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Design and Development of Off-Grid Solar-Battery Hybrid Eco Electric Air Conditioner (AC)

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Abstract: ***The concept of off-grid solar cell hybrid ecological electric air conditioner is environmentally friendly and does not produce any harmful gas. It is a combination of evaporation and smart world technology IOT and other different concepts. Utilizing the evaporation process and the characteristics of the terracotta warriors and horses, it produces a cooling effect when evaporation occurs, and provides air flow through the external medium, which will cause a sharp drop in temperature and can effectively cool commercially available dessert coolers. Since the entire system is bundled with solar energy and backup power, there is no electricity consumption provided through the grid, and no additional costs are required. The concept of using the clay tube as the evaporation medium will provide a longer service life for the off-grid solar cell hybrid ecological power AC. The clay pipe is a biological product when the broken pipe is damaged or replaced, and no hazardous waste is generated. Provide good health for mankind and the environment.***

I. INTRODUCTION

The human body requires an operating temperature that functions efficiently in response to rising outdoor temperatures by instructing the hypothalamus to send messages to blood vessels and dilate. This process warms blood, fluids, and salts in the outer layers of the body's skin and sets the way it evaporates.

In the sultry summer, we only need to blow the cool air gently. The more mercury rises, the greater the demand for air conditioners. However, exposure to alternating current air will cause adverse effects. Not only the environment, air conditioning can also significantly affect human health. You need to pay attention to some side effects of AC. Such as dry eyes, dehydration, difficulty breathing.

In order to reduce power consumption, reduce costs and be more efficient than traditional coolers, and incentivize and improve the employability of local potters and terracotta warriors, the proposed work "off-grid solar cell hybrid ecological electric air conditioner" has many advantages. Some key points of conventional air conditioners and coolers are as follows

A. It is similar as the functioning of an evaporator.
B. Gives more fast cooling air than celling fan.
C. It actually cools air by evaporating the air
D. It actually more efficient than conventional AC.
E. It is highly cost effective and has low maintenance.

II. LITERATURE REVIEW

In this undertaking, we joined various ideas on one stage to improve effectiveness. The principal idea is that when a fluid dissipates, its particles change from the fluid stage to the gas stage and get away from the surface. Warmth drives this interaction. All together for the atoms to leave the fluid surface and break as fume, they should devour heat energy along with the particles. The assimilated heat comes from the surface on which it dissipates. This makes a crash impact on the excess surface on the grounds that the atoms ingest heat as they leave.

Donald Miller pointed out that the evaporation process is causing a cooling effect. The second concept is that when hot air pours into each PET bottle, it is pushed to the edge and starts to expand. When air enters the target room, this expansion cools the air. This cooling is caused by pressure changes.

When air enters most of the PET bottle, it will escape from the bottleneck under high pressure. If it spreads quickly into the room, the temperature will drop. The thermodynamic principle here is called the Thomson effect, and the process is called the work of the throttle, liquefier, refrigerator, heat pump, and air conditioner. Th combining concepts with clay (especially terracotta warriors) and then cooling is a low-tech technique that has been used for hundreds of years.

III. METHODOLOGY

To build a model, it is necessary to combine and design an efficient model instead of consuming renewable energy. The model has different levels. In the "solar-based hybrid ecological communication model", each method has a specific purpose.

1) Level (1) Grade is an evaporation chamber made of clay pipes called clay, and its arrangement should be such that when water flows at its two ends, it starts to contact each other. The size and thickness of the terracotta warriors and horses should be enough to allow air to flow through them and keep them in good condition, without any resistance and thickness, to keep water in the porous surface of the terracotta warriors and horses. In this venture, the technique is completed in an evaporative cooler utilizing earthenware tubes. The cooled encompassing air is frozen and humidified by the earth tube-based evaporative cooling innovation. The reason for this examination is to acquire essential data about the impact of air and water on the warmth and mass exchange coefficients in the evaporative cooling measure through different facilitated and dispersed dirt cylinder the pressing factor drop were examined. The warmth and mass exchange coefficients of the test esteems were contrasted and the Coburn warmth and mass exchange local area. This reduces the consumption of AC power, helps reduce global warming, and produces environmentally friendly waste and less toxic waste. With the help of sensors, the temperature of the room can be monitored, and through the implementation of electronic equipment, the efficiency of the AC will be improved with lower electricity costs and lower heat transfer, just like other ACs.

