International Journal of Web of Multidisciplinary Studies
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
website: http://ijwos.com
Volume.03 Issue.01.
E-ISSN : 3049-2424
DOI: https://doi.org/10.71366/ijwos

SOLAR POWERED SAND BRICK MANUFACTURING MACHINE AUTOMATION

Prof. Sanvastsarkar K.P[1], Miss. Endait Vidya D[2], Miss. Gaikwad Nikita M[3], Mr. Kadam Aditya D[4], Mr. Shankhpal Manas S[5]

[1] *Lecturer, Santosh N Darade Polytechnic, Department Of Electrical Engineering, Yeola, Maharashtra India.*
[2,3,4,5] *Students, Santosh N Darade Polytechnic, Department Of Electrical Engineering, Yeola, Maharashtra India.*

Article Info

Article History:

Published:04 Jan 2026

Publication Issue:
Volume 3, Issue 01
January-2026

Page Number:
50-67

Corresponding Author:
Miss. Gaikwad Nikita M

Abstract:
India is the second largest producer of clay fired bricks, accounting for more than 10 percent of global production. India is estimated to have more than 100,000 brick kilns, producing about 150-200 billion bricks annually, employing about 10 million workers and consuming about 25 million tons of coal annually. India's brick sector is characterized by traditional firing technologies; environmental pollution; reliance on manual labour and low mechanization rate; dominance of small-scale brick kilns with limited financial, technical and managerial capacity; dominance of single raw material (clay) and product (solid clay brick); and lack of institutional capacity for the development of the sector.

Keywords: brick.

1. INTRODUCTION

India is the second largest producer of clay fired bricks, accounting for more than 10 percent of global production. India is estimated to have more than 100,000 brick kilns, producing about 150-200 billion bricks annually, employing about 10 million workers and consuming about 25 million tons of coal annually. India's brick sector is characterized by traditional firing technologies; environmental pollution; reliance on manual labour and low mechanization rate; dominance of small-scale brick kilns with limited financial, technical and managerial capacity; dominance of single raw material (clay) and product (solid clay brick); and lack of institutional capacity for the development of the sector.

Implementation of these measures can result in annual coal savings of the order of 2.5 to 5.0 million tons/year in brick firing operation and associated CO_2 emission reduction of the order of 4.5 to 9.0 million tons/year; significant reduction in air pollution (including SPM, black carbon, CO); improvement in profitability of brick enterprises; and improvement of working conditions for millions of workers employed in brick kilns.

Implementation of these measures requires a concerted effort by the government of India and the brick industry. On the policy and regulatory front, the government of India may wish to refer to the policies and regulations framed by some of the other developing countries in Asia. Among these, of particular interest are: the sustainable building material policy of Vietnam to promote resource-efficient brick production and the recent environment regulation of Bangladesh proposing a time-bound phasing out of FCBTK technology. The next immediate steps proposed toward achieving these recommendations include environmental regulation to phase out older, inefficient technologies like FCBTKs, the predominant technology in use today, and to introduce newer cleaner brick firing technologies; and undertaking an Indian brick development Programme to support financing, technology transfer, and skill development activities.

The growth in India's economy and population, coupled with urbanization, has resulted in an increasing demand for residential, commercial, industrial, and public buildings as well as other physical infrastructure. Building construction in India is estimated to grow at a rate of 6.6% per year between 2005 and 20301. The building stock is expected to multiply five times during this period, resulting in a very large increased demand for building materials. Solid fired clay bricks are among the most widely used building materials in the country. India is the second largest producer of clay fired bricks, accounting for more than 10 percent of global production2. India is estimated to have more than 100,000 brick kilns, producing about 150-200 billion bricks annually3. Brick making in India is characterised by the following features: • Brick making is a small-scale, traditional industry4. Almost all brick kilns are located in the rural and peri-urban areas. It is common to find large brick making clusters located around the towns and cities, which are the large demand centres for bricks. Some of these clusters have up to several hundred kilns. • The brick production process is based on manual labour, and brick kilns are estimated to employ around 10 million workers. Brick production is a seasonal vocation, as the brick kilns do not operate during the rainy season. Most of the workers migrate with their families from backward and poor regions of the country. Families, including young children, work in harsh, low paying conditions. There is typically a lack of basic facilities, such as access to clean drinking water and sanitation.

