14.05	14.56	164.55
Total	31.33	40.24	67.92	87.77	100.74	95.45	89.29	85.57	82.50	74.55	49.64	32.84	837.85

Cooling Load Calculation:

Original Cooling Load:

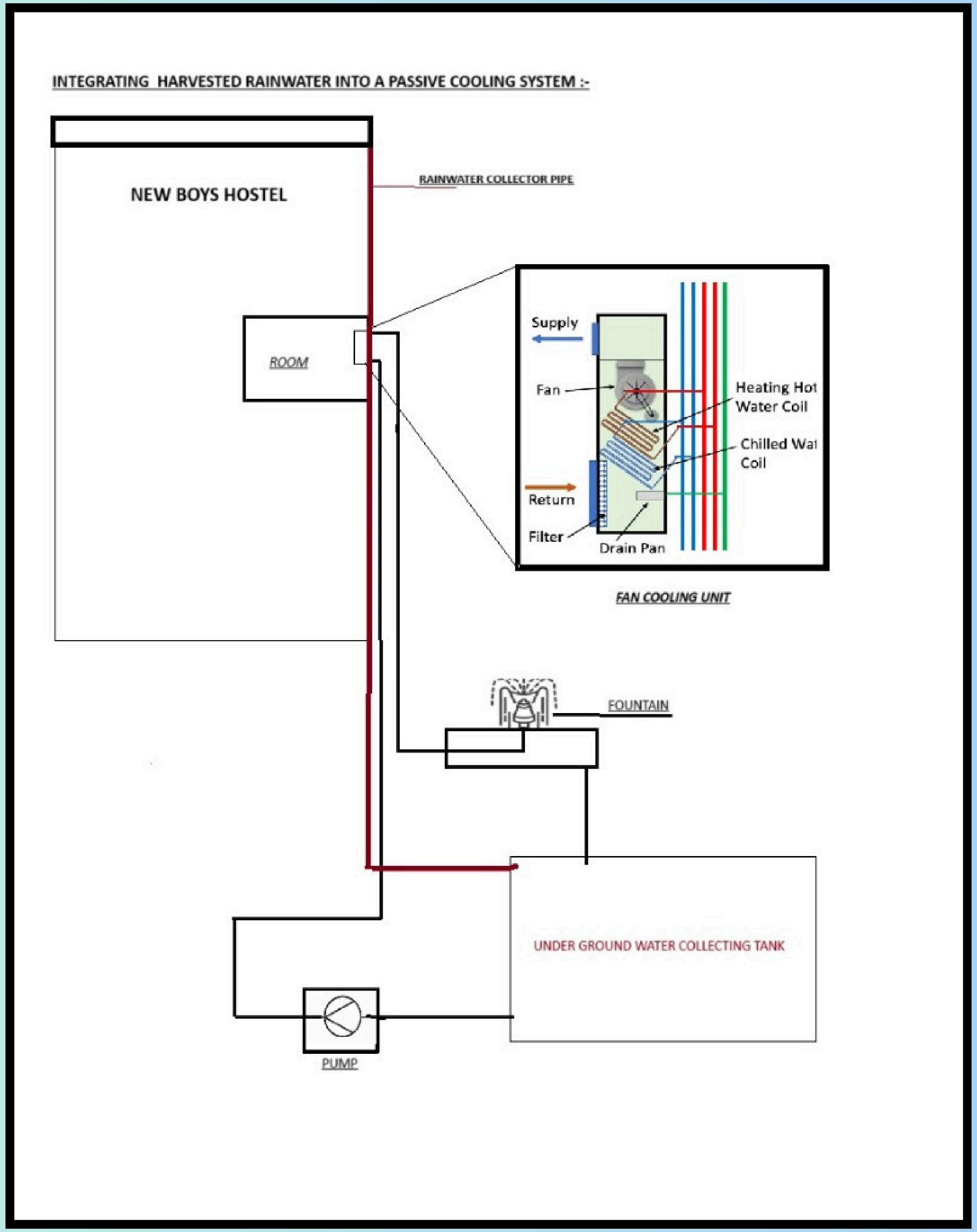
Maximum energy consumption in the month of May	=	100.74 * 1000 kWh
No. of hours per month for which cooling is required	=	420 hours
Cooling COP	=	2.5
Total cooling load	=	(100.74 * 1000*(9.7/2.5))/420
	=	930.64kW
Total cooling load in TR	=	930.64/2.5
	=	265 TR

