

Designing Solar Powered Food Stall and Enhancing Knowledge of Food Stall Holders by Using Solar Energy for Environment Conservation

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Solar energy is an understandable choice for domestic as well as commercial use. Majority of the population of India lives in rural areas, there is scope for generating and promoting the use of solar energy. The present study is focused on designing food stalls operating on solar energy for energy conservation and pollution reduction. More than three-fourth of the respondents (69.9%) cook for 4-to-6 hours in a day and one-half spend ₹200-₹400 during cooking. The majority of respondents used wood, coal, kerosene and LPG in the last 24 hours. Majority of respondents had awareness that fuel consumption can increase the emission of harmful gases in the environment. Pollution is one of the major negative effects of fossil fuel (91.6%), greenhouse gases can deplete the ozone layer (95.6%) and release of sulphur dioxide and nitrogen oxides from the burning of coal and oil contribute in smog and acid rain. The type of fuel used and the amount of fuel used during cooking and food preparation have a profound impact on the environment and air pollution. According to the data gathered it was revealed that the practices followed by the food stallholders for cooking food had adverse effects on the environment. To demonstrate the operation of actual solar operated food stall which was designed by the researchers the workshop was conducted online through Zoom Platform and the food stall owners were requested to join the workshop via the link provided. The study's findings will raise public awareness about the importance of using renewable resources to improve the lives of all people.

Keywords: Energy conservation; Eco-friendly; Food stalls; Pollution; Solar energy.

Rapid changes in the global climate have sparked widespread environmental concern. In order to overcome the situation, it is vital to conserve energy and reduce the rate of pollution and greenhouse gases emission.

Different initiatives in the electricity sector have been implemented all over the world to reduce greenhouse gas emissions. One of the

most effective power-related strategies adopted by all the regions of the world is the use of renewable energy as a source of electric power. Solar is the cost-effective and operationally feasible type of renewable energy resource as well as one of the major power sources in the renewable energy market¹.

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India is classified as a tropical country because it receives solar radiation almost continuously throughout the year, resulting in 3000 hours of sunshine per year. India has one of the lowest per capita electricity consumption rates in the world. Around 20 million people in the country do not have access to electricity². Several states in the Indian subcontinent have excellent potential for solar energy development due to their geographical position. These include Andhra Pradesh, Bihar, Gujarat, Haryana, Maharashtra, Orissa, Punjab, Rajasthan, and West Bengal.

India is a country where climatic condition fluctuates from being high alpine to tropical and subtropical. This climatic condition of India makes it ideally suitable for solar energy². The daily average solar energy incidence varies from 4 to 7 kWh/m² across the country, and most sections of the country have 250 to 300 days of sunshine per year³.

Since the majority of the population of India lives in rural areas there is much scope for generating and promoting the uses of solar energy in India. On the other hand, solar energy is a logical choice for domestic as well as commercial use due to its abundant availability with nil traces of carbon footprints. It is possible to obtain instantaneous and localized solar energy using new and advanced technologies. Various types of solar-powered gadgets are available for use in a variety of food processing applications including boiling, steaming, frying, blanching, drying, and roasting.

The street food vendors play an important role in not only generating self-employment but also meeting the nutritional requirement of many low-income people. At the same time, there are a number of concerns associated with street food vending⁴. Lack of sufficient food hygiene is one of the primary causes of foodborne infections (FBI), with 1 in 10 people worldwide becoming unwell each year as a result of eating contaminated food, according to the WHO FBI Burden Epidemiological Reference Group (FERG)⁵.

Street food and locally available foods can be perceived as fast food because preparation is fast and some sort of standard assembly process can be used⁶. Street foods are also dynamic for the economy of the country. Street foods, food carts, food trucks, and food stalls are widely neglected and considered an informal sector. However, the

informal sector is now recognized as a result of the rising population and reduced employment generation.

Eating at food stalls is relatively common for low-income workers and low-income families as well as students who live away from home.