Bricks are fired to a temperature of 700 -1100 oC, requiring a large amount of fuel for the firing operation. Brick kilns are estimated to consume roughly 25 million tonnes of coal per year, thus making them among the highest industrial consumers of coal in the country.

• A rapid increase in brick production and the clustering of brick kilns have given rise to environmental concerns: o Combustion of coal and other biomass fuels in brick kilns results in the emissions of particulate matter (PM), including black carbon (BC), sulphur dioxide (SO_2), oxides of nitrogen (NO_x), and carbon monoxide (CO). The emission of these pol In recent years, the higher cost and a shortage of good quality bituminous coal have resulted in an increased use of high-ash, high-sulphur coal, as well as in the use of industrial wastes and loose biomass fuels in brick kilns. All of these have resulted in new air emission challenges. o The use of large quantities of coal in brick kilns contributes significantly to emissions of carbon dioxide (CO2). o Good quality agriculture topsoil is used for brick production. Areas having large concentration of brick kilns suffer from land degradation.

• Apart from the environmental concerns, the industry faces other challenges, including: o A shortage of workers, resulting in an increase in wages and disruption of production. o A rapid increase in the fuel cost and limited availability of good quality coal. o A shortage of good quality clay in some regions and an inability of brick makers to adopt technologies to utilize alternate raw material. o Increased competition from other walling materials, such as concrete blocks. o New demands resulting from trend towards high-rise construction.lutants has an adverse effect on the health of workers and vegetation around the kilns.

2. Literature review

Sr. No.	Paper Details	Summary of paper	Conclusion
1	Cleaner Brick Kilns in India A win–win approach based on Zigzag fi ring technology	Transtion to cleaner brick production off ers immense potential for energy savings. In addition, there are reductions in SPM, BC and CO2 emissions, improvements in the incomes and working conditions of workers, and production of better quality building material. Wide-scale adoption of clean and effi cient brick-fi ring technologies such as Zigzag fi ring technology, production of hollow clay-fi red bricks	India is the second largest producer of clay-fi red bricks in the world with an annual production of about 250 billion bricks. Brick kilns consume a large amount of coal and are an important source of air pollution in the country. About 70% of the brick production in the country takes place through the 30,000 brick-making units that are based on FCBTK technology. Retrofi tting of the FCBTKs into Zigzag-fi ring technology off ers a win–win opportunity not only for brick-makers (by doubling their profi ts) but also for the nation leading to annual savings of 6 MT of coal and abatement of 455,000 T of SPM, 14 MT of CO2 , and 55,000 T of BC. Policy and regulatory measures at central and state levels,

		and non-fi red non-clay bricks are the main technological solutions for cleaner brick production	coupled with an eff ective technology delivery system linked with access to fi nance, can play a crucial role in the dissemination of Zigzag-fi ring technology. Th e changeover to Zigzag kilns could be the fi rst step towards modernizing the brick industry in India
2	Environmental Technologies for Brick Kilns in India	Air pollution is one of the major environmental issues in India. To address the air pollution problem in India, the Government of India through its Ministry of Environment, Forest, and Climate Change (MoEFCC) launched 'National Clean Air Programme (NCAP) in January 2019 as a national-level strategy to achieve the national level target of 20-30% reduction of PM2.5 and PM10 concentration by 2024. For priority action, 132 cities have been identified by MoEFCC as non-attainment cities due to air pollution levels in exceedance beyond ermissible National Ambient Air Quality Standards (NAAQS) based on data generated	Bengaluru is one of the brick clusters in the southern India, there are approximately 150 (Hundred and fifty) brick kilns in operation in Bengaluru cluster. The kilns are majorly located in clusters in the areas such as Kolar, Malur, Devanahalli, Hoskote, Anekal, Chandapura, White field, Chikka Tirupathi regions of Bengaluru district. Presently the brick market is highly competitive due to imbalance in demand and supply, late onset of spring weather and scattered rainfall are the two major factors responsible for this. This made brick kilns of Bengaluru cluster to operate entire year. Brick industries in the Bengaluru cluster use clay as raw material which is from nearby land and de-silting tanks. Down draught kiln (DDK) is the predominant technology used for brick making in the Bengaluru cluster.

