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"Design of Low Cost Housing Integrated With Wind-Solar Hybrid Energy System"

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Abstract:
This study presents an affordable housing prototype that uses a solar-wind hybrid power system. It is designed for urban fringe and rural areas. The focus is on cost-effective features, locally available resources, easy building methods, and independent green energy to meet daily home power needs, such as lighting, charging devices, ventilation, and small gadgets. It also aims to reduce ongoing energy costs. The setup combines compact rooftop solar panels with a small wind generator, supported by a basic battery system and a simple charging regulator. This combination provides reliable electricity year-round. Key elements include scaling based on location, energy-saving techniques, cost-efficient parts, and maintenance plans to improve reliability and affordability. Overall, the goal is to improve quality of life, address energy access challenges, and provide models that can be easily adopted by other communities.

Keywords: budget housing, solar-wind combo, standalone energy, solar panels, mini-turbine, energy storage, eco-design, accessible homes, village power.

I. Introduction

Budget-friendly homes and reliable power access are significant challenges for growth. Extending traditional grids is very expensive in isolated or low-income areas. Fuel-based generators can lead to high costs and harm the environment. Combining efficient, low-cost building methods with local green power sources, like solar and wind, offers a practical way to meet essential energy needs without increasing initial or ongoing costs. This combined approach includes passive building strategies, such as sun blocking, airflow design, and heat-retaining materials, along with a compact mix of renewable energy tailored for key uses. The goal is to create durable, low-maintenance homes that reduce ongoing power bills and improve residents' quality of life.

II. Research Gap

Many pilot projects focus on budget housing or small green power networks, but few provide a complete and easy-to-copy plan. These plans should include eco-friendly home features, basic building practices, and affordable solar and wind power options for tight budgets. Key gaps include: (1) clear instructions for scaling small solar and wind setups for minimal home power needs; (2) cost breakdowns showing savings compared to regular fuel or lighting costs; (3) maintenance routines for groups without expert knowledge; and (4) flexible plans that use nearby resources while meeting comfort and durability standards.

III. Problem Statement

Country families and city families with tight budgets often lack reliable, affordable power and live in homes with poor heat regulation. This increases health risks and expenses. The goal is to create a

combined, cost-effective home system that (a) improves heat comfort with minimal powered cooling, (b) provides essential electrical benefits through a compact wind-solar mix, and (c) is affordable to build, operate, and maintain using local materials and simple construction methods.

IV. Objectives

1. Create a budget-friendly home model that combines eco-friendly tactics with everyday basics.

2. Set up a wind-solar system to reliably meet important family needs, such as lights, phone and web charging, fan, radio, and a mini-fridge or DC freezer.

3. Recommend affordable parts, cabling and power setups, and simple management tools like a charge regulator and a converter for DC flow.

4. Calculate initial costs, ongoing expenses, and basic return on investment compared to typical alternatives like kerosene or diesel units.

5. Provide care and training tips aimed at areas with limited tech knowledge.

6. Create adaptable guidance and options for different weather conditions and income levels.

V. Working

A. Home Layout (Eco-passive features)

Orientation and sun block: The main length runs east to west. Use covered openings on the east and west sides. Add roof extensions and basic porches to block direct sunlight.

Airflow design: Create airflow with a chimney and side breezes using upper and lower vents, along with a simple roof vent to reduce indoor heat.

Heat storage and barrier: Use local materials like packed earth bricks, empty cement blocks, cane, or reused stone, combined with inexpensive ceiling barriers such as mirror sheets, foam, or hay pads to manage daily heat changes.

Sunlight entry: Design openings and light shafts to reduce the need for daytime lighting.

Water collection and basic waste recycling can be added for reliable supply.

B. Power Demands (Core; sample scales)

LED bulbs: 4 to 6 bulbs at 7 to 10 W each, totalling about 40 to 60 W max.

Device charging and small gadgets: Approximately 20 to 40 Wh daily.

Overhead fan(s): 40 to 60 W for short bursts.

Compact DC cooler or 12 V DC unit (optional): 30 to 50 Won average during cycling.

Aim for a daily power draw of 1.0 to 3.5 kWh for a typical family, depending on budget and needs.

