



Team Kill Bill

2017 U.S. Department of Energy Race to Zero Student Design



Presenters

Arihant Jain
Pooja Mundhe
Sahil Priyadarshi
Vasudha Sunger



1. Context



2. Project



3. Design



4. Vision



India

Challenges and Issues

Population growth

Water scarcity

Air pollution

Health infrastructure

Energy consumption

Statistics

2.1 % every year

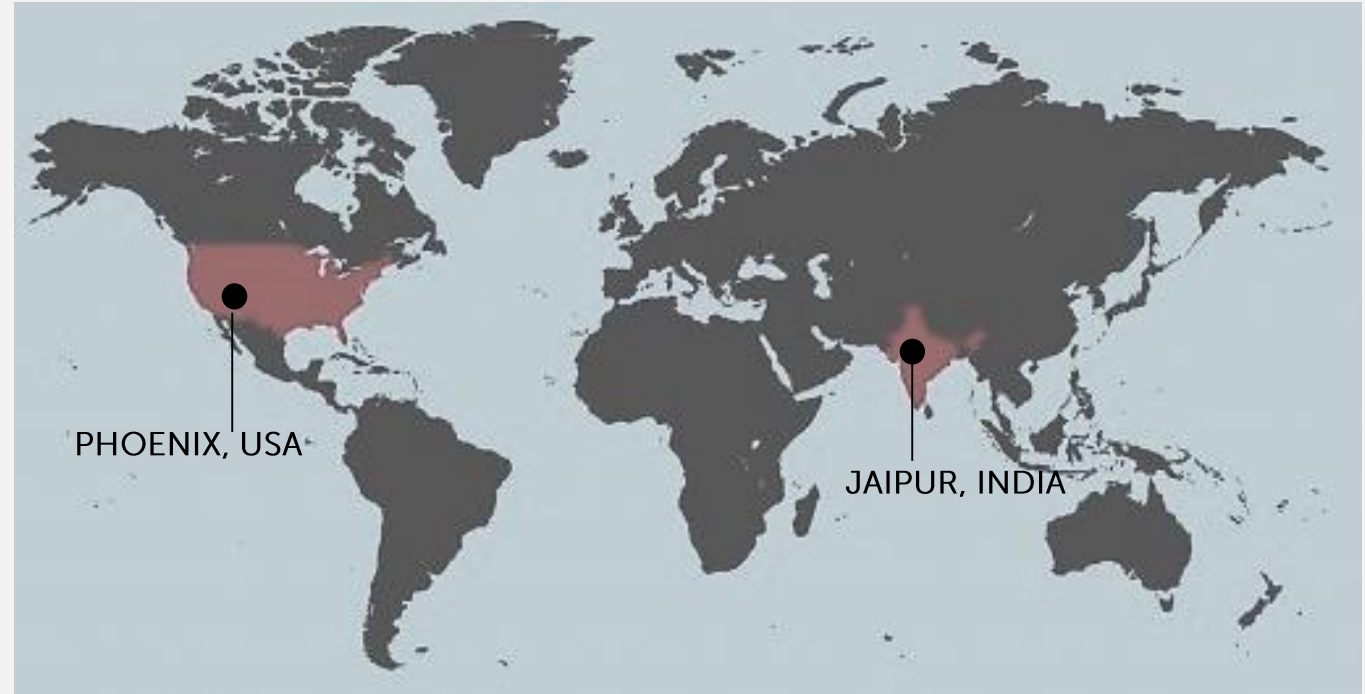
41% scarcity

Ranked **6th** reason for death

21% of the world's disease burden rates of maternal and infant mortality.

80 TWh in 2000 to **186 TWh** in 2012, and constitutes **22%** of total current electrical consumption

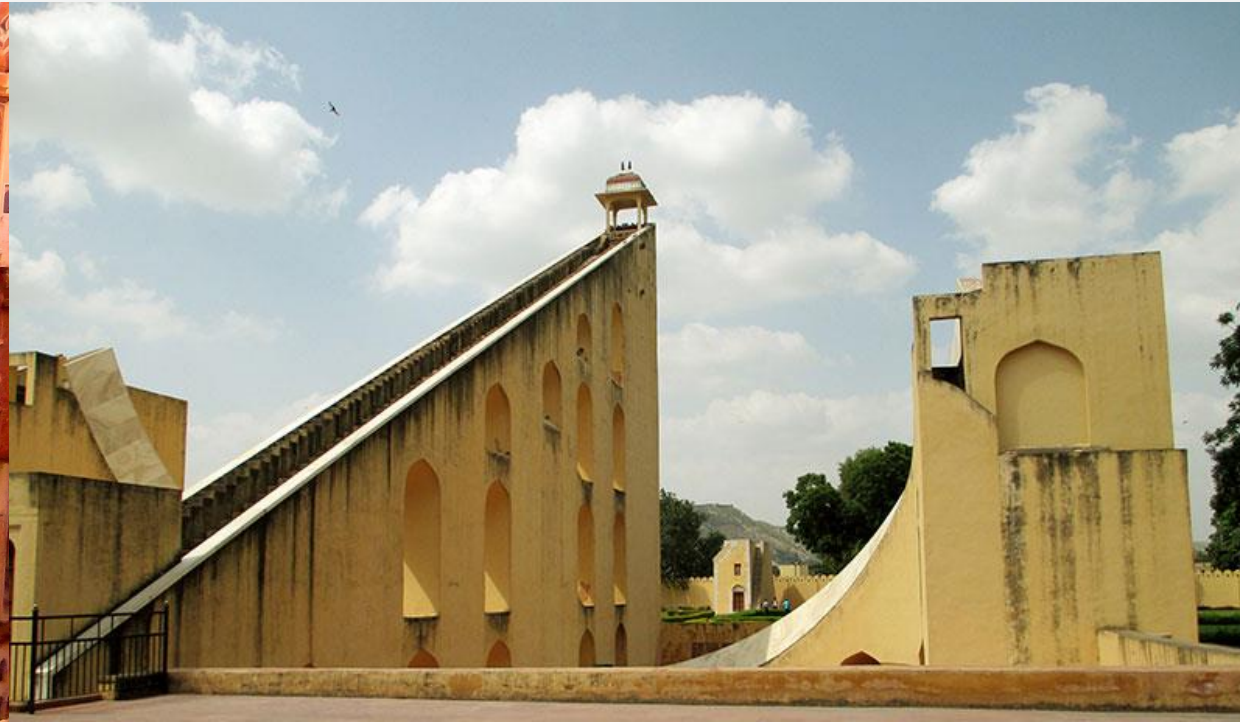
India, the world's 4th largest carbon emitter, ratified the Paris agreement on climate change.



Climate of **Jaipur** is like **Phoenix Zone 2B**, Hot & Dry except-

Climatic condition	Jaipur	Phoenix
Rainfall mm (inch)	550(21.6)	211(8.7)
Minimum DB temp. (Peak) °C (°F)	Minimum temp. 3.7 (38.66)	Minimum temp. - 2.8 (26.9)

Jaipur the City



Capital city of Rajasthan

Heritage of architecture and astronomy

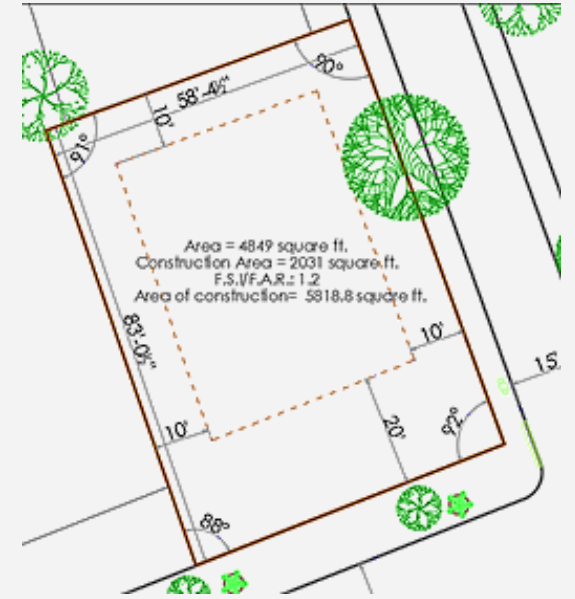
6,337 person/sqkm density

Hub for **trade, commerce and tourism**

Rajasthan: **1/6th** of the country's RE potential

Air quality: PM 2.5 and 10 are critical (WHO)

Site location & Neighbourhood



Residential Zone of the developed area
boundary of Jaipur Development Authority
Built-up area allowed: 1.2 x site area
Max height of the building: 39.3 ft.
Front margin: 20 ft.
Side margin 10 ft. on two sides