		under National Air Quality Monitoring Programme (NAMP) during 2011 2015.	
3	Brick Industry as a Source of Pollution-Its Causes and Impacts on Human Rights	Through this paper a discussion is carried out to examine as how the manufacturing activities of brick kilns of Palasbari Revenue Circle lead to environmental degradation. It is observed that in performing manufacturing activities these industries ignore the concept of sustainable development. So as a consequence of their manufacturing activities, different environmental pollutions have been created which directly or indirectly violates the human rights. With a view to systematizing the discussion of the topic referred to here, the entire paper is divided in to three parts. First part entitled "Background of the Study" which includes Introduction, Review of literature, Meaning of human rights, Objectives	In this part an attempt is being taken to highlight as how the environmental pollution created by the brick kilns leads to the violation of human rights. In doing so, the various provisions of the different international treaties, national acts and the constitution of India are discussed.

		and Methodology of the study. The second part entitled "Impact of Different Pollutions on Human Rights" is a comprehensive study where the brick kilns of Palasbari Revenue Circle are discussed and their production activities are examined. Thereby it is highlighted as how the production activities of these industries not only deteriorating but also directly or indirectly leading to violation of human rights. The third part entitled "Conclusion" whereby it is justified as how the manufacturing activities of the brick kilns have been violating the human rights.	
4	How to reduce pollutants from brickmaking Industries	Bricks are the oldest and most used building materials. Even though easy access to brick clay and a simple manufacturing process, brickmaking recognizes as the principal pollutants generators that are affecting the surrounding	details of the brick manufacturing process are described and confirmed that brickmaking in a traditional kiln is a principal source of pollution, and the kiln types, fuel used, and kiln internal airflow patterns are the leading causes of polluting the surroundings and the environment that will be changing the airflow pattern and in recent future, the traditional types of kilns will be replaced with renewal energy kilns

		area with particulate matter and the environment by emitting greenhouse gases. Through this paper, we are trying to find the solution to replace the traditional types of kilns with better kilns to minimize the pollutants and also try to improve the airflow pattern to show that fuel can burn completely and fewer pollutants can be produced. This paper reviews the manufacturing process and the kiln's emission performance also.	like solar power, wind power, and hydropower kiln

Objectives Of the project

1) Solar powered Oxygen pump for effective burning of material used in brick layers
2) Solar powered Carbon emission monitoring and control
3) Automatic Brick pressing machine for sand using solar energy

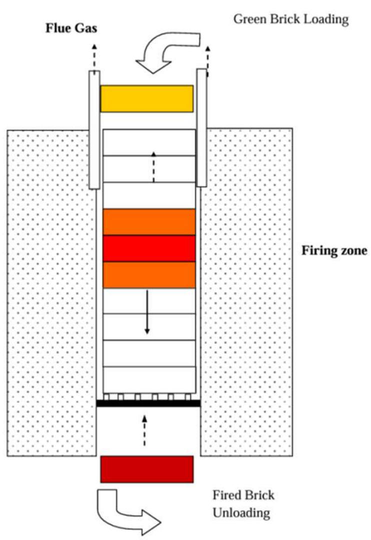
3. Methodology

Brick making in India is characterised by the following features: • Brick making is a small-scale, traditional industry14. Almost all brick kilns are located in the rural and peri-urban areas. It is common to find large brick making clusters located around the towns and cities, which are the large demand centres for bricks. Some of these clusters have up to several hundred kilns. • The brick production process is based on manual labour, and brick kilns are estimated to employ around 10 million workers. Brick production is a seasonal vocation, as the brick kilns do not operate during the rainy season. Most of the workers migrate with their families from backward and poor regions of the country. Families, including young children, work in harsh, low paying conditions. There is typically a lack of basic facilities, such as access to clean drinking water and sanitation. • Bricks are fired to a temperature of