2) Level (2) is the water tank at the frame and base. The frame should be strong and strong enough to withstand the weight of the clay pipe and the water tank filled with water at the bottom of the frame when wet.

3) Level (3) is an electronic device. The DC power source comes from the solar panel installed above it. To obtain continuous DC power, a battery needs to be installed to store solar energy in it. There are 3 parts in total.

The first thing that needs to be supplied is a DC fan, which will be installed behind the Hybrid Eco Electric Ac to push the air forward, followed by a submersible water pump, which will maintain the flow of water on the terracotta pipes and maintain the evaporation process, and the last one is through the mobile app with the control unit, we can monitor the humidity and temperature levels, and then can make the AC close and open from a remote location on the part of the IOT.

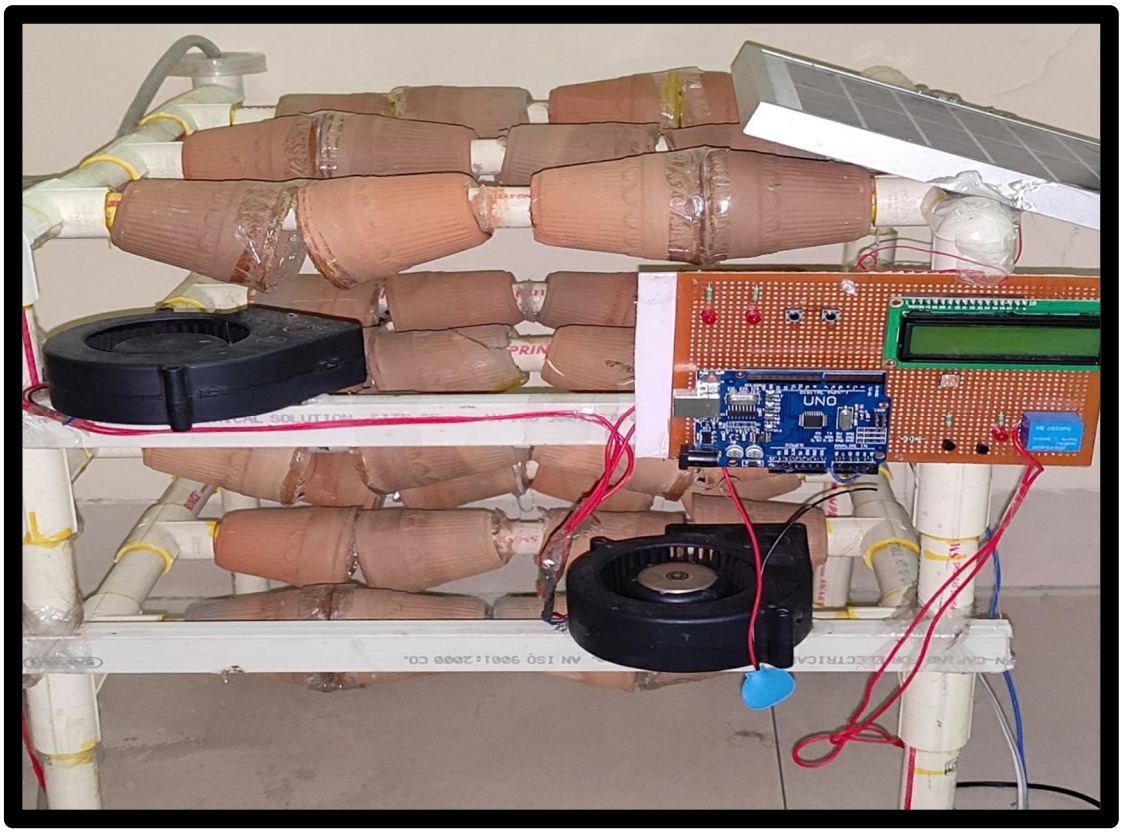

Fig 1: - Model of Off-Grid Solar Battery Hybrid Eco Electric AC

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IV. RESULT ANALYSIS

To analyse the effectiveness of the Solar Based Hybrid Eco Electric AC first power calculation is done as per the components used in the system.

Total power (Pt)

Power if individual components is taken as P1, P2, P3, etc.

Pt = P1 + P2 + P3

By applying formula power consumption of Solar Based Hybrid Eco Electric AC is 30 Watts. This power is much less in comparison to cooling system available in market.

Solar Based Hybrid Eco Electric AC run on the solar system with the battery of 12V 7Ah and solar panel of 12V 15W. It is enough to provide power which plays important role in power demand.