Site Constraints & Goals

Constraints

Energy Scarcity

Climate change

Water Scarcity

Developing economy

Degraded Air Quality

Devoid of vegetation



Goals

Energy performance

Adaptability

Zero water discharge

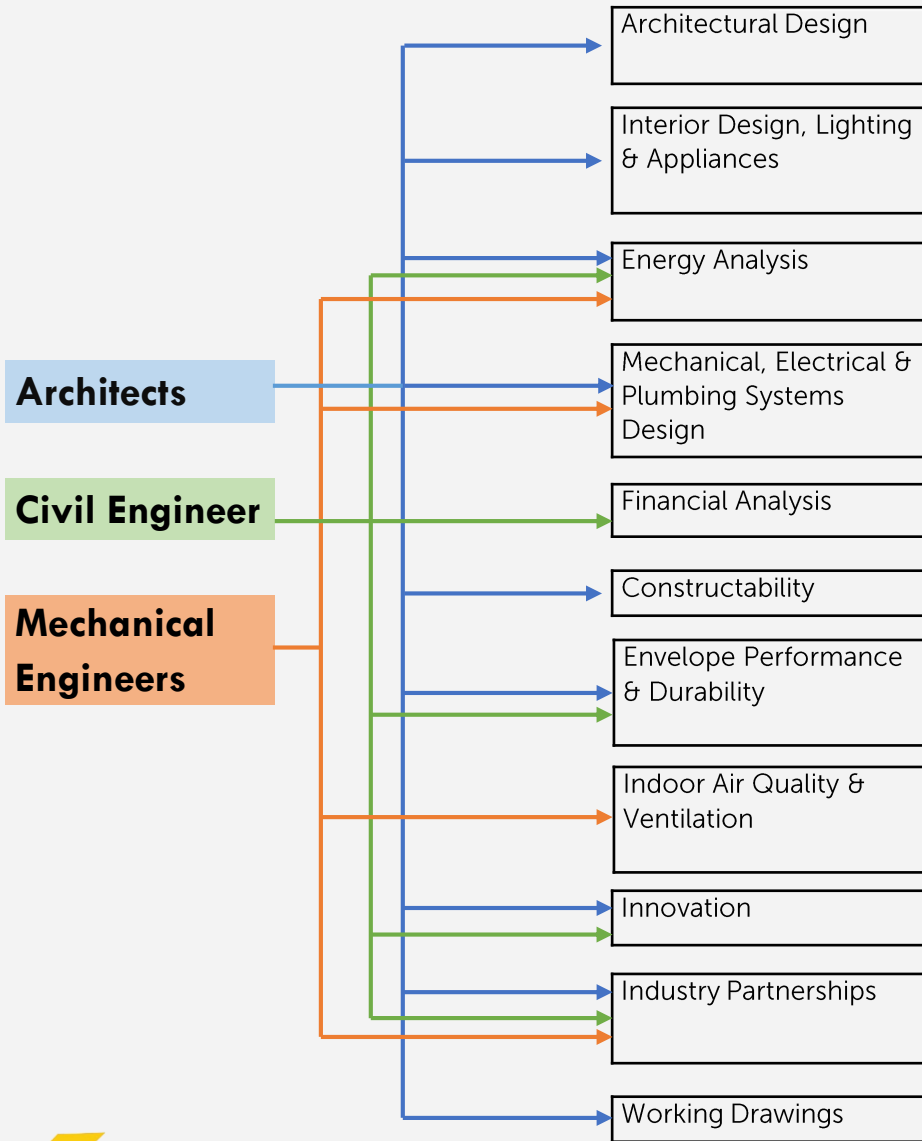
Affordability & durability

Indoor air Quality

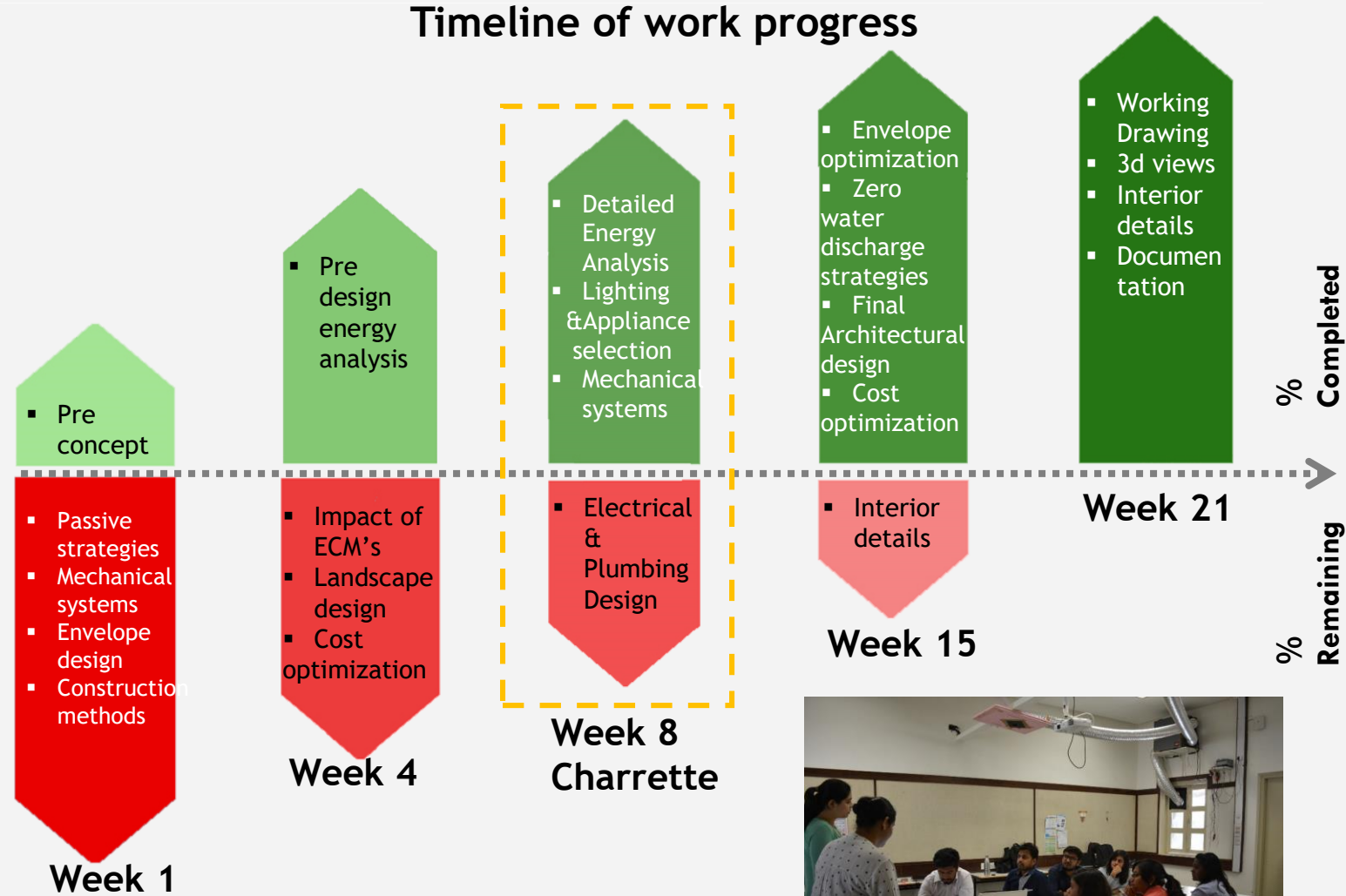
Regenerative oasis landscape



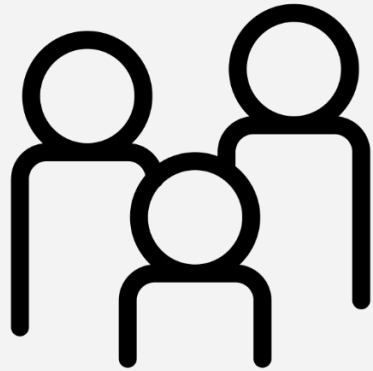
Multidisciplinary team



Timeline of work progress



Pre-design Analysis



Family of 4

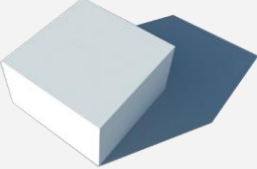
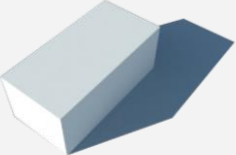
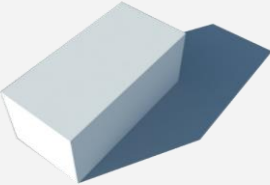
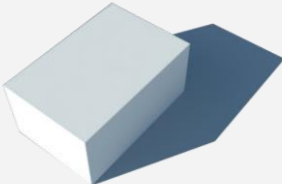
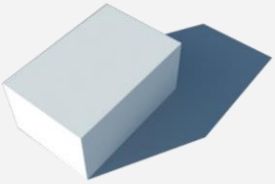