700 -1100oC, requiring a large amount of fuel for the firing operation. Brick kilns are estimated to consume roughly 25 million tonnes of coal per year, thus making them among the highest industrial consumers of coal in the country. • A rapid increase in brick production and the clustering of brick kilns have given rise to environmental concerns: o Combustion of coal and other biomass fuels in brick kilns results in the emissions of particulate matter (PM), including black carbon (BC), sulphur dioxide (SO_2), oxides of nitrogen (NO_x), and carbon monoxide (CO). The emission of these pollutants has an adverse effect on the health of workers and vegetation around the kilns. In recent years, the higher cost and a shortage of

Types of Brick Layouts layering methods

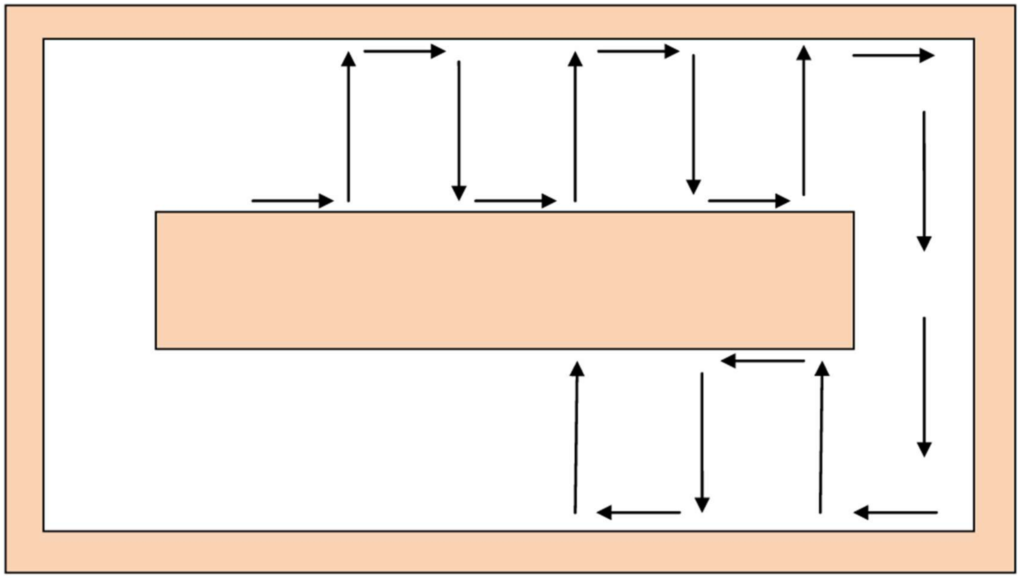
1) Vertical Brick Layering



In this method heat exchange taking place between the air moving up (continuous flow) and bricks moving down (intermittent movement). Green bricks are loaded from the top in batches; the bricks move down the shaft through brick pre-heating, firing and cooling zones, and are unloaded at the bottom. The combustion of powdered coal (put along with bricks at the top), takes place in the middle of the shaft. Air for combustion enters the shaft at the bottom, and gets preheated by the hot fired bricks in the lower portion of the shaft before reaching the combustion

zone. Hot flue gases preheat the green bricks in the upper portion of the shaft before exiting from the kiln through the shaft or the chimney

