Journal of Scientific Research & Reports

18(3): 1-6, 2018; Article no.JSRR.37401
ISSN: 2320-0227

The Ecological, Economical and Social Impact of Adopting Solar Cooking in Mubi Metropolis Adamawa State, Nigeria

Ojo Samuel[1*], Mohammed Baba[1] and Abasiryu Thlimabari[2]

[1]Department of Chemical Engineering, Federal Polytechnic, Mubi, Adamawa State, Nigeria.
[2]Department of Mechanical Engineering, Federal Polytechnic, Mubi, Adamawa State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JSRR/2018/37401
Editor(s):
(1) Luigi Dell'Olio, Professor, School of Civil Engineering, Channels and Ports, University of Cantabria, Cantabria, Spain.
Reviewers:
(1) Ashok Kundapur, India.
(2) Jackson Akpojaro, Samuel Adegboyega University, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/23623

Original Research Article

Received 7th September 2017
Accepted 15th November 2017
Published 13th March 2018

ABSTRACT

Based on observed global trends, the use of solar cookers has proven to be a better, cheaper, healthier and more environmentally friendly source of energy for household cooking. This research work looked at the ecological, economical, social impacts and the benefits of adopting solar cooking in Mubi metropolis of Adamawa state. Feasibility studies carried out by the group shows that Mubi geographical location makes it viable for the adoption of solar cooking. An investigation conducted by the group also shows that if solar cooking is adopted, each solar stove used in Mubi can save one (1) tone off fire wood annually; about N4.7million can be saved daily (i.e. N1.7 billion annually) in addition to several health and social benefits.

Keywords: Ecology; economic; social; solar; cooking; impact; solar cookers.

**Corresponding author: E-mail: femioctober22@gmail.com;*

1. INTRODUCTION

Nigeria is a country endowed with very high solar radiation. Nigeria receives 20 MJ/m^2 per day with little variation throughout the year [1]. Nigeria with a population of more than 140 million [2] with more than two third of this population living in the rural areas, largely depend on fuel wood as the source of energy, despite the fact Nigeria produce 2.3 million barrels of crude oil daily. The over-dependence on fuel wood for energy is chiefly because of its relatively low prices and easy accessibility. Other reasons are constraints in the supply of the conventional fuels and the growing population with a larger segment still falling below incomes that cannot afford the cost of conventional fuels [3]. Therefore, majority of the Nigerian rural people have been using and will continue to use the dried biomass fuels for energy for many years to come [4]. Daily consumption of firewood by the rural communities in Nigeria is estimated at 27.5 million kg/day [5]. This paper tends to look at the ecological, economical and social impact of this dependence on firewood and how solar cooking can reduce these problems.

2. METHODS

The research team went into the town to determine the current price of a kg of firewood and purchased it. The group then averagely determines the percentage of the population using firewood as a source of fuel from the retailers of firewood within the metropolis. It was discovered that an average of 1.5 kg is used by a person daily. The area of study is predominantly an agrarian settlement with about 70% of the population depending on firewood as source of fuel. They then multiplied the values of 70% of the population of the area of study by the amount of 1.5 kg to determine the amount of money spend on firewood and quantity consumed daily.

2.1 Study Area

Mubi metropolis consists of two local government areas, Mubi North and Mubi South local government areas with a total population of about 281,471, [2] of which about 70% depends solely on firewood for household cooking. It is located between 9°26' S and 10°10' N and between longitude 13°1' and 13°44' [6]. The area is marked with typical wet and dry seasons. The dry season spans from late October to mid May, while the wet season is between June to September. The vegetation is of the Sudan savannah type, which connotes grass land interposed by shrubs.

3. FEASIBILITY OF SOLAR COOKING IN MUBI METROPOLIS

3.1 Scientific Aspect

Availability of solar energy depends on the geographical location and the time of day. The energy received by a square foot of solar collector can cook all the food a person can eat; solar radiation has low entropy, and with concentration it can create a high temperature of several thousand degrees Celsius. Even without concentration, using the greenhouse effect alone more than 2000 degrees Celsius can be achieved in solar ovens — this is essentially the stagnation temperature of flat plate solar collectors; such temperatures are sufficient for all kinds of cooking. The geographical location of Mubi made it such that it receives an average of 20MJ/m^2 per day.