COOLING LOAD

- **Based on the graph and table, it's clear that the cooling load peaks during May and June, while it is at its lowest in December and January.**

- **According to the eQUEST model, the maximum cooling load for May is approximately 265TR.**

Schematic Diagram of proposed system for Passive cooling of NBH:



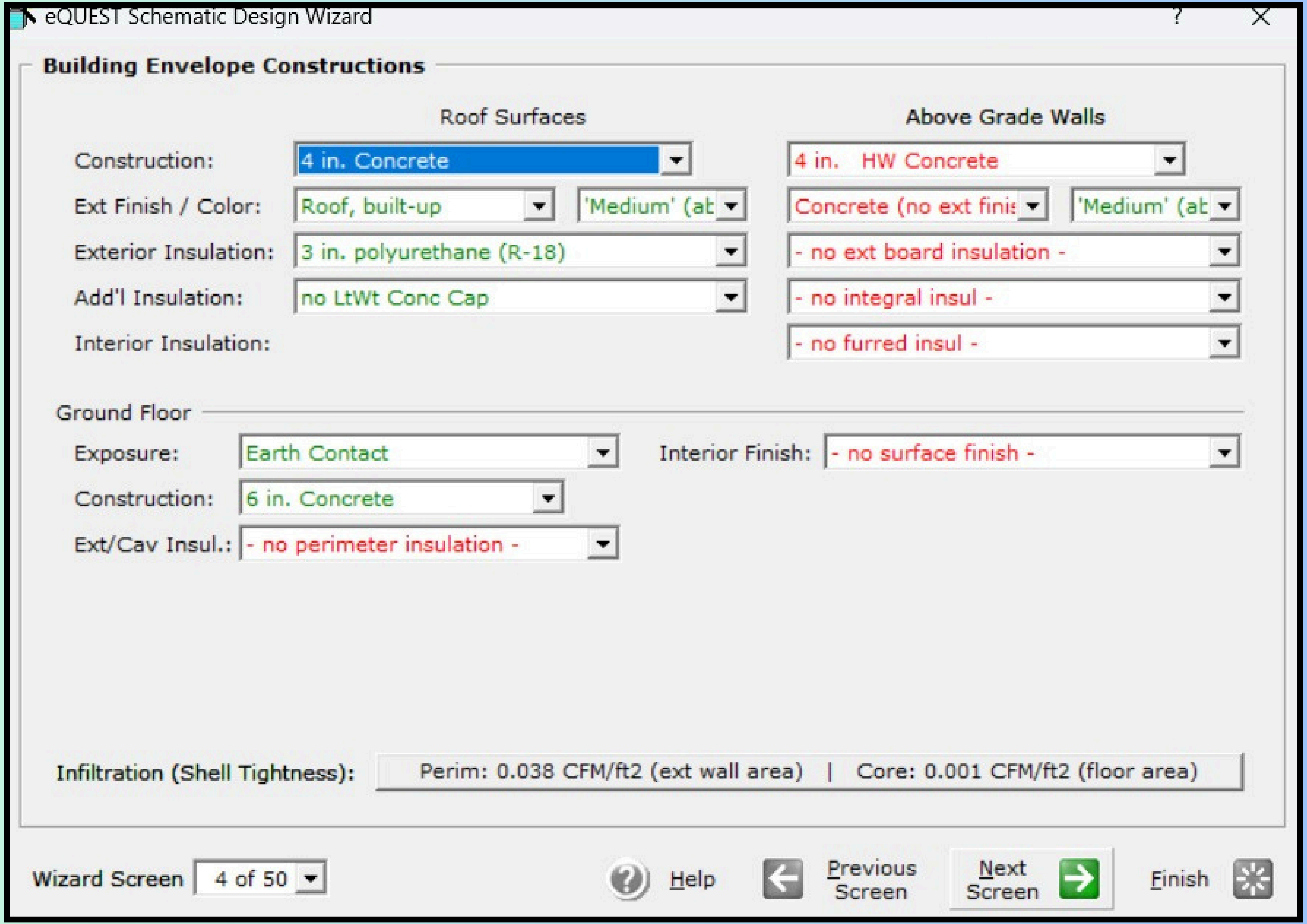
Dining Hall Specification:

Area	1851 ft^2
Dimension of Window(6)	9.8X3.5 ft^2
Dimension of Window(2)	6.5X3.5 ft^2
Dimension of Door(2)	5X6.5 ft^2
Floor to Floor Height	9.5 ft
Foor to Ceil Height	9 ft.