1) Zigzag Brick Layering Method

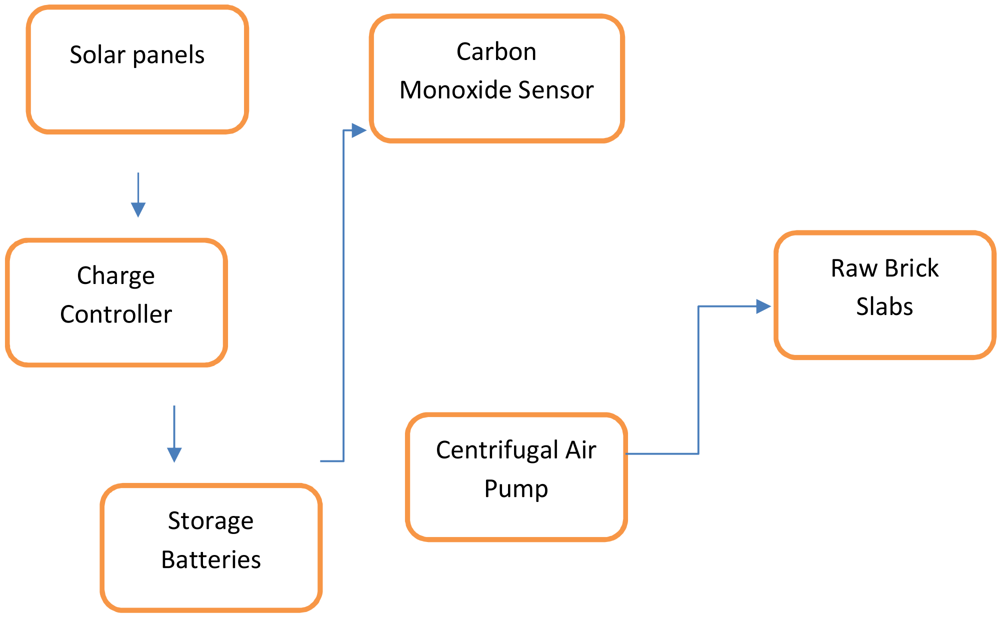


Green bricks to be fired are placed in the annular space and covered with a layer of partially fired or green bricks. Similar to a FCBTK, a layer of ash and brick dust is spread over the top to seal the kiln and provide thermal insulation. The brick-unloading end is kept open for air entry into the kiln. The brick-loading end is sealed with the help of a metal, cloth, paper or plastic damper. Fuel is fed manually in the feed holes provided on the top of the kiln. Fuel feeding is intermittent.

In a zig-zag kiln, the fire follows a zig-zag path instead of the straight path followed in a FCBTK.The zig-zag kiln is considered an improvement over the FCBTKs and results in: a) Higher heat transfer rates between the air and bricks due to higher velocities and turbulence caused by the frequent change in direction of air/flue gas. b) Improved combustion due to better

mixing of air and fuel in the combustion zone and longer time available for volatiles in the combustion zone. c) Shorter length of the kiln and hence smaller footprint of the kiln.

Block Diagram



List of components

Sr. No.	Name Of the Material	Specifications	Quantity	Cost Total
1	Solar Panel	12V, 40 Watt Monocrystalline Solar Panel	1	4000
2	Air Blower	Centrifugal Air blower Operating Voltage – 12V DC	3	900
3	Battery	12v, 2200mAh	1	440
4	Air Ducts	GI Metal Rectangular Air Ducts	2 mtr	~500
5	Solar charge controller	12V, 60 Watt PWM Charge Controller	1	320
6	Switch	ON Off Type 16 Amp	1	60
7	Brick Layers demo	-----	1	-----
8	Fan speed Control	12v, 6 Amp PWM DC Motor speed controller	1	450
9	Sensor	Mq135 Air Quality Sensor	1	150
10	Microcontroller	Atmega328p Arduino Nano	1	400
11	Display	16*2 LCD	1	300

Specifications of the components

1) Solar

Solar Panel

Open Circuit Voltage	11 - 21 V
Short Circuit Current	0.80 - 2.80 A
Maximum Power Voltage	8.3 - 17.6 V
Maximum Power Current	0.45 - 2.85 A
Power (Pmax)	20 Watt

Air Blower Solar Operated

Specifications

1. 12V 2-point Pin DC 0.13A.
2. Made of high-quality PBT 30% glass line VO
3. Bearing is a high precision, long life, and low noise.
4. Excellent for cooling heat sinks on hot ends, prints, or other cooling needs

7530 12V DC Blower Cooling Fan made of special and premium materials. It is high temperature resistant and extremely durable. Excellent for cooling heat sinks on hot ends, prints, or other cooling needs. This blower fan has projector blower centrifugal fan for powerful air throw.
It is made of high quality PBT+30% glass line +VO and Bearing with high precision make it provide long life and low noise. It can be taken in use to handle the temperature cooling 75°C. Its Working temperature 40°C with the continuous working of 24 hours capacity.