To prove its efficiency in terms of energy consumption we will run hybrid eco electric air conditioner model on AC source of energy and compare the cost of energy consumption as per tariff plans of different state with the commercial 3000 Watts AC and average of each model will discuss.

A. Power Consumption by Commercially Available AC

A central air conditioner is used in a home to provide cooling by circulating cool air through ducts from an air conditioner unit typically situated outside the house. The central air conditioner will run 3 to 7 months of the year depending on the outside temperature. An average central AC will use 3000 to 5000 Watts of power per hour for around 9 hours a day during the summer.

Applying formula $E_{(kWh/day)} = P_{(W)} \times t_{(h/day)} / 1000_{(W/kW)}$

Here,

E = energy in KW-h

P = power in Watts

T = hours/day

1) Taking 3000 Watts of AC used in India on an average.

2) The below unit rates for the consumption of units from 201 to 500 units on an average

3) The average rate tariff plan is taken from the state wise by using the formula (5.1)

4) All cost is calculated so, further we can compare the billing with our Solar Based Hybrid Eco Electric AC.

Table 1. Billing of energy consumption of 3000 W of AC according to state planes calculation using the above formula

S. No.	State	Avg. Rate (₹) For KW/h	Hour used/ day	Power use (Watts)	Cost/ Hour (₹)	Cost/ Day (₹)	Cost/ Month (₹)	Cost/ Year (₹)
1	Andhra Pradesh	6.9	1	3000	20.7	20.7	629.69	7556.33
2	Andaman &Nicobar	6.6	1	3000	19.8	19.8	602.32	7227.79
3	Arunachal Pradesh	4	1	3000	12	12	365.04	4380.48
4	Asom	7.7	1	3000	23.1	23.1	702.70	8432.42
5	Bihar	7.8	1	3000	23.4	23.4	711.83	8541.94
6	Chandigarh	5.2	1	3000	15.6	15.6	474.55	5694.62
7	Chhattisgarh	5.3	1	3000	15.9	15.9	483.68	5804.14
8	Daman & Diu	2.3	1	3000	6.9	6.9	209.90	2518.78

9	Delhi	6.5	1	3000	19.5	19.5	593.19	7118.28
10	Goa	4	1	3000	12	12	365.04	4380.48
11	Gujarat	5.2	1	3000	15.6	15.6	474.55	5694.6
12	Haryana	6.3	1	3000	18.9	18.9	574.94	6899.26
13	Himachal Pradesh	5.4	1	3000	16.2	16.2	492.80	5913.65
14	Jammu & Kashmir	3.2	1	3000	9.6	9.6	292.03	3504.38
15	Jharkhand	5.5	1	3000	16.5	16.5	501.93	6023.16
16	Karnataka	7.6	1	3000	22.8	22.8	693.58	8322.91
17	Kerala	6.7	1	3000	20.1	20.1	611.44	7337.30
18	Lakshadweep	6.5	1	3000	19.5	19.5	593.19	7118.28
19	Madhya Pradesh	6.3	1	3000	18.9	18.9	574.94	6899.26
20	Maharashtra	11.1	1	3000	33.3	33.3	1012.99	12155.83
21	Manipur	5.6	1	3000	16.8	16.8	511.6	6132.67
22	Meghalaya	5.7	1	3000	17.1	17.1	520.18	6242.18
23	Mizoram	5.1	1	3000	15.3	15.3	465.43	5585.11
24	Nagaland	7	1	3000	21	21	638.82	7665.84
25	Odisha	5.7	1	3000	17.1	17.1	520.18	6242.18
26	Puducherry	5.1	1	3000	15.3	15.3	465.43	5585.11
27	Punjab	7.1	1	3000	21.3	21.3	647.95	7775.35
28	Rajasthan	6.7	1	3000	20.1	20.1	611.44	7337.30
29	Sikkim	4.93	1	3000	14.8	14.8	449.91	5398.94
30	Tamil Nadu	4.6	1	3000	13.8	13.8	419.80	5037.55
31	Telangana	9	1	3000	27	27	821.34	9856.08
32	Tripura	7.2	1	3000	21.6	21.6	657.07	7884.86
33	Uttar Pradesh	6.2	1	3000	18.6	18.6	565.81	6789.74
34	Uttarakhand	5.4	1	3000	16.2	16.2	492.80	5913.65
35	West Bengal	7.3	1	3000	21.9	21.9	666.20	7994.38

On a calculation the yearly consumption of India when using 3000 Watts AC 1 hour/day the average cost will be ₹ 6484.71

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B. Power Consumption Hybrid ECO Electric AC

Since we know that clay utensils have been around for a long time. Though we use the Italian word "terracotta" (literally meaning "baked earth").