**Unoccupied
Hours
10 AM to 6PM**



**India Model for
Adaptive (Thermal)
Comfort**

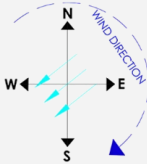
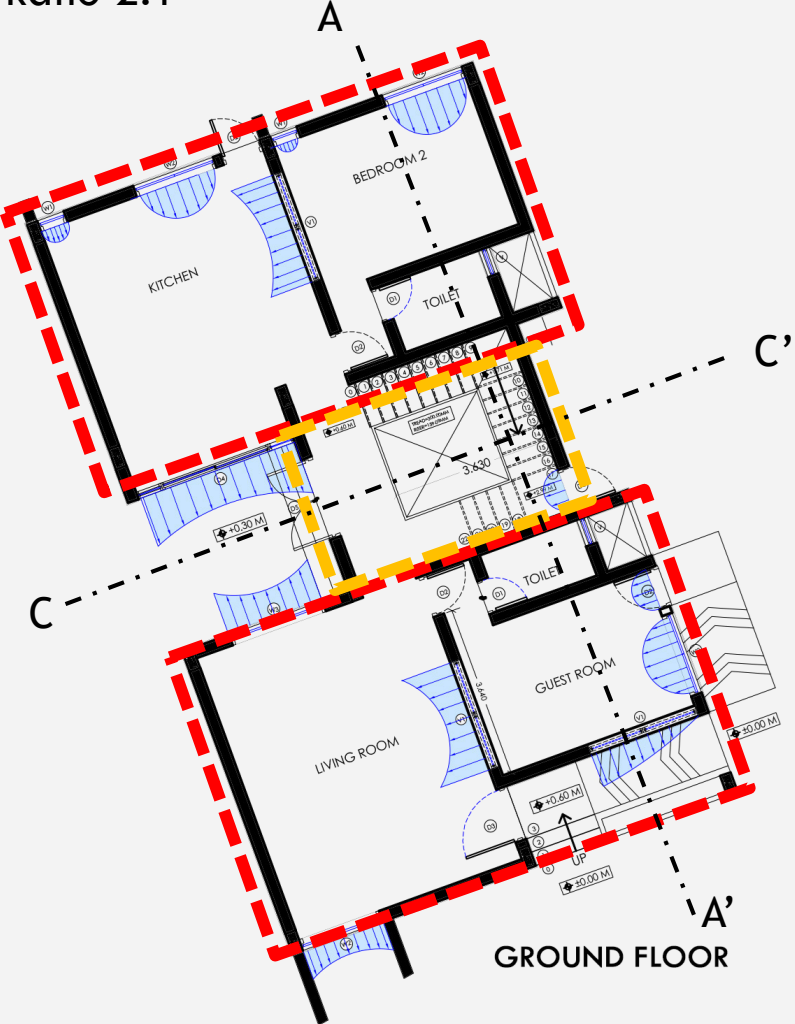
Pre-design Analysis

Model	Orientation	Aspect Ratio	WFR	Comfort Hours
	--	1:1	5	3058
			10	3075
			15	4396
	EW	1:2	5	5404
			10	5539
			15	5597
	NS	2:1	5	4995
			10	5087
			15	5124
	EW	2:3	5	5440
			10	5549
			15	5475
	NS	3:2	5	5138
			10	5058
			15	5051



Plans

Aspect Ratio 2:1

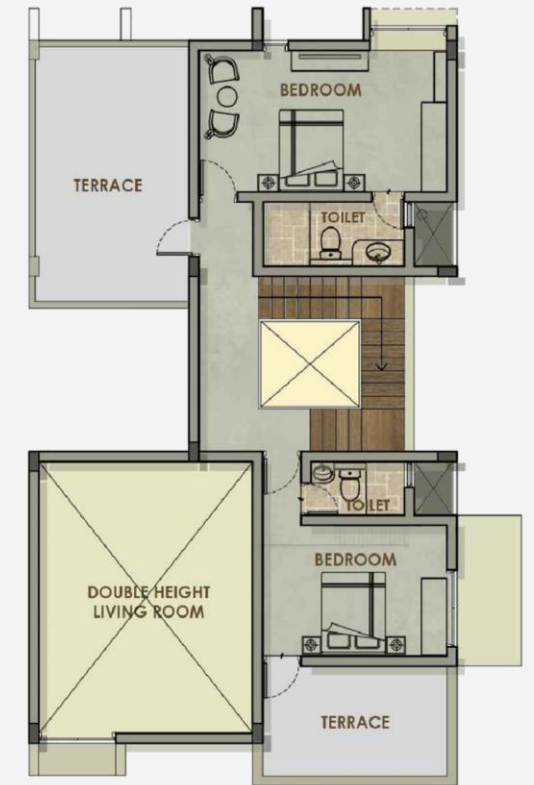


Plans

- Equal distribution of built and open spaces
- Service spaces towards road for easy accessibility
- Central courtyard garden— Oasis feel
- Endemic planter species to reduce water usage
- Vastu principle



Site Plan



First Floor Plan

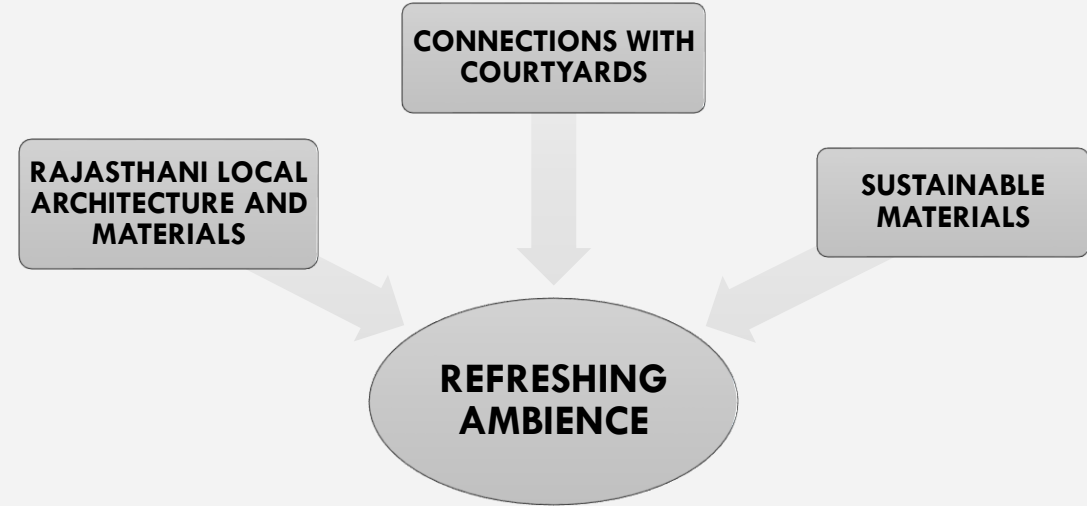
 Airbnb



Interiors



View of the Pooja Area

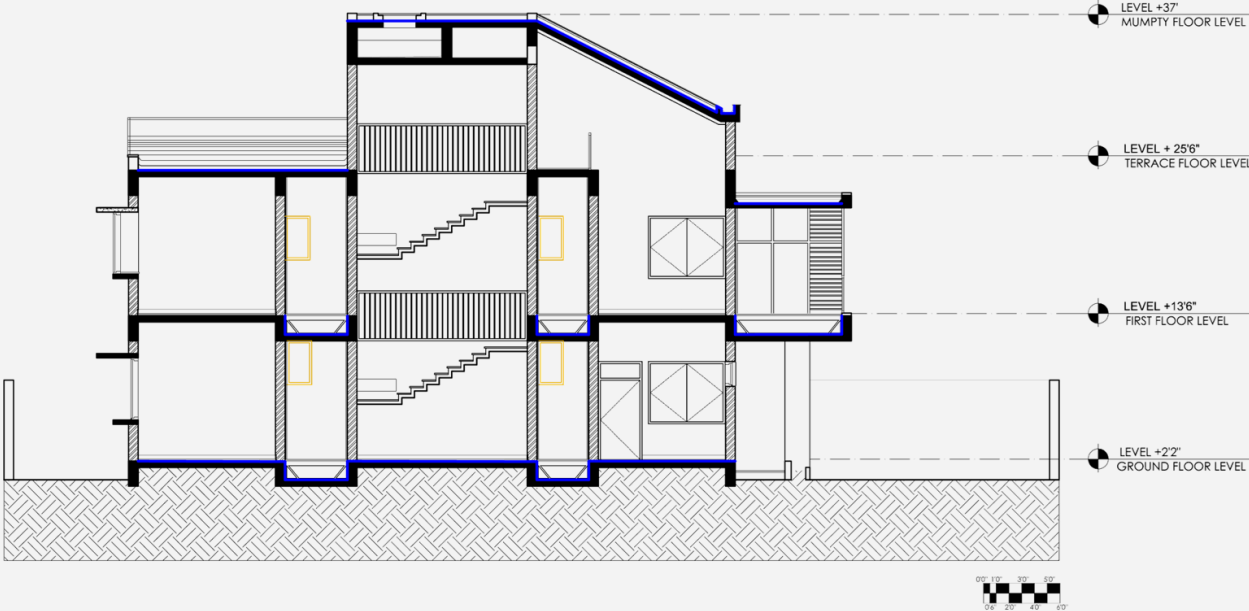


Materials used in the interiors:

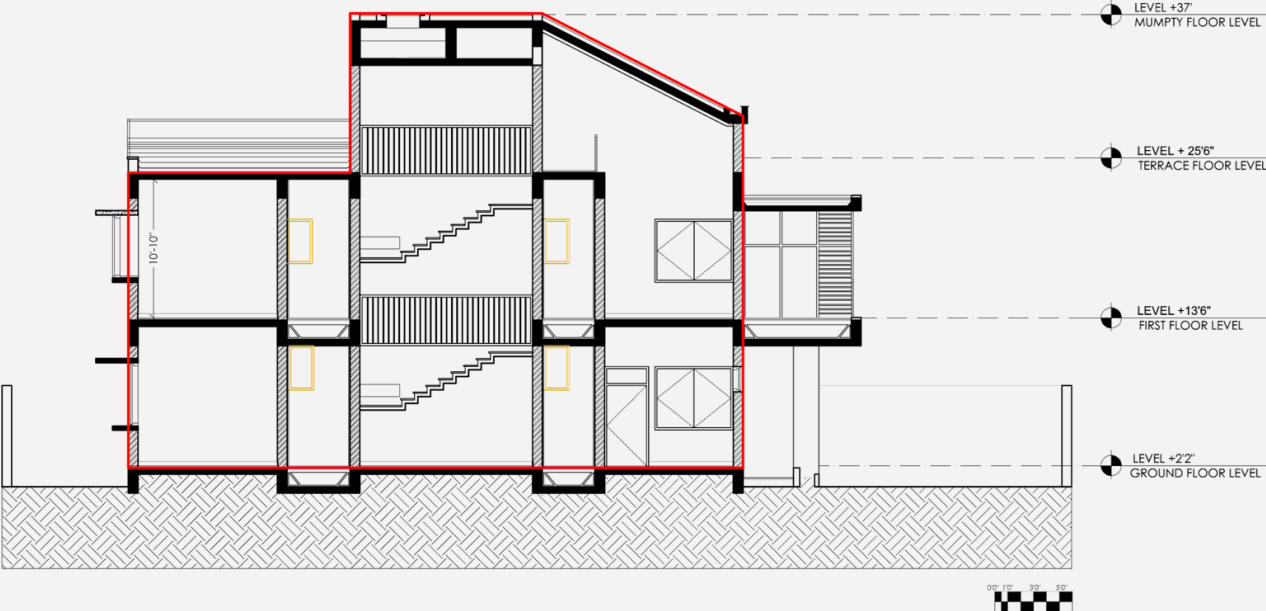
- Polished Concrete flooring-Low cost, low energy and durable
- Particle Board-Sustainable replacement for wood used in interiors
- Low VOC paints-To improve indoor air quality
- Eco friendly fabric-Easy maintenance and to protect the indoor air quality

Sections & Constructability

Vapor Barrier



Insulation lining



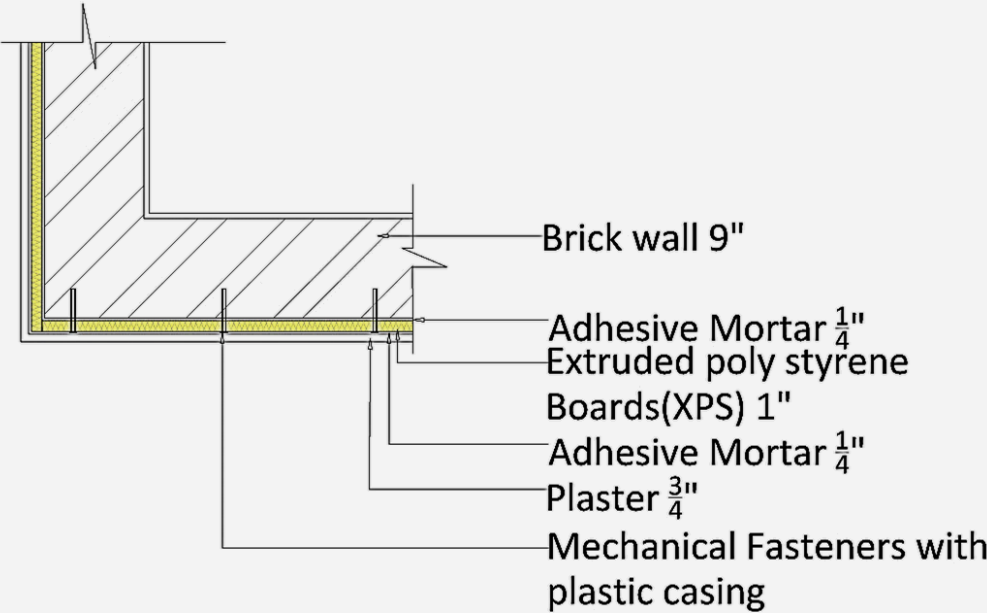
Exterior view



Constructability & Envelope Durability



The challenge in constructability was to figure out such construction detail that would be easily understood by the Indian masons.