Features:

1. 12V 2-point Pin DC 0.13A.
2. Made of high-quality PBT 30% glass line VO
3. Bearing is a high precision, long life and low noise.
4. Excellent for cooling heat sinks on hot ends, prints, or other cooling needs

Li-Ion Cell

18650 Battery Cells

Datasheet

Samsung 18650 Battery Cell

Specifications and Features:

Very Small in size and weight compared to Ni-Cd, Ni-MH and Lead Acid Batteries

Full Charge in 90 minutes with Li-ion battery charger

Cell Specifications:

3.7V 2600mAh

Diameter 18mm, height 65mm

Weight 45grams

Maximum safe discharge current 5200mA (2C)
Maximum charging voltage 4.2V (Do not overcharge the cell, it may explode or be internally damaged.)
Maximum charging current 1000mA
Safety Standards

1 Overcharge test

Test method: To charge with 20A-20V at 25°C for 3hr.

Criteria: No fire, and no explosion.

2 External short-circuit test

Test method: To short-circuit the standard charged cell (or 50% discharged cell) by connecting positive and negative terminal by 80mΩ wire for 10min.

Criteria: No fire, and no explosion.

3 Reverse charge test

Test method: To charge the standard charged cell with charge current 10A By 0V for 2.5 hours.

Criteria: No fire, and no explosion.

4 Heating test

Test method: To heat up the standard charged cell at heating rate 5°C per minute up to 130°C and keep the cell in oven for 10 minutes.

Criteria: No fire, and no explosion.

MQ8 Gas Sensor Module:-

MQ8 GAS SENSOR Module

MQ8 Hydrogen Gas sensor Module:-

A sensitive material MQ-8 Hydrogen Gas Sensor Module H2 Alarm Detection use in clean air low conductivity tin oxide (SnO_2). When there is the environment in which the combustible gas sensor, conductivity sensor with increasing concentration of combustible gases in air increases. Using a simple circuit to convert the change in conductivity of the gas concentration corresponding to the output signal.

MQ-8 hydrogen gas sensor of high sensitivity, the monitoring of the other hydrogen-containing gas is also very satisfactory. This sensor can detect a wide range of hydrogen gas, city gas, in particular, is a low-cost sensor for a variety of applications.

Features MQ8 Gas Sensor Module:-

- Using high-quality dual-panel design, with power indicator and TTL signal output instructions.
- The switching signal having a DO (TTL) output and analog output AO.
- TTL output valid signal is low. (Low-level signal when the output light can directly connect to the microcontroller or relay module)

- The higher the voltage, the concentration of the analog output voltage is higher.
- A hydrogen gas detection with good sensitivity.
- There are four screw holes for easy positioning.
- Has a long life and reliable stability.
- Rapid response and recovery characteristics.

Specifications MQ8 Gas Sensor Module:-

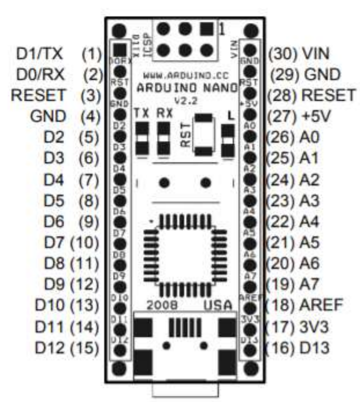
- Input voltage : DC 5 Volts.
- Power consumption (current) : 150 mA.
- Digital D0 output : TTL digital 0 and 1 (0.1 and 5 Volts).
- Analog A0 output : 0.1-0 .3 V (relative to pollution), the maximum concentration of a voltage of about 4V.

Applications MQ-8 Hydrogen Gas Sensor Module:-

- Suitable for home or industrial hydrogen leakage monitoring devices.
- it Can not interfere with ethanol vapor.
- soot.
- Carbon monoxide and other gases.