The food stall is known as a mobile immobile kitchen which is set up on the street corners to provide a variety of food to the people. In the 21st Century, innovations have included modular designs of food stalls made easily available materials such as stainless steel, fibre-reinforced plastic, and aluminium⁷. Food stalls occur in a variety of shapes and sizes; some might move from one location to another while some are associated with concerned restaurants.

People in the food industry are shifting toward eco-friendly food stalls as a cost-effective way to save renewable energy sources and provide eco-friendly food services. A growing number of restaurants and cafés are becoming ecologically conscious or “green,” and food booths should follow the same.

Street food is a main source of livelihood mainly for those who are excluded from formal income opportunities and companies. Street food vending is an important part of urban life and food supply in developing countries⁸. With the increased need for ready-to-eat food in India and across the country, solar energy’s function in food preparation could play a significant role in meeting those expectations. Even if it is employed on a smaller scale, solar energy plays a significant role in food preparation. The use of solar energy in food preparation plays a major role even if it is used on a smaller scale. According to³, “Solar food processing brings in two emerging technologies together to solve the two major problems the world is facing in 21st Century, namely, how to create adequate energy for a rising global population and how to feed the ever-growing world population?”

The use of solar-based technologies plays a great role in the industry of food processing. Due to a lack of confidence, the high initial cost of installing solar panels and acquiring solar gadgets, and a lack of actual understanding about the use of solar energy, it is now only used on a small scale and in major companies. Due to a lack of guidance from society and government initiatives, the solar food processing, and production industry has not

flourished at the desired pace. India had a limited number of government fund-providing schemes that invoke to take such initiatives and reduce the payback period for small-scale and micro-scale entrepreneurs.

Due to a lack of knowledge among food vendors and food stallholders about alternative use of wood, kerosene, and LPG gas for food processing, the food stall owners are unaware of the uses of solar energy for the same. They are not aware of the types of solar equipment and the solar technologies which are used in the various food processing processes.

The current research focuses on developing solar-powered food kiosks for energy conservation and pollution reduction. As a result, it is predicted that the project's designs would encourage food stall operators and the general public to adopt solar energy practices for the benefit of society in terms of energy conservation and pollution reduction. Solar energy will also provide sanitary food with fewer polluting emissions. The food industry has progressed significantly, and business owners are now looking for better stalls and more environmentally friendly power sources. The current study will also encourage solar professionals to pursue novel research and design initiatives, as well as encourage the government to fund and develop specific social programs.

Objectives

1. To assess the food stall owners' knowledge and awareness of the fuel used and its environmental impacts.
2. To propose a design for a solar-powered food stall for fuel conservation and pollution reduction for food stall owners.
3. To conduct a workshop to educate food stall owners about issues linked to fuel use and its impact on the environment.

Methodology

An action designing project was undertaken to achieve the desired goal of developing a solar operating food stall with detailed designs and drafts. The food stall owners who were willing to participate in the research study were those who were operating food stalls and were using fuels such as wood, crop residues, dunk cakes, coal/coke/lignite, charcoal, kerosene, electricity, LPG, biogas, or any other type of fuel for cooking and preparing the food item. The sample size for the

present study comprised 300 food stallholders (male & female) engaged in operating food stalls. The interview schedule was used as a tool to gather the necessary information and to achieve the objectives of the study. The research was conducted in four phases, with the first phase assessing the background information of Vadodara city food stallholders, the second phase assessing the level of awareness of the food stallholders regarding fuel use and its effects on the environment, the third phase conducting a workshop for educating the food stallholders regarding the issues related to fuel use and its effects on the environment with regards to the design drafted.

Major Findings of the Study

The current study included a full overview of the research conducted to design a solar-powered food stall for energy conservation and pollution reduction.