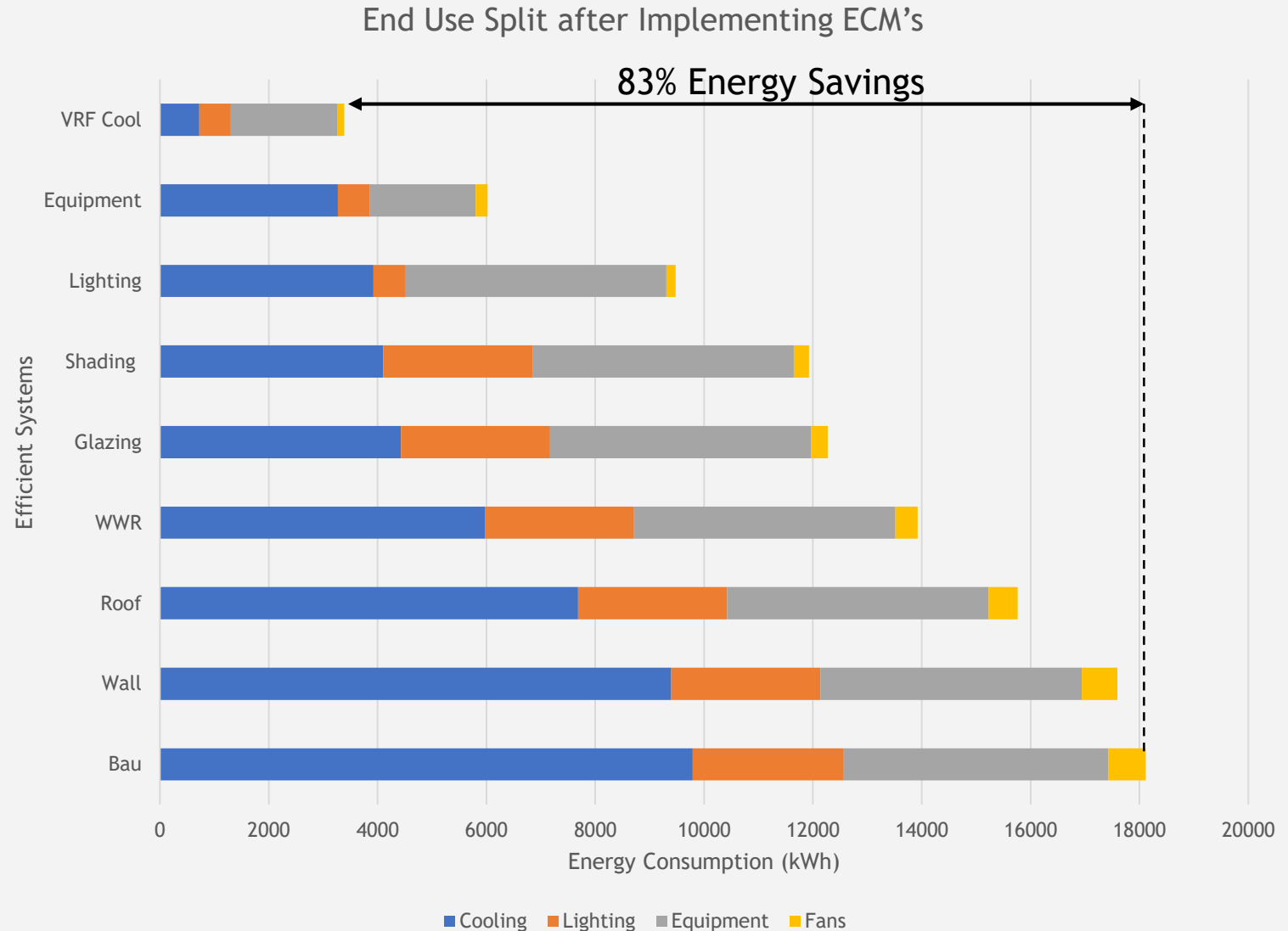


Wall Plan
XPS fixing detail

Energy Performance

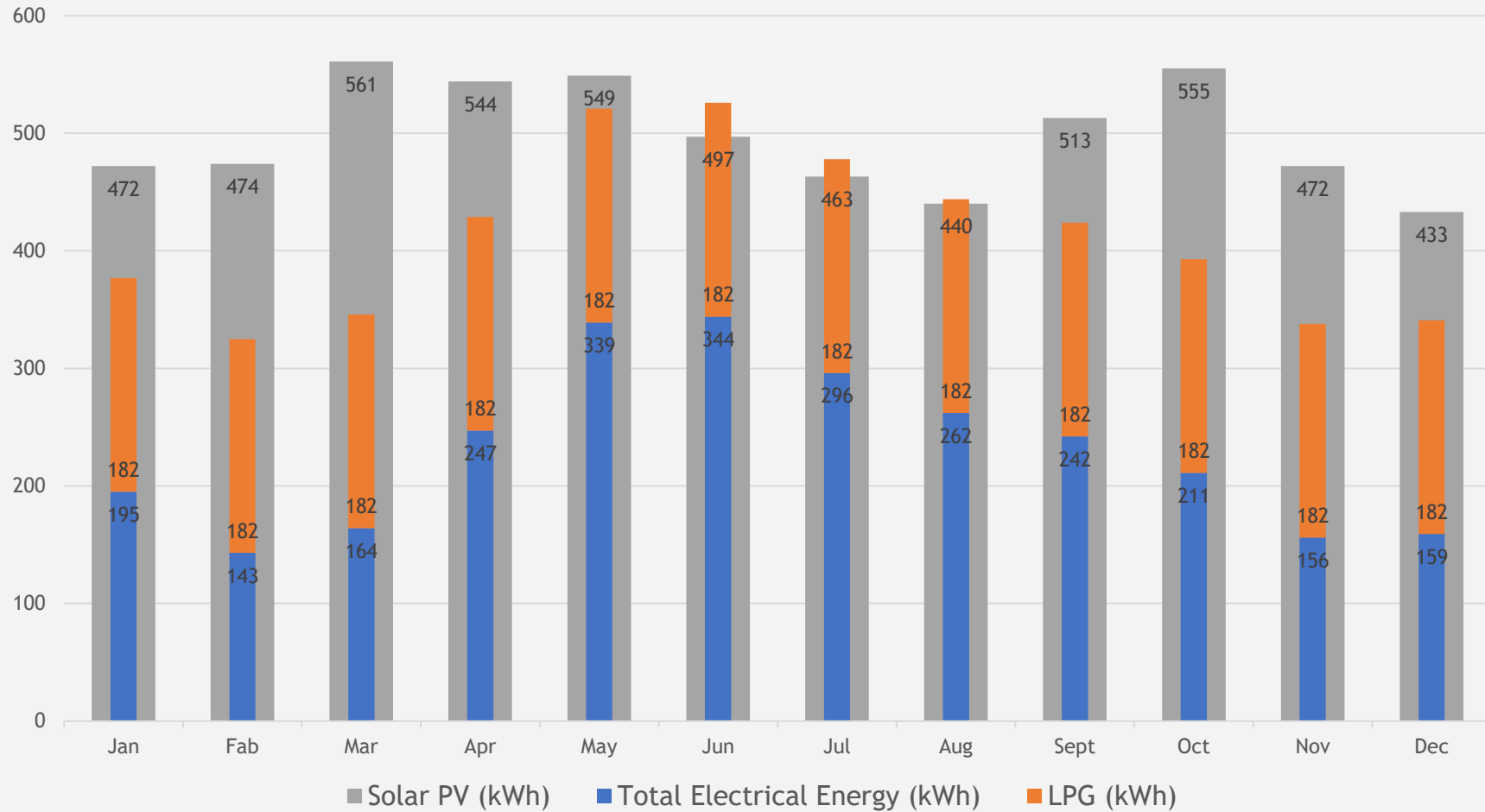
Energy Conservation Measures implemented :

- Wall U-value = 0.132 Btu/h.ft²F
- Roof U-value = 0.28 Btu/h.ft²F
- Window to Wall Ratio = 15%
- Double Glazed Unit U value = 0.29 Btu/h.ft²F
- Shading
- Lighting Power density of 0.16W/ft²
- Equipment Power Density of 1.06W/ft²
- Variable Refrigerant Flow system EER = 15



