JK GREEN TECHNOLOGIES LLP
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DESIGN FOR SOLAR AIR HEATER FOR MECHANICAL VENTILATION AND STANDALONE NET-ZERO APPLICATIONS

Progress & Challenges

Revision-1

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1. Executive Summary

1.1. About JK Green Technologies

This innovative project/solution is being designed and executed by JK Green Technologies (JKGT). JKGT services include system design, system automation, system implementation supervision, commissioning, and testing and system advisory service for Energy optimization and Sustainability.

Our focus on sustainability ensures that our solutions are efficient, cost-effective, and environmentally responsible. Overall, JKGT Consultancy's commitment to innovation, sustainability, and reliability makes us a trusted partner for clients seeking top-notch design consultancy services and solutions in the fields of central hot water, and power and energy automation and optimization leading to Net-Zero buildings.

1.2. Standards and Framework

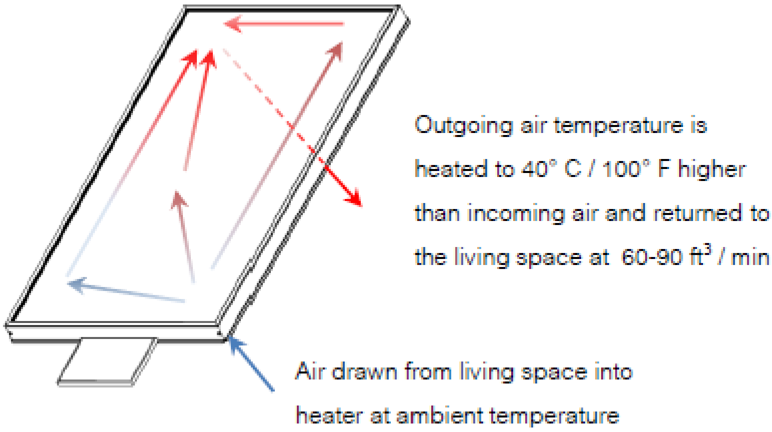
- ECBC 2017 Energy Conservation Building Codes (ECBC)
- GRIHA VERSION 2019 MANUAL (VOLUME I)
- GRIHA –Green rating for Integrated Habitat Assessment
- SVAGRIHA V.3 Abridged Manual
- SVAGRIHA, an abbreviation for Simple Versatile Affordable small offices/ houses

1.3. SolarWall ® Concept

India has pledged to be a Net Zero Emission nation by the year 2070 in COP 26. Heating, Cooling, and Electricity account for about 30% of global energy consumption and 28% of global CO_2 emissions. This initiative reduces the carbon foot print for heating a building.

A 1500W solar air heater is an innovative renewable energy solution for heating ventilated air using solar energy. Heater uses 4" standard ducting for inlet and outlet connection, and mounts to south facing wall (recommended) or roof using standard PV mounting rails or brackets.

Figure 1 Solarwall® working



Using a patented heat exchanger design and high R value insulation, this heater is a simple product, and with proper installation and maintenance should bring you years of free, renewable, supplemental heating to the adoptive space. Under full sunlight it can generate close to 1,500 W / 5,000 BTU / hr of space heating

A well-designed solar air heater represents an intelligent, sustainable approach to heating that offers significant economic and environmental benefits.

2. High Level design Overview

We’re developing a 1500W solar air heater with an automated solar collector. An efficient way to heat ventilated air using solar energy.

Figure 2 Solarwall front/back view

Below are the advantages, key calculations, and design considerations for such a system.

2.1. Advantages of a SolarWall

1. Energy Independence – 100% solar-powered, zero fuel costs.
2. Smart Automation – Self-regulating via temperature-controlled dampers/fans.
3. Air Quality Enhancement – Continuous fresh air exchange reduces mold/condensation. Maintains Indoor Air Quality (IAQ)
4. Carbon-Neutral Operation – No combustion emissions.
5. Minimal Maintenance – No fluids or complex plumbing (unlike solar water systems).
6. Instant Heat Transfer – Air is heated directly, avoiding heat exchanger delays.
7. Modular Expandability – Add collectors linearly for higher capacity.