Arduino Nano Datasheet

Arduino Nano Board



Arduino Nano Pin

Pin No.	Name	Type	Description
1-2, 5-16	D0-D13	I/O	Digital input/output port 0 to 13
3, 28	RESET	Input	Reset (active low)
4, 29	GND	PWR	Supply ground
17	3V3	Output	+3.3V output (from FTDI)
18	AREF	Input	ADC reference
19-26	A7-A0	Input	Analog input channel 0 to 7
27	+5V	Output or Input	+5V output (from on-board regulator) or +5V (input from external power supply)
30	VIN	PWR	Supply voltage

Pin Configuration

Technical Specification

Microcontroller	ATmega 32
Architecture	AVR
Operating Voltage	5v
Flash Memory	32 kb of switch2kb used by bootloader
SRAM	2kb
Clock Speed	16mhz
Analog I/O pins	8
EEPROM	1kb
DC Current per I/O pins	40mA I/O pins
Input Voltage	7-12v
Digital I/O pins	22
PWM Output	6
Power Consumption	19mA
PCB size	18*45mm
Weight	7g
Product Code	A000005

Advantages

1) Pollution Reduction from brick factories

2) Increased Fuel Burning Efficiencies
3) Increased or maintained air quality for nearby areas

Disadvantage

The return on investment (ROI) for solar panels can be high, with typical annual ROIs of **18–25%** in India, based on factors like location, consumption, and subsidies. Issues to consider include high upfront costs, which can be mitigated by subsidies, and technical considerations like panel efficiency, sunlight availability, and maintenance.

Applications

1) Brick Factories
2) Food Processing plants based on wood and coal
3) Sugar factories
4) Coal fired furnace
5) Clay pot baking furnace
6) Waste burning / incineration plants etc

Future scope

Return on investment (ROI)

- **Annual ROI:** A typical residential solar system in India can have an annual ROI of 18–25%, depending on specific circumstances.
- **Payback period:** The time it takes to recoup the initial investment is generally 3–5 years for commercial installations and 4–5 years for residential systems after subsidies.
- **Long-term savings:** Once the system pays for itself, the energy produced is virtually free for the remaining 18–22 years of its lifespan, providing stable, long-term financial benefits.
- **Higher savings for high-bill consumers:** Households with high electricity bills can see an even higher ROI, as their annual savings are greater.
- **Inflation hedge:** Solar is a reliable, inflation-hedged investment that is less volatile than market-dependent investments like mutual funds.

Possible issues and challenges

- **Upfront cost:** The initial cost of panels, installation, and necessary equipment can be high, though it is offset by savings and subsidies.

- **Government subsidies and policies:** The amount of financial benefit is dependent on government subsidies and your local electricity provider's net metering or billing policies for excess energy.
- **Panel efficiency and sunlight:** The amount of energy your system generates depends on the panel's efficiency and the amount of sunlight it receives, which is affected by the panel's location and angle, weather, and maintenance.
- **Maintenance and lifespan:** While solar panels are durable, they require some maintenance, and their efficiency may decrease over their 25+ year lifespan.
- **Grid connection and electrical upgrades:** Some installations may require electrical system upgrades or modifications to work with the existing infrastructure.

5. Conclusion

Pumping air into a burning process provides the oxygen needed to sustain the combustion, ensuring a more efficient, complete, and powerful reaction. This can lead to increased heat, higher efficiency, and a more complete burn, but too much air can be counterproductive and lead to instability. Pumping air into a wood-burning process improves efficiency by promoting more complete combustion, which results in more heat and fewer emissions. Pumping air can be done through secondary air injection to burn unburnt gases, or through systems like external air kits and heat recovery units to increase overall heat output and circulation.

References

1. Bhandari, P. & Garg, S. (2019). Energy-efficient and sustainable brick manufacturing technologies: A review. Journal of Cleaner Production, 220, 593–610.
2. Kumar, R., Singh, A., & Verma, P. (2020). Design and automation of brick manufacturing machinery using electro-mechanical systems. International Journal of Mechanical Engineering and Robotics Research, 9(3), 45–52.
3. Patel, V. & Chauhan, D. (2018). Application of solar photovoltaic systems for powering small-scale industrial machines. Renewable Energy Advances, 5(2), 112–118.