Section I

This section constituted the background information of the food stallholders and their family where the researchers found that the majority of the respondents (60%) falls between 31-42 years of age group, and more than three-fourths of the respondents (91.6%) are male, less than one-half of the respondents (40.4%) were educated up to primary level, more than half of the respondents (58.4%) had total monthly income between 1 6000-1 10000. Whereas three-fourth of the respondents (84.8%) belonged to the nuclear family, little less than one-half of the respondents (46.8%) lived in the medium-sized family, more than three-fourths of the respondents (84.4%) had permanent food stalls, more than three-fourths of the respondents (83.6%) owned 1 food stall and less than half of the respondents (40.4%) had 5 years-10 years of experience. Whereas more than three-fourth of the respondents (98.8%) used LPG for food preparation and it was found that the majority of the respondents faced problems in refilling cooking gas, completion of fuel when there is a high number of customers waiting, leakage of gas while cooking, burns, uncontrollable gas flames and transportation of gas cylinders.

It was found that little more than one-third of the respondents (33.6%) used wood for cooking, less than one-tenth of the respondents (3.2%) used coal for cooking, little less than one-fourth of the respondents (22.4%) used kerosene

for food preparation, more than three-fourth of the respondents (98.8%) used LPG for food preparation and less than one-tenth of the respondents (7.6%) used electricity for food preparation. It was found that majority of the respondents (83.6%) owned 1 food stall, little more than one-tenth of the respondents (13.6%) owned 2 food stalls and less than one-tenth of the respondents (2.8%) owned more than 2 food stalls. Therefore the fuels used by them were multiple. As there are multiple responses for fuel used for food preparation so the percentage exceeds 100 per cent.

Section II

This section comprised of a scale to find out the information on fuel consumption practices adopted by the food stallholders during cooking where the researchers found that less than three-fourth of the respondents (69.9%) cooks for 4-to 6 hours in a day and one-half of the respondents (50%) spend ' 200-' 400 in a day during cooking. It was found that the majority of the respondents used wood, coal, kerosene and LPG in the last 24 hours. It was observed that more than one-half of the respondents (65.6%) utilized more than 1 hour

FUEL USED FOR FOOD PREPARATION

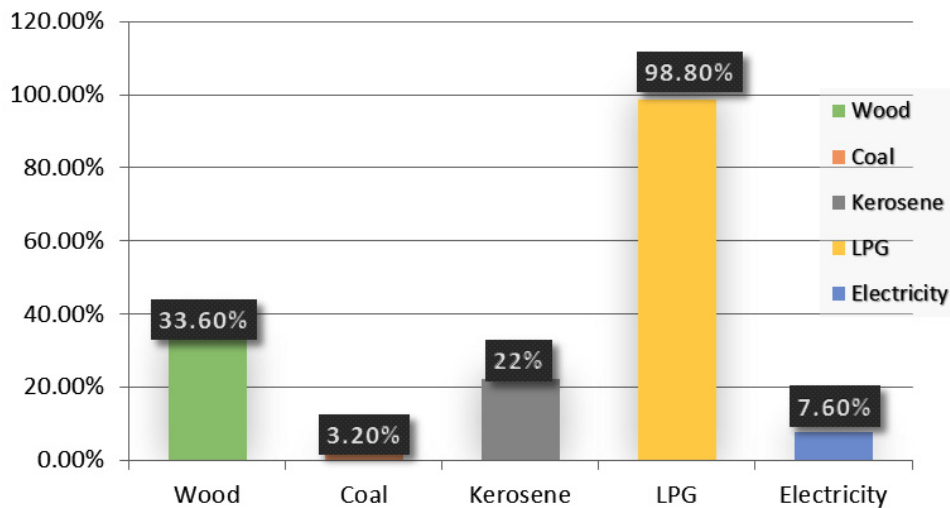


Fig. 1. Graphical representation of the respondents according to the fuel used for food preparation*
 *Percentage exceeds 100 per cent due to multiple responses.