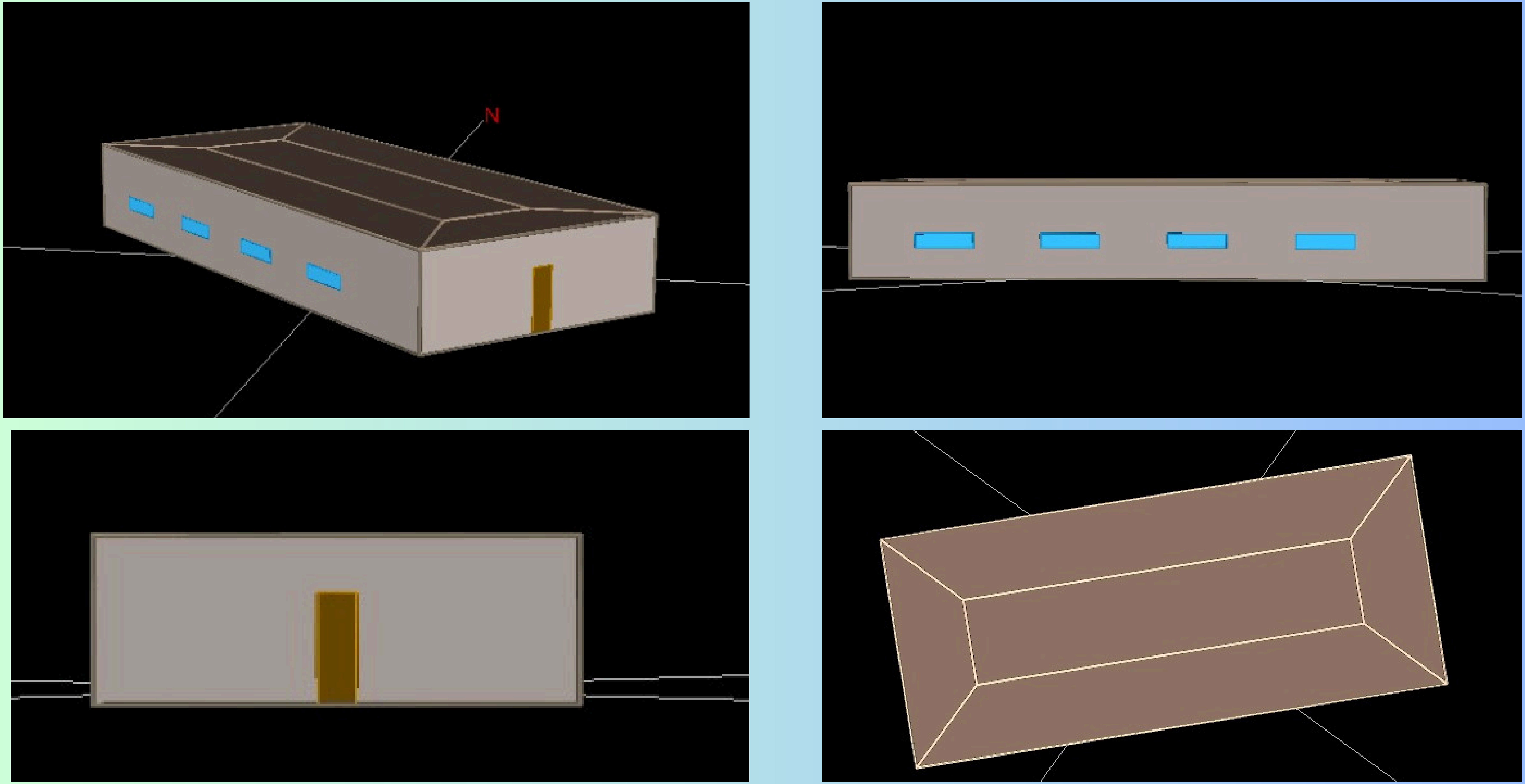
eQUEST SIMULATION INPUT:
-Dining Hall-

Cooling System	EATHE
Weather Data	IND_UP_Allahabad-Bamrauli.AP.424750_ISHRAE2014
Operating Schedule	Monday-Sunday(5x7)
Construction Roof	Concrete 4inch
Building Orientation	South-West