2.2. Key Calculations for a 1500W Solar Air Heater

Required Collector Area

- Solar irradiance: ~1000 W/m^2 (peak sunlight)
- Efficiency of solar air collector: ~50-70% (depends on design)

Collector Area (m^2)=Heating Power (W)Solar Irradiance (W/m^2)×EfficiencyCollector Area (m^2)=Solar Irradiance (W/m^2)×EfficiencyHeating Power (W)

For 1500W output at 60% efficiency:
Area=15001000×0.6=2.5 m^2Area=1000×0.61500=**2.5m^2**

Airflow Rate Required

- Desired temperature rise (ΔT): ~20°C (e.g., from 10°C to 30°C)
- Specific heat capacity of air (Cp): ~1005 J/kg·K
- Air density (ρ): ~1.2 kg/m^3

Airflow (m^3/s)=Heating Power (W)ρ×Cp×ΔTAirflow (m^3/s)=$\rho \times Cp \times \Delta T$Heating Power (W)

Airflow=15001.2×1005×20≈0.062 m^3/s (≈220 CFM)Airflow=1.2×1005×201500 ≈0.062m^3/s(≈220CFM)

Fan Power Requirement

- Pressure drop in system: ~50-100 Pa (depends on duct design)
- Fan efficiency: ~50%

Fan Power (W)=Airflow (m^3/s)×Pressure Drop (Pa)Fan EfficiencyFan Power (W)=Fan EfficiencyAirflow (m^3/s)×Pressure Drop (Pa)
Fan Power=0.062×750.5≈9.3 W Fan Power=0.50.062×75≈9.3W

- If using a small PV panel to power fans/controllers (~50-100W).

Features

- **Temperature Sensors** – Adjusts fan speed/damper position.
- **Motorized Dampers** – Open/close based on solar heat availability.
- **Variable Fan Speed** – Optimizes airflow for efficiency.
- **PV-Powered Control** – Can run independently of grid.

Conclusion

- **Collector Size:** ~2.5 m^2 for 1500W output.
- **Airflow Needed:** ~220 CFM for a 20°C rise.
- **Fan Power:** ~10W (small additional energy use).
- **Automation:** Improves efficiency and usability.

3. Further Research and Development

3.1. R&D Priorities for Performance Boost

Table 1 Summary of R&D in progress

Component	Standard	Optimized	Gain
Absorber	Flat black paint	Anodized aluminium fins	+10% efficiency
Glazing retention	Single polycarbonate	Double-glazed low-iron glass	+15% heat
Insulation	Fiberglass	Reflective foil + aerogel	+20% reduction in losses
Tilt Angle	Fixed 45°	Seasonal adjustment (±15°)	+5-10% winter yield
Automation		Develop Microcontroller based sensory control system	

Goal: Boost efficiency to **>70%** (instead of 50–60%).
Performance Hacks
✓ **Blackened Aluminium Fins** – Improves heat absorption.
✓ **Double Glazing** – Reduces heat loss (use old window panes).
✓ **Reflective Backing** – Foil-lined insulation increases heat capture.
✓ **Tilt Angle Optimization** – Adjust seasonally for max sun exposure.
Result: Can increase output to **1800–2000W**, cutting payback time by **~20%**.

Use Free Solar Electricity
Problem: Small fans (10–50W) add to energy use.
Solution: Power the fan with a **200W solar panel** (no grid dependency).
Savings: Eliminates **~300 kWh/year** of fan power use.

3.2. Target High-Value Applications (Faster ROI)

Instead of home heating, use the heater for:

- **Garage/Workshop Heating** (replaces expensive electric heaters).
- **Greenhouse Air Heating** (extends growing season = value).
- **Pre-Heating HVAC Air** (cuts furnace runtime by 10–30%).
- **ROI Boost:** If used commercially (e.g., drying crops), payback can be **<1 year**.
- **Hybrid System (Solar + Waste Heat Recovery) Idea:** Add a **heat exchanger** to scavenge waste heat from:
  - Attic hot air
  - Compost piles
  - Exhaust vents

Result: +20–30% free heat, reducing needed collector size.

With these tweaks, **your payback could be under 2 years**—making it one of the fastest-ROI solar.