ACTUAL TIME TAKEN FOR COOKING

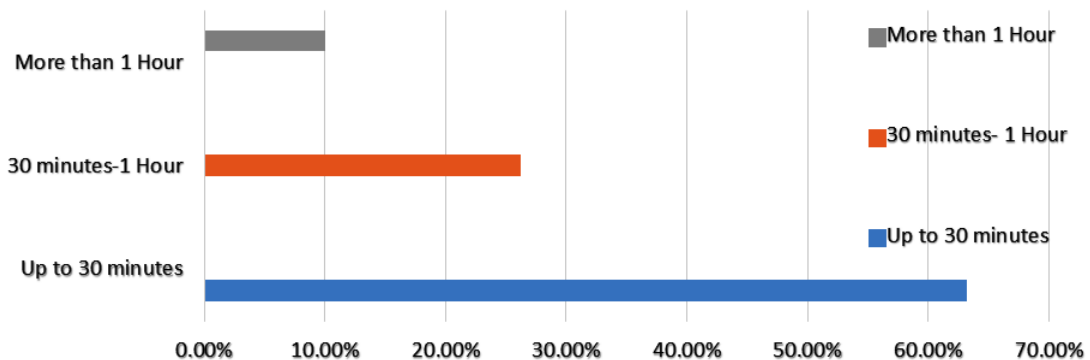


Fig. 2. Graphical representation of the respondents according to the actual time taken for cooking

Table 1. Frequency and Percentage distribution of respondents according to the awareness of food stall holders related to the fuel used and its effects on the environment

No.	Statement	Respondents (n=250)					
		Aware		Undecided		Unaware	
		f	%	f	%	f	%
1	Fuel consumption can increase emission of harmful gases in the environment.	227	90.8%	23	9.2%	0	0
2	Air pollution is caused due to the burning of wood.	236	94.4%	11	4.4%	3	1.2%
3	Global Warming is a result of burning of fuels	213	85.2%	21	8.4%	15	6%
4	Since kerosene is an inflammable substance it increases the air pollution and has adverse effect on health.	15	6%	38	15.2%	197	78.8%
5	LPG causes long-term distressing effects on the environment as well as on the human body.	19	7.6%	18	7.2%	213	85.2%
6	The food cooked using kerosene as fuel is not safe as it can catch fire easily if not handled with care.	2	0.8%	23	9.2%	225	90%
7	The carbon dioxide produced during cooking on a coal stove have an adverse effect on the environment.	2	0.8%	16	6.4%	232	92.8%
8	Burning of fuels generate toxic gases to the environment (greenhouse gases	211	84.4%	15	6%	24	9.6%
9	Compressed Natural Gas is used as a fuel now a days due to its fuel efficiency and environment friendly properties	230	92%	13	5.2%	7	2.8%
10	Biogas is one of the Natural gas obtained by the fermentation of animal, human waste or the garbage.	250	100%	0	0	0	0
11	Most of the Hotels produce Steam which is used to cook.	1	0.4%	23	9.2%	226	90.4%
12	Emission of greenhouse gases during fuel consumption can harm earth	60	24%	23	9.2%	167	66.8%
13	Each individual is responsible for deteriorating of environmental	247	98.8%	0	0	3	1.2%

14	resources available when using fuel.							
15	Use of wood should be avoided for cooking .	232	92.8%	4	1.6%	14	5.6%	
16	Charcoal pollutes environment	16	6.4%	48	19.2%	186	74.4%	
17	Environmental pollution is a result of burning of fossil fuels.	199	79.6%	17	6.8%	9	3.6%	
18	Smoke coming out of fuels causes air pollution	209	83.6%	39	15.6%	2	0.8%	
19	LPG is highly inflammable.	237	94.8%	11	4.4%	2	0.8%	
20	Cutting of wood from trees causes environmental degradation	187	74.8%	4	1.6%	59	23.6%	
21	Coal mining can cause soil or environmental pollution	3	1.2%	53	21.2%	194	77.6%	
22	Electricity is used for cooking but is very expensive form of fuel.	18	7.2%	48	19.2%	184	73.6%	
23	Cooking through Electricity makes the cooking process expensive.	2	0.8%	69	27.6%	179	71.6%	
24	Solar energy uses the energy of sunlight to heat food or drink to cook it or sterilize it.	218	87.2%	6	2.4%	26	10.4%	
25	Pollution is one of the major negative effects of fossil fuels.	3	1.2%	18	7.2%	229	91.6%	
26	Green House Gases can deplete the Ozone layer	8	3.2%	3	1.2%	239	95.6%	
27	Fossil fuels are non-renewable source of energy.	18	7.2%	25	10%	207	82.8%	
28	Carbon dioxide is released when burning fossil fuels which raise the temperature.	3	1.2%	9	3.6%	238	95.2%	
29	Release of sulphur dioxide and nitrogen oxides from the burning of coal and oil contribute in smog and acid rain	0	0	8	3.2%	242	96.8%	