Net Zero Energy Performance

Energy Consumption of OASIS ABODE



Over a period of one year

Total electrical energy consumed 2758 kWh

Total LPG cooking gas energy consumed 2128 kWh

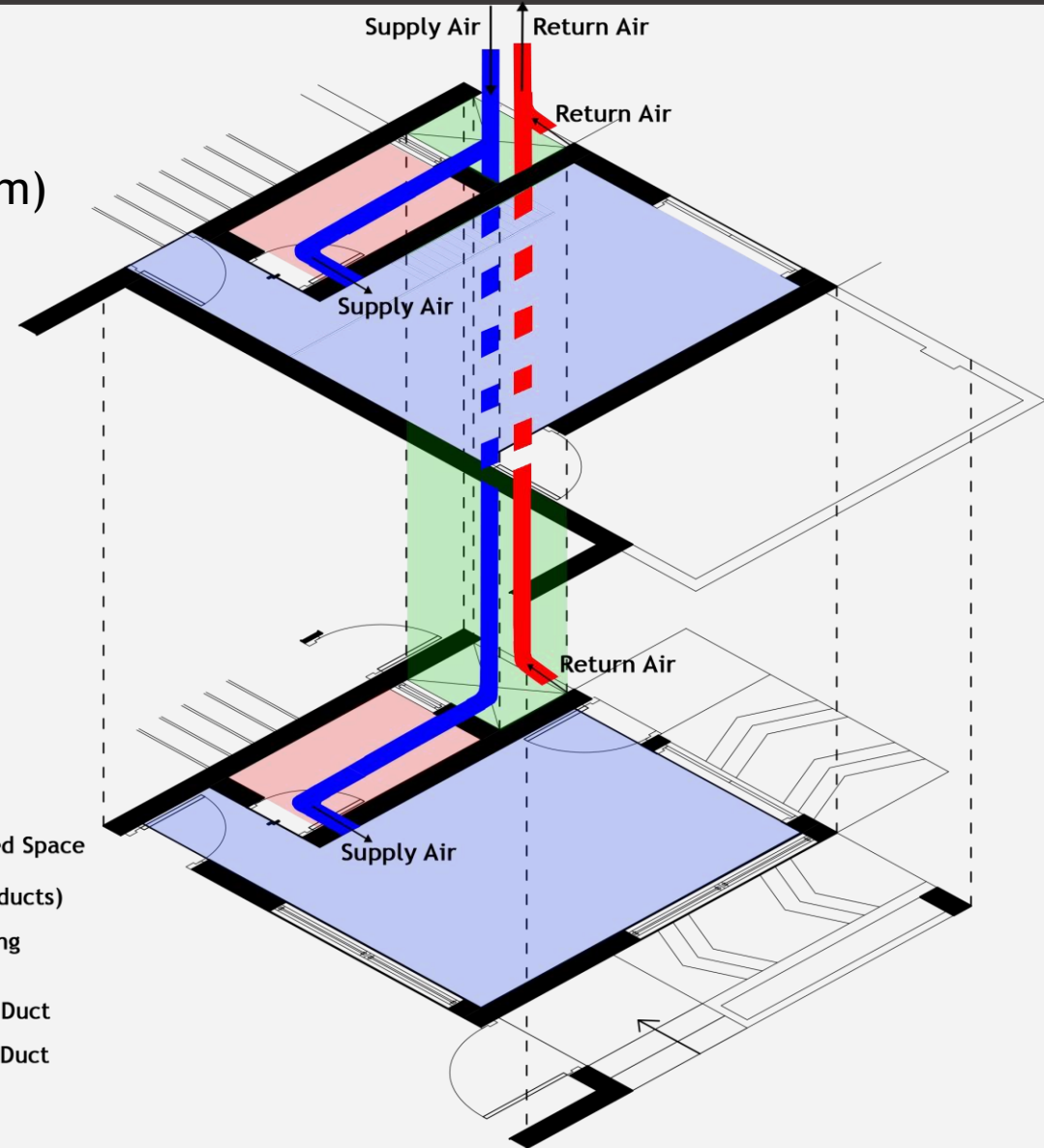
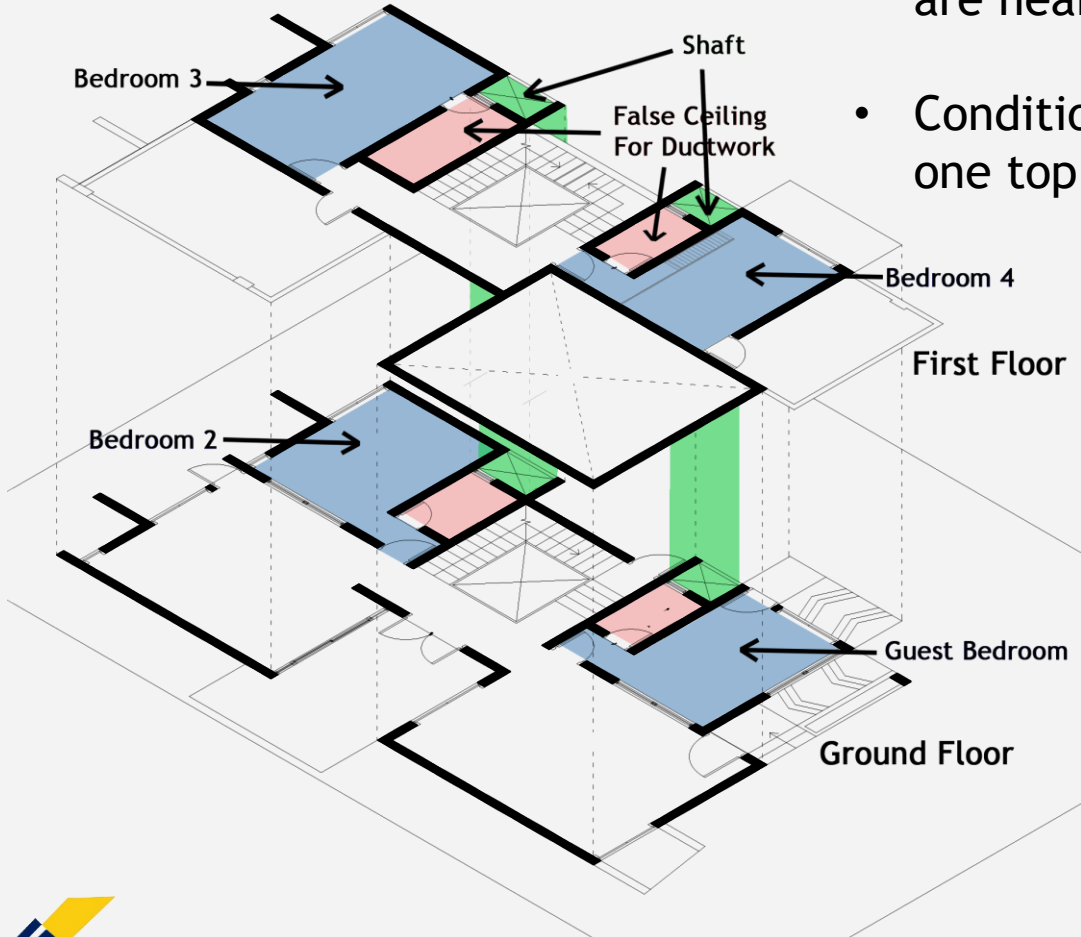
Total energy consumed 4886 kWh

Total electrical energy generated 5973 kWh



HVAC: HRV Duct Length Optimization & Distribution

- Conditioned Zones & False Ceiling (Bath room) are near the Shaft.
- Conditioned zones are one top of the other.



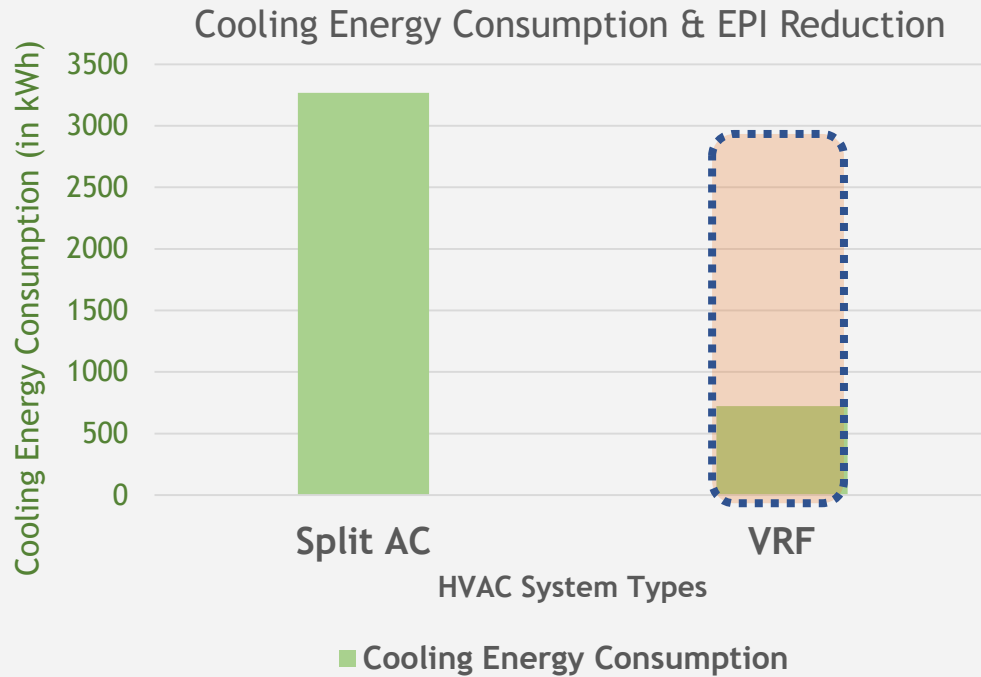
- Conditioned Space
- Shaft (for ducts)
- False Ceiling (for ducts)
- Return Air Duct
- Supply Air Duct



HVAC: System Selection & Operation

Why VRF

- VRF HVAC System is used because of low cooling energy and hence more reduction in EUI.



VRF Outdoor Unit		
Model	Daikin - RXYQ6TRY6 (E)	
EER	15.11	
SEER	22.66	
Power Consumption	kW	3.63

VRF Indoor Units			
	Model	FXAQ32PVE	FXAQ25PVE
Cooling Capacity	kCal/h	3100	2400
	Btu/h	12300	9600
Power Consumption	kW	4	3.2

Why only cooling: During winters, indoor air temperature remains between 19°C (66.2°F) and 26°C (78.8°F).

Indoor Air Quality (IAQ)

Oasis Abode IAQ measures:

- Admixtures for concrete slab to reduce moisture ingress.
- High Density Polymer sheet as vapor barrier to reduce moisture ingress.
- Point source strategy (Chimney) to remove combustion pollutants.



