TEAM 085

Nature Inspired Saudi Home Design to Enhance SustainBiophilicability and Well-being

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CEE AECM Design D2D Demolition 3 AI CHE

Introduction

Due to resources being less abundant, innovative solutions are essential. This project presents a biophilic house design that prioritizes energy and water conservation with minimal carbon emission both in construction and post construction. The project focus in three key systems include HVAC, greywater recycling and carbon capture systems. The design follow Saudi codes and regulations. This poster highlights.

Constraints

- The design withstand ambient temperatures up to 50°C.
- Housing must adhere to the Saudi Building Codes.
- 90% of materials and technologies used are sourced locally.
- Full scale design occupy 200 m^2

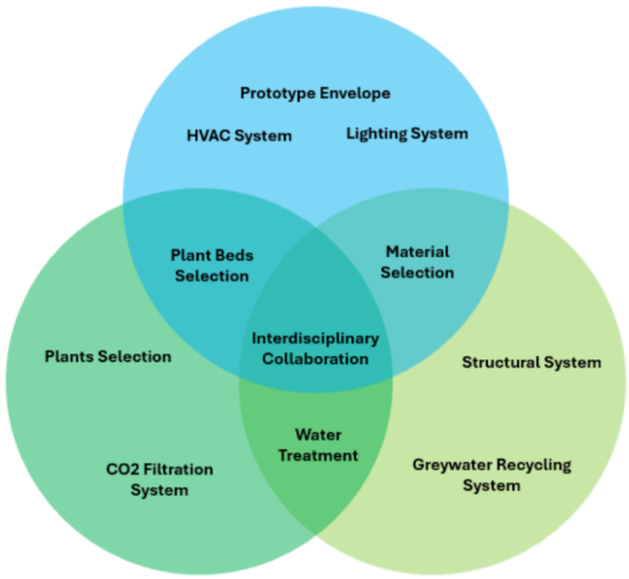
Specifications

- **Space**: 200 m².
- **Thermal Performance:** R-value ≥ 2 m²·K/W.

Specifications

- **Windows:** >50% WWR; 50% with green views.
- **Green Area:** ≥20% of plot.
- **Cooling:** COP ≥ 3.5.
- **Irrigation:** ≥40% water saving.
- **Ventilation:** ≥0.6 ACH naturally.
- **Water Recycling:** ≥50% reuse.
- **Materials:** ≥50% recycled or low-carbon.
- **Energy:** ≥10% savings with real-time monitoring.
- **Emissions:** Net-zero carbon.

Design Prosses



Result

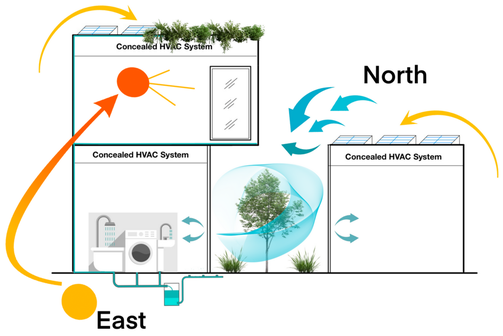
Greywater System:

assumption	Greywater WSFU = 22, 22.9 GPM	Blackwater WSFU = 12, 16 GPM	Total wastewater = 38.9 GPM
Average usage of 15 minutes	343.5	240	583.5

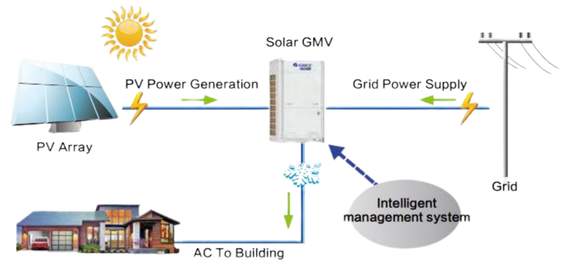
Geopolymer Concrete:

Component	Proportion / Value	Unit	Source / Notes
Volcanic Ash (Binder)	400 – 500	kg/m³	Local
Sodium Hydroxide (NaOH)	8 – 16	kg/m³	Mostly Local
Sodium Silicate (Na_2SiO_3)	20 – 40	kg/m³	Mostly Imported
Fine Aggregates	600 – 700	kg/m³	Local
Coarse Aggregates	1200 – 1400	kg/m³	Local
Water	30 – 50	kg/m³	Local
Superplasticizer	1 – 2% of binder weight	—	Mostly Imported
Density	1900	kg/m³	
Weight	3.860	kg	
Thermal Conductivity	0.823	W/m·K	

Natural Ventilation:



HVAC System:



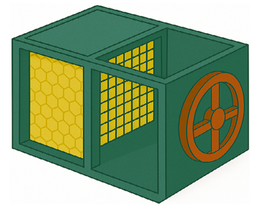
Carbon Capture Methods:

- Natural: Using plants

$$6CO_2 + 6H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$$

People No.	Total green spaces area in the house	CAM consumption rate per area	C4 plants consumption rate per area	Rate of carbon dioxide produced by people	Rate of carbon dioxide consumed by plants
6	117.336 m²	0.0152 kg/day.m²	0.152 kg/day.m²	6 kg/day	16.364 kg/day

- Mechanical: Using soda lime



Overall air inlet flowrate	Carbon dioxide inlet molar flowrate	Carbon dioxide inlet composition	Carbon dioxide outlet flowrate	Carbon dioxide outlet composition
5.45 mol/s	2.45 * 10^{-4} mol/s	550 ppm	2.75 * 10^{-4} mol/s	490 ppm

Conclusion

The biophilic prototype effectively integrated architectural, civil, and chemical engineering systems within a 3×3 meter module. It featured a lighting system, envelope design, and basic greywater and CO_2 treatment, all developed using available resources. The final design proved to be comfortable, sustainable, and cost-efficient.