PROJECT ABSTRACT

Solar Chimney Ventilation Model

A working tabletop model of a solar chimney: a glazed collector over a black absorber plate heats air with sunlight, and the hot air rising through a tall stack draws fresh air in at the inlet — passive ventilation driven purely by buoyancy — with multi-point temperature and airflow logging on an Arduino data logger. Delivered as a built-to-order student project with hardware, report, PPT and viva preparation.

01. Introduction / Background

Buildings in hot climates spend a large share of their energy on mechanical ventilation and cooling, yet one of the oldest ventilation principles needs no electricity at all: heat air, let it rise through a tall stack, and fresh air is pulled in to replace it. A solar chimney turns this stack effect into a building system — a glazed solar collector heats air, a tall chimney amplifies the buoyancy draft, and the building ventilates itself whenever the sun shines. This project models that system on a bench-top rig: a glass-covered collector box with a black absorber plate, a vertical chimney stack of about one metre, inlet vents, and a full sensor set — temperatures at inlet, collector and chimney plus airflow velocity at the outlet — feeding an Arduino data logger. Students vary collector area, chimney height and irradiance and watch the ventilation rate respond, the core relationship every solar-chimney study is built on.

02. Problem Statement

Passive solar design is usually taught through equations for buoyancy pressure and heat transfer, leaving students with no feel for how strongly ventilation responds to sun, stack height or collector design. A physical solar-chimney model closes that gap: it makes the stack effect visible and measurable, lets students run controlled experiments (including indoors with sun-simulator lamps), and produces real temperature and airflow datasets for analysis — the honest experimental basis the report is built on.

03. Objectives

- Build a tabletop solar chimney: glazed collector, black absorber plate and ~1 m chimney stack.
- Instrument the model with DS18B20 temperature sensors (inlet, collector, chimney) and an outlet anemometer.
- Log all measurements on an Arduino data logger with LCD readout and timestamped CSV export.

- Enable indoor demonstration with sun-simulator heat lamps independent of weather.
- Support student experiments varying irradiance, chimney height and collector configuration.

04. Proposed Methodology

- Fabricate the glazed collector box with a black absorber plate and seal the glazing for heat trapping.
- Erect the vertical chimney stack with inlet vents sized for the collector area.
- Mount DS18B20 sensors at the inlet, inside the collector and along the chimney, plus the anemometer at the outlet.
- Develop the Arduino logger firmware: sensor polling, LCD display and serial CSV export.
- Run the experiment matrix (irradiance levels, with/without lamps, chimney height variations) and record datasets for the report.

05. System Architecture / Working

Sunlight — or the sun-simulator lamps for indoor demos — passes through the glazing and heats the black absorber plate. Air inside the collector box warms, becomes less dense and rises into the chimney stack. The tall stack amplifies the buoyancy pressure difference, accelerating the upward flow; hot air exits at the chimney top while cooler ambient air is drawn in through the inlet vents, creating continuous passive ventilation. DS18B20 sensors log temperatures at the inlet, collector and chimney while the anemometer measures outlet velocity, and the Arduino displays live readings plus exports timestamped CSV so students can plot ventilation rate against irradiance and temperature difference.

06. Hardware / Software Requirements

- Glazed collector box with black absorber plate (~0.5 m^2)
- Vertical chimney stack (~1 m, scaled model) with inlet vents
- DS18B20 digital temperature sensors (inlet, collector, chimney)
- Anemometer for outlet airflow velocity
- IR/heat sun-simulator lamps for indoor demonstration
- Arduino data logger with LCD; firmware source; serial CSV export (any terminal software)

07. Expected Outcomes

- A working solar-chimney model producing measurable buoyancy-driven airflow.
- Student-recorded datasets of temperature and airflow versus irradiance and geometry.

- Demonstrated indoor operation using the sun-simulator lamps.
- Complete documentation: report, PPT, viva Q&A and experiment procedure.

08. Applications

- Teaching heat transfer, buoyancy-driven flow and solar thermal collection in mechanical laboratories.
- Demonstrating passive building ventilation concepts for sustainable-design coursework.
- Base rig for studying solar-updraft power generation with an added turbine.

09. Future Scope

- Turbine-generator at the chimney outlet for solar-updraft power demonstration.
- Active damper control and night-flushing ventilation strategies.
- Larger collector arrays and parametric optimisation of stack geometry.