Air Purifier



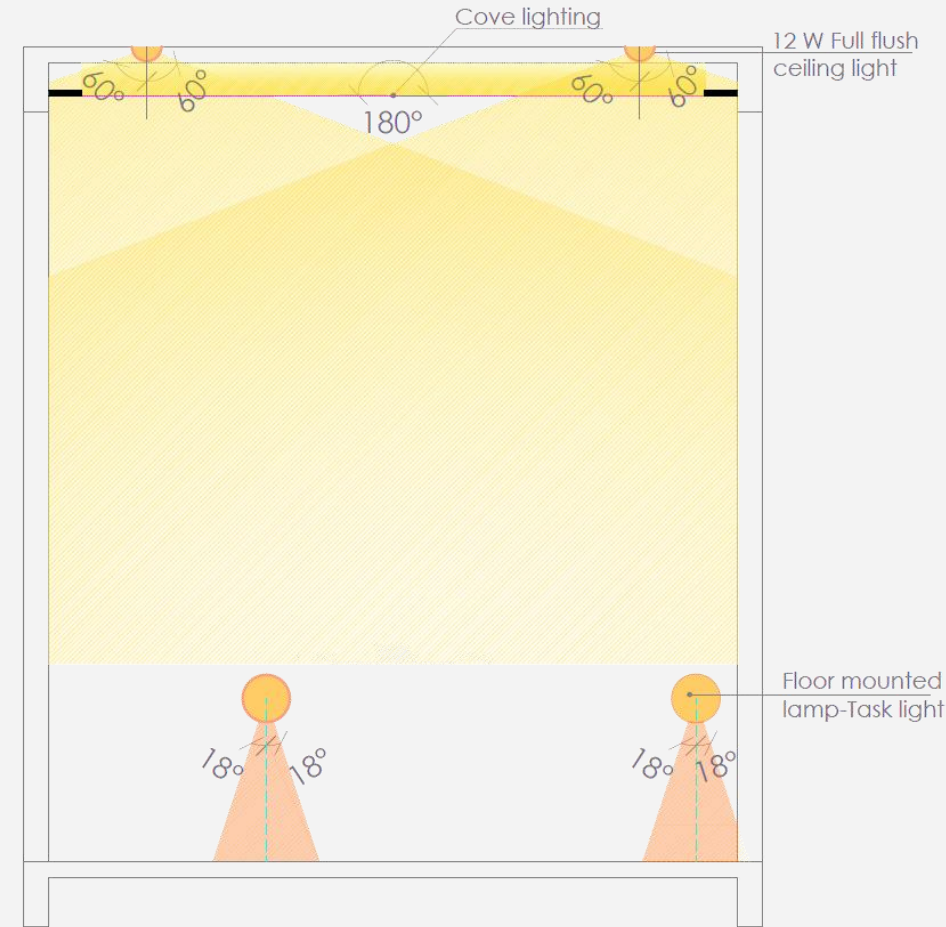
MERV 16 filter

Oasis Abode Pollutant Concentration Reduction Strategy

Building Operation Mode	Natural Ventilation	Mechanical/cooling ventilation
Occupancy hours/ day	7hours	8hours
Type of filtration provided	Air Purifier (Philips AC 4025)	MERV 16 filter (ERV unit)



Lighting design



Types of lighting used in living room



India



USA

Strategy of Task-ambient system for lighting design

Task light system for ambient light- 85 lux (avg.)

Ambient light system- 44 lux (avg.)



Lighting that is not BEE star rated

Maximum luminous efficacy- lm/W

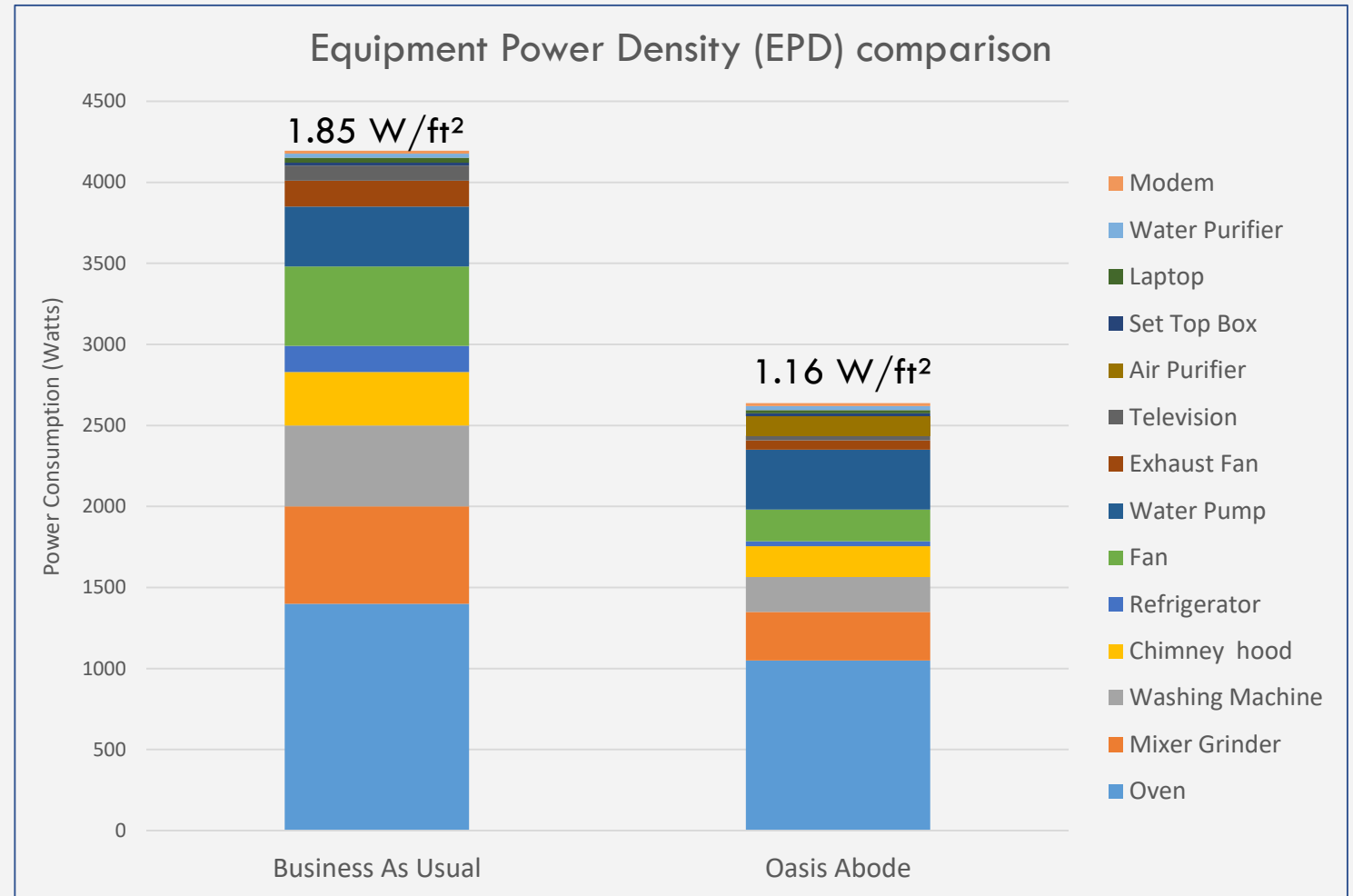
Beam angle- degree

Energy saving appliances

EPD reduction of **37.2 %** by using energy efficient appliances

Equipment selected on the basis of star rating by **BEE** (Bureau of Energy Efficiency)

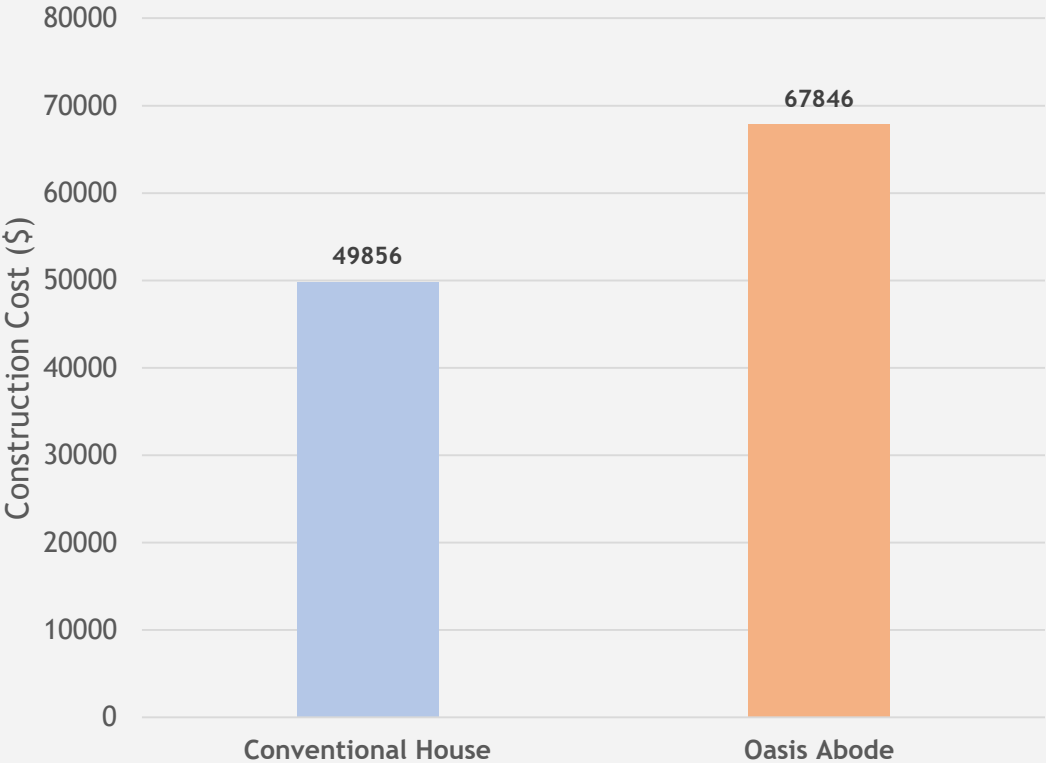
When there is no BEE rating the most efficient equipment available in the market is selected



