TEAM 048

Eco-Merge: Smart Adaptive Biophilic Design for Sustainable Urban Living (Biophilic Sustainable Saudi Housing)

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Introduction

❖ Problem statement

An interdisciplinary team is developing a sustainable residential design that integrates technology and biophilic principles to eliminate household CO_2 emissions and reduce energy consumption.

❖ Constraints

Withstand up to 50°C ambient temperature
Compliance: Must follow Saudi Building Codes (energy + safety)
Land Use: ≤ 100 m² per full-scale single-family unit
Prototype Budget: ≤ SR 10,000

❖ Specifications

Reduce energy consumption
Prototype: 5 m² footprint
WWR > 50%
50% of windows face green areas
Green Space: ≥ 20% of land area
COP ≥ 3.5
Irrigation: ≥ 40% water savings vs. traditional systems
Cross-ventilation with ≥ 0.6 ACH
Greywater: Reuse ≥ 50% of household wastewater
Materials: ≥ 50% recycled or low-carbon sources
Energy Monitoring: Smart controls with ≥ 10% savings
Zero net operational carbon

Prototype Design

❖ Room dimensions:

2.5m x 2m x 2.4m

❖ Wall material: Wood

❖ Cooling system :

1ton mini split AC unit

Water Filtration Stages:

1.Sediment (50µm): Removes rust, dirt
2.Fine Sediment (25µm): Traps fine silt
3.Carbon Block: Removes chlorine, odor
4.RO Membrane: Filters salts
5.GAC Filter: Removes VOCs & pesticides
6.Alkaline Filter: Raises pH, adds minerals
7.Mineral Filter: Adds Ca, Mg, improves taste
8.UV Sterilizer: Kills bacteria & viruses

Testing & Validation

❖ Greywater 50% Recovery calculation

Average water usage: 100 to 150 L/d/person
Assuming 4-person per household: 400 to 600 L/d
Shower & Bathtub: 160 to 240 L/d
Bathroom sink: 40 to 60 L/d
Total: (40 to 60) + (160 to 240) = 200 to 300 L/d
Recovery: (200 to 300)/ (400 to 600) = 50%

Conclusion

This project offers a sustainable and smart solution for residential housing, achieving zero net operational carbon emissions. These results highlight a clear pathway to improving energy efficiency and reducing emissions, aligning with Saudi Vision 2030.