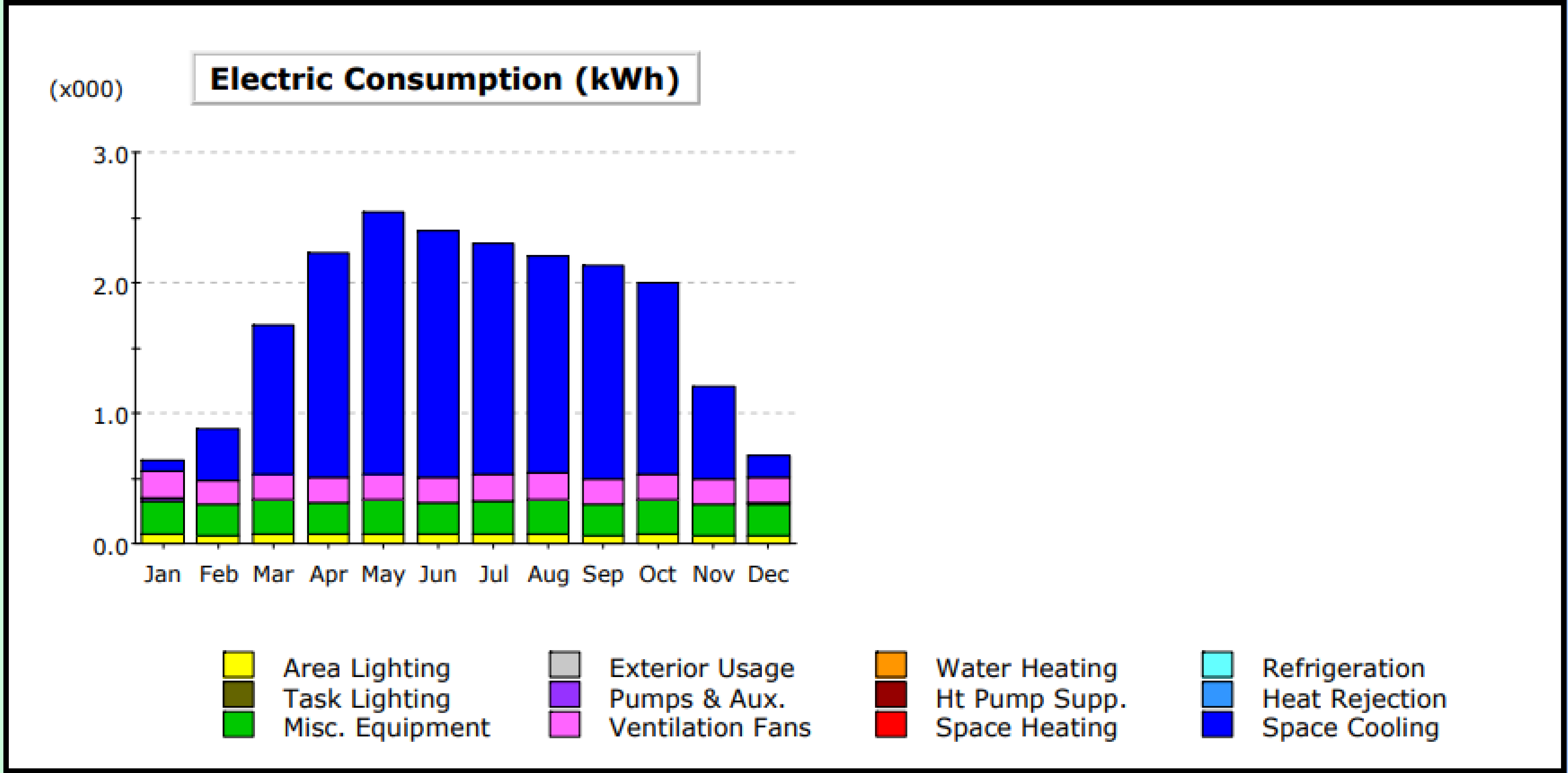
eQUEST INPUT:



MODEL OF Dining Hall MADE USING eQUEST:



eQuest Output Electric Consumption(KWh) for Dining Hall:



eQuest Output Electric Consumption:

Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.09	0.41	1.14	1.73	2.01	1.89	1.78	1.66	1.64	1.47	0.70	0.17	14.68
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0.20	0.18	0.20	0.19	0.20	0.19	0.20	0.20	0.19	0.20	0.19	0.20	2.33
Pumps & Aux.	0.02	0.00	-	-	-	-	-	-	-	-	-	0.01	0.03
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.26	0.23	0.26	0.25	0.26	0.25	0.26	0.27	0.24	0.26	0.24	0.24	3.03
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.06	0.06	0.82
Total	0.63	0.88	1.68	2.23	2.55	2.40	2.30	2.20	2.14	2.00	1.20	0.68	20.89