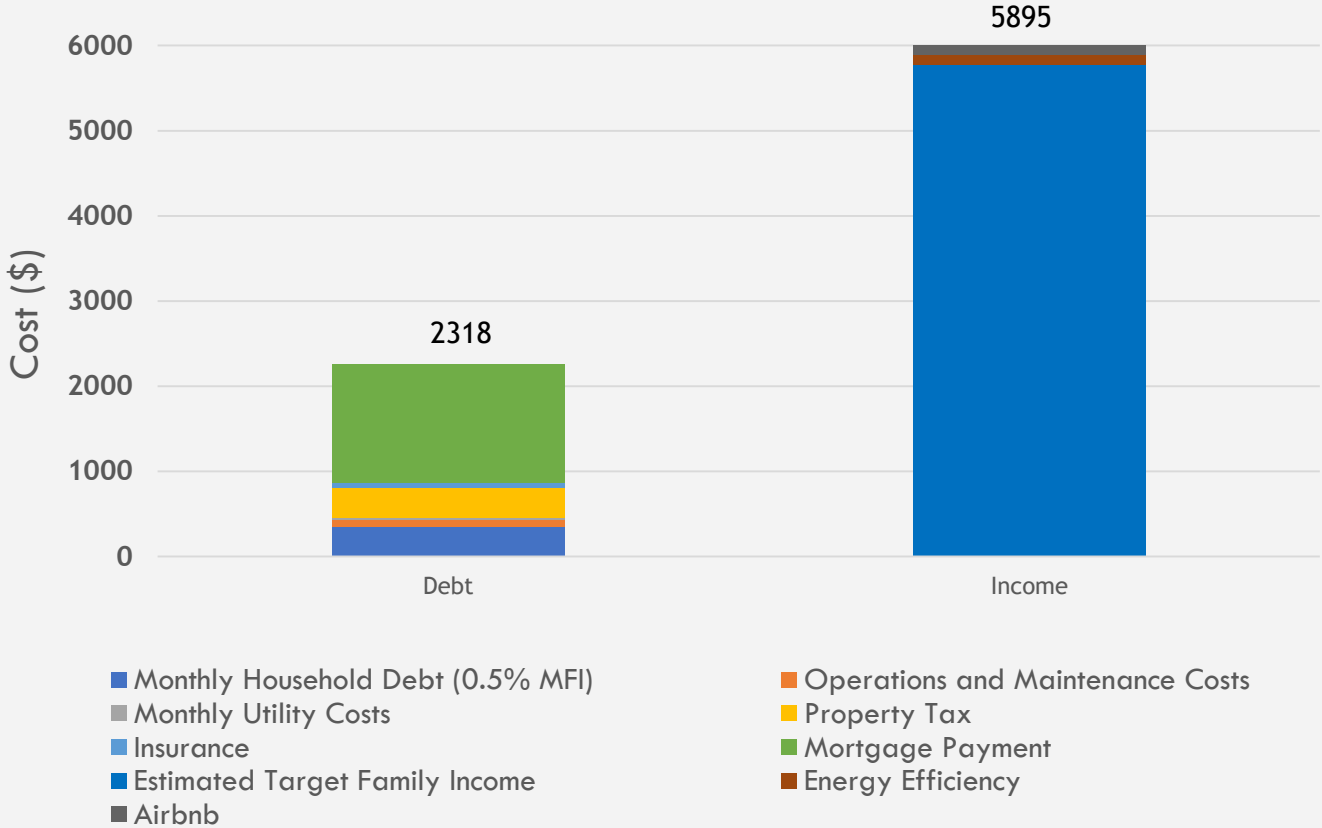
Financial Analysis

Oasis Abode's **Debt to Income Ratio is 39%** which is less than home ownership affordability of India (40%).

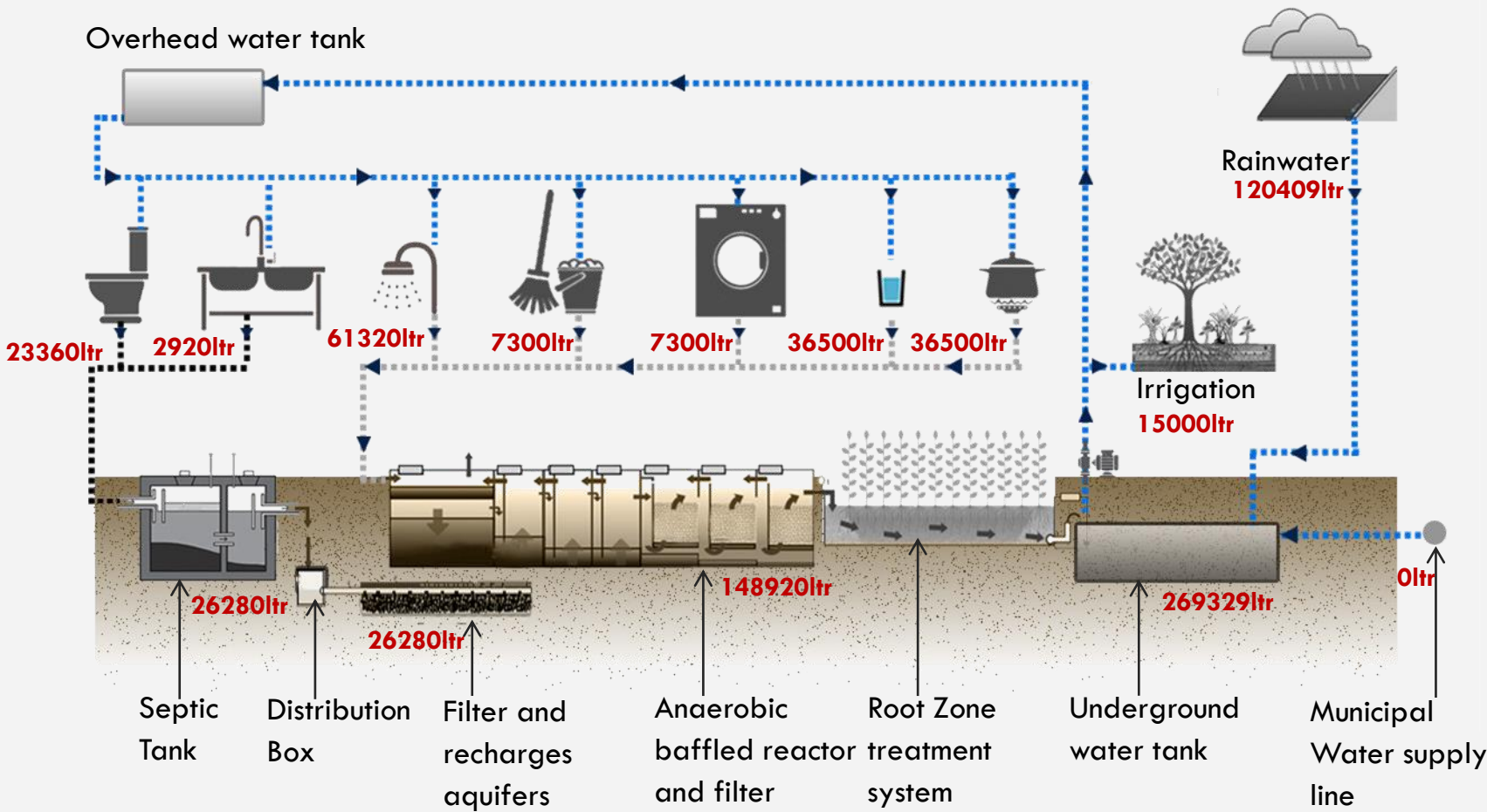
Construction Cost Comparison



Debt to Income

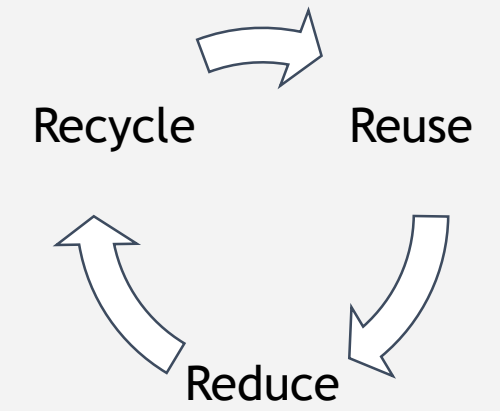


Zero water discharge



Strategies

- Low flow fixtures
- Reverse osmosis system
- Water conserving plants
- Rainwater harvesting



Rainwater collection months **6**
 Annual Rainfall- 559mm, **22** inches
 Total Rainwater collected: **120,409** litres



*Oasis Abode will act as an **affordable energy efficient prototype** that can be used by the developer in India.*

*Aesthetically similar to typical houses, is based on vastu principals and therefore is an **easily marketable** solution.*