C. Combo Power Parts & Scale Basics

Solar setup: Install a roof-mounted system of 300 to 1000 Wp based on needs. Solar provides consistent power during the day and can charge batteries.

Mini-wind unit: Use a small 400 to 1000 W pole-mounted turbine (or roof-mounted if space is tight) that works well in breezy weather or at night. Set the wind speed for easy starts based on local gusts. Wind power is helpful if the area experiences regular evening breezes.

D. System Run & Oversight

Energy flow: Solar power feeds daytime usage directly; extra energy charges batteries. At night or during low light, batteries provide power for usage. Wind charges batteries when conditions are favourable; add a waste load or a shift controller to protect fully charged batteries. Include manual or simple automatic switches for additional usage options.

Energy monitoring: Use a basic amp-hour gauge and charge-level display. Educate users on how to manage energy use.

Part Selection Plan (cost-saving): Choose sturdy, easily repairable parts. Select common, easy-to-find converters and charge regulators for quick replacements.

Whenever possible, use DC LED bulbs and DC fans to save on converter expenses.

For wind units, select models with local service options or proven durability in similar setups.

Consider community-level spare parts kits to reduce repair times.

Advantages

1. Power availability: Steady essential electricity for lights, connectivity, and small devices.

2. Cheaper running expenses: Reduces or lowers spending on lamp oil, flashlight batteries, or gas-powered units.

3. Better indoor comfort: Eco-passive setup cuts excess heat and reliance on mechanical cooling.

4. Wellness and security: Less indoor smoke from oil and better lighting for education and safety.

5. Expandability: Flexible combination systems can grow as funding allows.

6. Durability: Mixed power reduces reliance on one source and provides partial nighttime function using wind and reserves.

7. Economic and ecological aspects: Upfront investment can be kept low through stages, starting with solar and battery, and adding wind later.

Inexpensive local building materials reduce construction costs and create local jobs.

Long-term savings from switching fuels usually provide returns within a few to several years, depending on local fuel prices and system size.

Lower carbon emissions compared to traditional fuel options.

8. Maintenance and user guidance: A simple manual with visual guides for regular checks, like the battery fluid for wet lead-acid systems, cleaning PV panels, and securing fastenings.

Regular evaluations every three months by trained local professionals, with village workers learning to provide affordable help.

Parts reserve strategy: Keep essentials like circuit breakers, solar connectors, battery breakers, and a small toolset nearby.

Provide power planning advice: Focus on critical needs, such as timing coolers and large draws during sunny or windy periods if possible.

9.Future potential and improvements: Incorporate affordable smart power monitors, such as automatic cut relays and budget charge controllers, to extend battery life and usage access.

Use more efficient, long-lasting batteries like LiFePO4 as prices drop to reduce overall costs.

Develop village mini-grids that link several homes for shared reserves and power, lowering costs for each household.

Introduce revenue-generating options, such as device charging stations or mini-cooling for crops, to improve financial sustainability.

Conduct research on combining elements for local climates and run extended on-site tests to identify optimal practices and cost trends.

Promote local production or assembly of components, like supports and battery enclosures, to decrease expenses and improve repairability.

VI. Future Scope

Blending affordable smart power controllers, such as auto-load cut relays and budget charge monitors, can improve battery life and usage.

Using more efficient, longer-lasting batteries like LiFePO4 is becoming viable as prices decrease, helping to lower long-term costs.

Setting up village mini-nets can connect several homes, allowing for shared resources and power generation, which reduces expenses for each family.

Introducing new revenue-generating options, like a device charging hub or a compact crop cooler, can strengthen financial stability.

Research on tuning combinations for local mini-climates and ongoing site trials will help establish the best methods and cost strategies.

Assembling or crafting parts locally, like supports and battery casings, can lower costs and make repairs easier.

VII. Conclusion

A carefully designed mix of affordable housing ideas and a small wind-solar power system can give reliable, low-cost electricity and better indoor comfort to disadvantaged and remote families. Key benefits come from smart planning on energy use, eco-friendly features to lower power needs, choices of durable parts that can be repaired locally, and community-focused maintenance training. Gradual implementation and adaptable scaling allow homes to develop over time with affordable beginnings. With proper guidance and local support, this combined approach offers a path to address energy shortages and improve quality of life.

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