Cooling Load Calculation for Dining Hall:

Original Cooling Load:

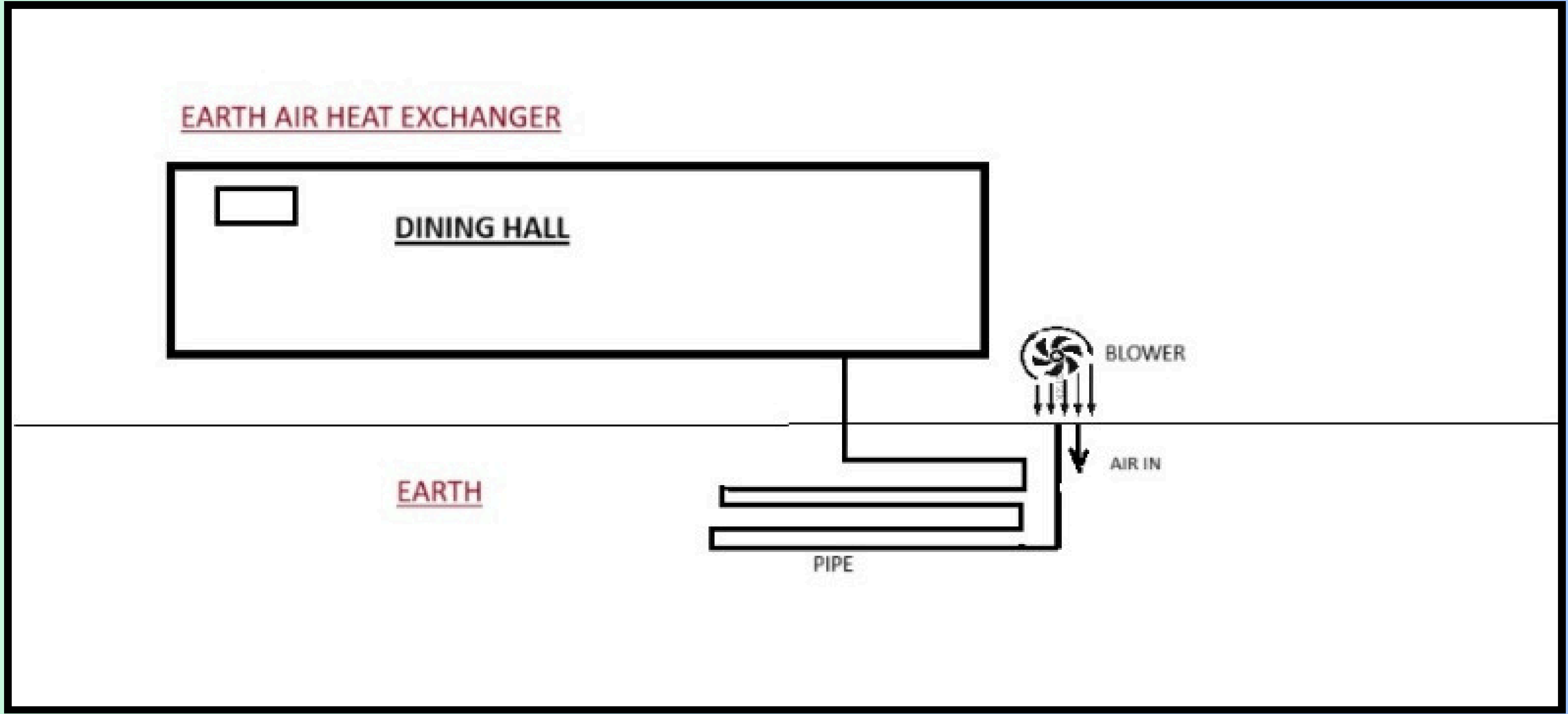
Maximum energy consumption in the month of May	=	2.55X10^3 kWh
No. of hours per month for which cooling is required	=	150 hours
Cooling COP	=	2.5
Total cooling load	=	(2550 *(9.7/2.5))/150
	=	65.96 kW
Total cooling load in TR	=	65.96/3.5
	=	18 TR

COOLING LOAD

- Based on the graph and table, it's clear that the cooling load peaks during May and June, while it is at its lowest in December and January.

- According to the eQUEST model, the maximum cooling load for May is approximately 18 TR.

Schematic Diagram of Proposed System for Passive cooling of the Dining Hall:




THANK
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