The porous terra-cotta units absorb water that then seeps to the outer surface where it evaporates and turns into the cold air. The flow of water empties out into a collection basic and gives the installation a beautiful waterfall effect.

For better human comfort, the living environment is vital in tropical climates. Evaporative cooling process remains one of the least expensive technique. Evaporative cooling is based on the thermodynamics process of evaporating water to the surroundings air, which involves exchange sensible heat and latent heat between air and exposed water surface at constant enthalpy.

1) The designed system has total of 76 Watts at 230V AC supply
2) Taking 76 Watts in consideration
3) Applying formula for the calculation

Table 2 Billing Of Energy Consumption Of 30 W Of Solar Based Hybrid Eco Electric Ac According To State Rate Plans Calculation Using Above Formula

S. No.	State	Avg. Rate (₹) For KW/h	Hour used/ day	Power use (Watts)	Cost/ Hour (₹)	Cost/ Day (₹)	Cost/ Month (₹)	Cost/ Year (₹)
1	Andhra Pradesh	6.9	1	30	0.21	0.21	6.21	75.55
2	Andaman & Nicobar	6.6	1	30	0.20	0.20	5.94	72.27
3	Arunachal Pradesh	4	1	30	0.12	0.12	3.6	43.8
4	Asom	7.7	1	30	0.23	0.23	6.93	84.31
5	Bihar	7.8	1	30	0.23	0.23	7.02	85.41
6	Chandigarh	5.2	1	30	0.16	0.16	4.68	56.94
7	Chhattisgarh	5.3	1	30	0.15	0.15	4.77	58.04
8	Daman & Diu	2.3	1	30	0.07	0.07	2.07	25.185
9	Delhi	6.5	1	30	0.195	0.195	5.85	71.175
10	Goa	4	1	30	0.12	0.12	3.6	43.8
11	Gujarat	5.2	1	30	0.16	0.16	4.68	56.94
12	Haryana	6.3	1	30	0.189	0.189	5.67	68.985
13	Himachal Pradesh	5.4	1	30	0.162	0.162	4.86	59.13
14	Jammu & Kashmir	3.2	1	30	0.096	0.096	2.88	35.04
15	Jharkhand	5.5	1	30	0.165	0.165	4.95	60.225
16	Karnataka	7.6	1	30	0.228	0.228	6.84	83.22
17	Kerala	6.7	1	30	0.201	0.201	6.03	73.365
18	Lakshadweep	6.5	1	30	0.195	0.195	5.85	71.175
19	Madhya Pradesh	6.3	1	30	0.189	0.189	5.67	68.985
20	Maharashtra	11.1	1	30	0.33	0.33	9.9	120.45

21	Manipur	5.6	1	30	0.168	0.168	5.04	61.32
22	Meghalaya	5.7	1	30	0.171	0.171	5.13	62.415
23	Mizoram	5.1	1	30	0.153	0.153	4.59	55.845
24	Nagaland	7	1	30	0.21	0.21	6.3	76.65
25	Odisha	5.7	1	30	0.171	0.171	5.13	62.415
26	Puducherry	5.1	1	30	0.153	0.153	4.59	55.845
27	Punjab	7.1	1	30	0.213	0.213	6.39	77.745
28	Rajasthan	6.7	1	30	0.201	0.201	6.03	73.365
29	Sikkim	4.93	1	30	0.1479	0.1479	4.437	53.983
30	Tamil Nadu	4.6	1	30	0.138	0.138	4.14	50.37
31	Telangana	9	1	30	0.27	0.27	8.1	98.55
32	Tripura	7.2	1	30	0.216	0.216	6.48	78.84
33	Uttar Pradesh	6.2	1	30	0.186	0.186	5.58	67.89
34	Uttarakhand	5.4	1	0	0.162	0.162	4.86	59.13
35	West Bengal	7.3	1	30	0.219	0.219	6.57	79.94

On a calculation they yearly consumption of India when using 30 W Solar Based Hybrid Eco Electric AC for 1hr/day the average cost will be ₹ 74.78.