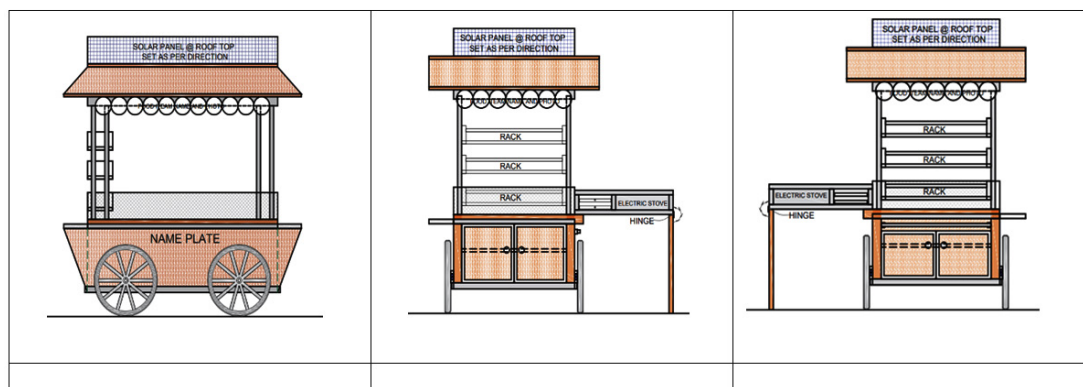


Fig. 3. Designs of the Food Stall operating on solar energy for energy conservation and reduction in pollution

for pre-preparation of food items and more than one-half of the respondents (63.2%) utilized up to 30 minutes for cooking food items.

Section III

This section is comprised of a scale to find out the extent to which the respondents had awareness regarding the fuel and its effects on the environment. It was found that the majority of the respondents had the awareness that fuel consumption can increase the emission of harmful gases in the environment (90.8%), air pollution is caused due to the burning of wood (94.4%), global warming is a result of the burning of fuels (85.2%), burning of fuels generate toxic gases to the environment (84.4%), compressed natural gas is used as a fuel nowadays due to its fuel efficiency and environment-friendly properties (92%), biogas is one of the natural gas obtained by the fermentation of animal, human waste or the garbage (100%), each individual is responsible for deteriorating of environmental resources available when using fuel (98.8%), Using wood should be avoided for cooking (92.8%), LPG is highly inflammable (94.8%) and solar energy uses the energy of sunlight to heat food or drink to cook it or sterilize it (87.2%).

Whereas the majority of the respondents were unaware that LPG causes long term distressing effects on the environment as well as on the human body (85.2%), the food cooked using kerosene as fuel is not safe as it can catch fire easily if not handled with care (90%), the carbon dioxide produced during cooking on a coal stove have an adverse effect on the environment (92.8%), most

of the hotels produce steam which is used to cook (90.4%), pollution is one of the major negative effects of fossil fuel (91.6%), greenhouse gases can deplete the ozone layer (95.6%), carbon dioxide is released when burning fossil fuels which raise the temperature (95.2%) and release of sulphur dioxide and nitrogen oxides from the burning of coal and oil contribute in smog and acid rain (96.8%).

Section IV

Designing Food Stall operating on solar energy for energy conservation and reduction in pollution

The proposed size of the designed food stall is 6'x 3'-8 1/2"x 7'-3" (L x W x H). The cart was designed in a burger-shaped structure with a solar panel on top. An electric stove is placed on a sliding channel which moves towards the cooked side. The aluminium/steel structure of the food stall is supported by many batten supports. Partition provided for storing solar-related equipment such as the battery, inverter, electric points, extra battery, etc., and another partition for storing cooking materials and large utensils.