C. Comparison Of Cooling Systems

Table 3 Comparison Table According To Electricity Bill From The Table 1&2

S. NO.	COOLING SYSTEM	COST (yearly for 1hr/day avg.)
1	Commercial AC	₹ 6484.71
2	Hybrid Eco Electric AC	₹ 74.78

On comparison of two cooling systems i.e., commercial and hybrid eco electric ACs, hybrid eco electric AC has been found cheaper and more efficient in cooling. This system could be easily adopted by the rural mass of India due to availability of plenty of solar energy.

V. CONCLUSION

Through this concept of reduced power consumption, it is also eco-friendly, which has a positive impact on humans and the environment. The concept is new and no one has used this type of idea.

Due to global warming and the rapid increase in power consumption, the concept will provide efficient cooling settings, while reducing energy consumption and reducing noise pollution (such as old-style coolers).

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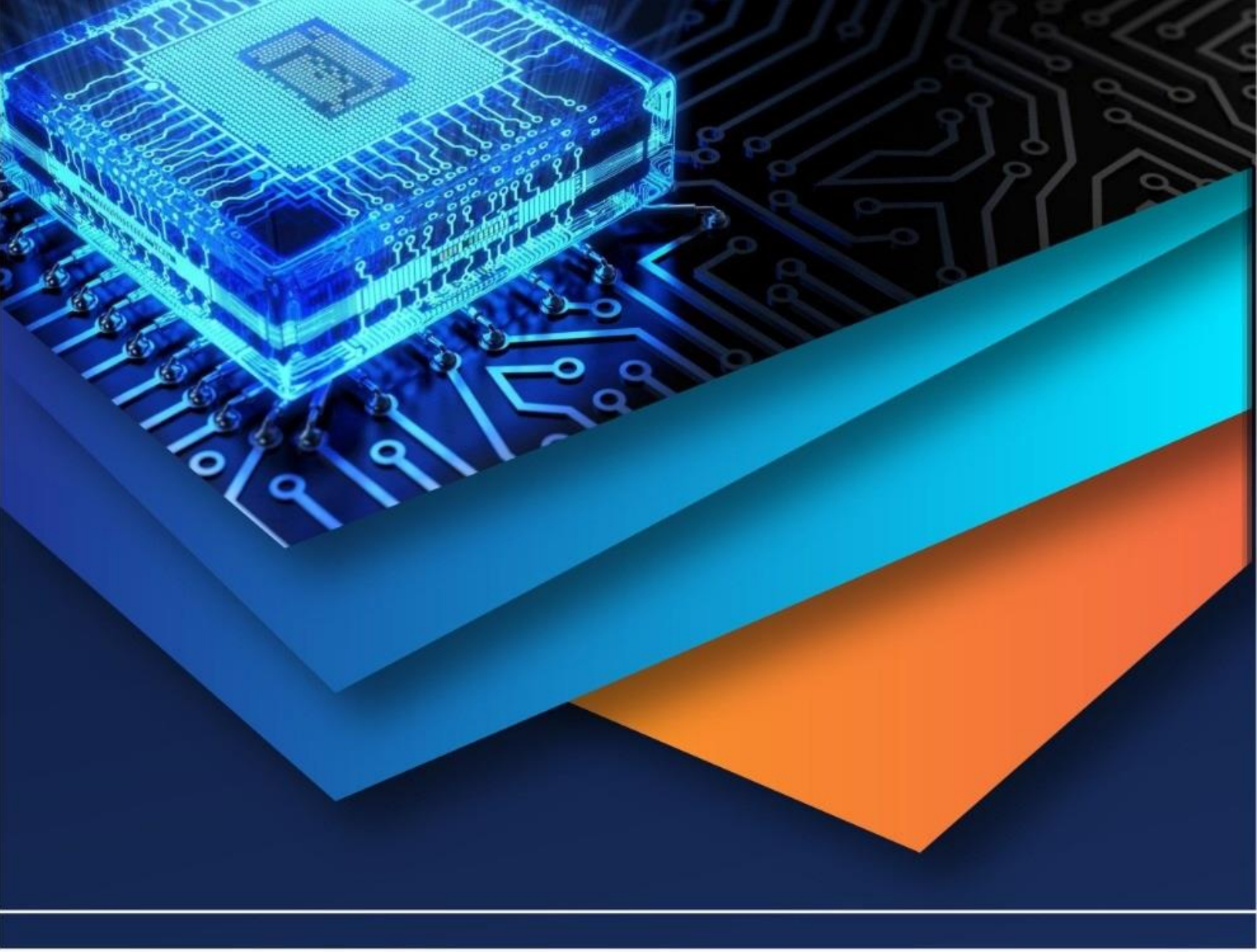

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