The base of the structure is designed of aluminium and customized ACP sheet/ MDF sheet/ Ply or any other material that can be applied for aesthetic purposes. Solar panels are designed on the rooftop with angular channels which can be rotated as per the direction of the sun to get maximum exposure. The base of the structure is designed of aluminium and customized ACP sheet/ MDF sheet/ Ply or any other material that can be applied for aesthetic purposes. Outer shutters of the food stall are designed in such a way that when not in

need they can be utilized as a tabletop for seating if provided. The solar panels attached to the food cart are joined using the angular channel.

These shutters are designed in such a way that they can be easily slid back into the space provided. The support pipes of the food stall are designed hollow through which the required wiring supply can pass. Researchers have designed and constructed a food cart running on solar energy for energy conservation and reduction in pollution. The food cart was then utilized for making tea and

flitters (pakoras) using solar energy. Local public volunteers were asked to join in and review the design, quality, and idea of the food cart.

Fixed cost for the setup cost of solar panel on cart= INR 28400.00

Setup cost of the Generator (Honda AB-HD-20211345) = INR 35000.00

The total Running time is 5hrs.

The running cost for the Solar panel is nil.

The running cost for the Generator is 3 lt. gasoline for 5hrs running = 3× INR 95.00=INR 285.00

	Solar Panel		Generator	
Panel required=	1	9400.00	Honda AB-HD-20211345	1 35,000.00
Charge controller =	12V-20Amp	7000.00		
Battery	12V 15Ah	12000.00		
Total setup Cost	28400.00			
Difference	-6600.00			

Power requirement for 5hrs per day:		
LED Bulb	9w	0.075 A
DC Fan	30 w	2.5A
Total consumption per hr		2.575 Ah
Total consumption per day for 5hrs		12.875 Ah
Total consumption per day in the unit		0.1 Unit

Calculation for Load consumption:

LED 9w (0.075 Ah Consumption)
 DC Fan : 30w (2.5Ah Consumption)
 Total Consumption= 2.575A
 =2.575×5hr = 12.875Ah

From the conversion:

83.3 Ah = 1kWh
 1Ah=1/83.3 kWh
 12Ah=12/83.3 kWh
 =0.144KWh=0.1 unit

From the above table, it is apparent that the setup cost of a solar panel is cheaper than installing a generator, however by calculating power daily power requirement for using one LED bulb and a fan, it is only 0.1 unit for 5 hours. The running cost of the generator is approximately INR 285.00 per day, which is much higher, and in 100 days it will exceed the setup cost of the solar panel.

SECTION V

Workshop for educating the food stall holders regarding the issues related to current fuel use and its effects on the environment and for demonstrating the actual food stall

On the basis of the data collected a workshop was conducted on 16th November 2021- Tuesday to educate the food stallholders regarding the type of fuel they are currently using and the harmful effects of the fuel on the environment and to demonstrate the operation of actual solar operated food stall which was designed by the researchers. The workshop was conducted online through Zoom Platform and the food stall owners were requested to join the workshop via the link provided.

CONCLUSION

The type of fuel used and the amount of fuel used during cooking and food preparation have a profound impact on the environment and air pollution. According to the data gathered it was revealed that the practices followed by the food stallholders for cooking food had adverse effects on the environment. The study’s findings will raise public awareness about the importance of using renewable resources to improve the lives

of all people. The findings of the study would be beneficial for various educational institutions, NGO's, social service departments, various state, national and international bodies dealing with environmental problems.

Implications of the study

The findings of the study will be beneficial to various educational institutions, NGO's Government institutions, social service departments, and various State, National and International authorities dealing with environmental concerns and remedial measures. By learning about the food stall owners' awareness and remodeling their knowledge about the use of fuel and its impacts on the environment, everyone will be more aware of the importance of using renewable resources for the development of all human beings' lives.

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Conflict of Interest

There is no conflict of interest.

Funding Source

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