3.2 Technical Aspect

Solar cookers are easy to construct in that the materials for construction are readily available locally and are cheap. In this work, a solar cook kit which is recommended is estimated to cost about N 650. It does not require much special skill and place for construction. This suggests that it can be constructed and used by even an average rural dweller with little training.

3.3 Ecological Effects

Firewood is used in almost all the rural areas all over the world [7]. Its consequences result in loss of forest area, loss of fertile soil due to erosion. The measured firewood used per capita for cooking in developing countries is on average approximately 1.5 kg/day [7]. There exists a direct relationship between human population and wood fuel demand, hence, the cutting down of wet wood can be said to be on the increase [8]. The rate of consumption of fuel wood in Nigeria exceeds the rate of production. It is therefore right to say this renewable source of energy would sooner or later be scarce should these form of exploitation continue. Low income nations depend most heavily on wood for fuel. Five countries: Brazil, China, India, Indonesia and Nigeria account for about half the firewood and charcoal produced and consumed each year [9]. According to the Forest Resources Assessment (FRA) Country Report Nigeria's total

wood removals from forests in 2005 amounted to 86626.797 tons, and removals for wood fuel from forests in the year 2005 were 72710.935 tons, the difference being made up by industrial round wood, which accounted for 13915.862 tons. According to the 2006 census, there are about 140,000,000 Nigerians [2], two third of which lives in the rural areas and largely depends on fire wood for cooking. It then implies that, about 93,000 tones of fire wood is consumed in Nigeria every day. At this rate, Nigeria will have no remaining forests within the next twenty years if there is no meaningful and holistic intervention to reverse the current trend. In Mubi metropolis alone, it could be estimated that about 422.2 tones of fire wood is used daily. UNDP predicts 70% of fuel wood consumption can be replaced by renewable energies like the sun.

3.4 Economical Impact

An average Nigerian spends nearly a quarter of their income on fire wood [10]. Study has shown that 70% of Nigerians live on less than US$1 per day [11]. Nigeria will have no remaining forests within the next twenty years. Not only is this an environmental crisis — it is a cooking fuel wood crisis which will lead to increased poverty levels as firewood becomes scarce and expensive, and as families are forced to switch to other fuels. An investigation conducted by the group shows that firewood is currently sold at the rate of N16.00/kg and that at least 1.5kg is consumed by an individual daily in Mubi with about 70% of the population (197,030) using firewood. It was then estimated that 295.5 tones of firewood is consume daily, which means that about N4.7 million, is spent on fuel wood daily. Each solar cooker in sunny, arid climates can save one ton of wood per year [12]. If renewable energy (solar cooking) should be adopted in Mubi metropolis, about N1.7 billion can be saved annually (i.e. $4.7 million).

3.5 Social Impact

In a typical rural setting, women are saddled with the responsibility of searching for firewood from the forest. Such women are exposed to the risk of being raped or attacked by wild animals. There are significant health costs from cooking with firewood. Especially when cooking fires are inside, where women tend them with their youngest children on their backs in the room, the smoke causes emphysema and other respiratory illnesses and eye problems. An estimated 1.6 million deaths per year in developing countries are caused from diseases related to cooking smoke [13]. The search for firewood due to its scarcity has led to communal crisis as communities claim ownership of trees within community.

3.6 Benefits of Solar Cooking

3.6.1 Solar cookers save money and time

- Sunshine is free. Solar cooking saves precious fuel for evenings, cloudy days and cold weather.
- Foods cook unattended while you do other things.
- Pots are easy to clean. Food doesn't stick on the inside and there's no soot on the outside.
- A solar cooker is easy to make from a variety of materials.

3.6.2 Solar cookers are safe, healthy and convenient

- There is no fire to cause burns or blow out of control.
- There is no smoke to injure eyes and cause lung problems. People allergic to smoke can now enjoy "solarcues" (barbecues without the smoke).
- Most solar cookers cook at 82-121°C (180-250°F), ideal for retaining food nutrients, moisture and flavor and not burning them. Wood and gas fire temperatures, by contrast, exceed 260°C (500°F).
- You can bake, boil and lightly fry foods in their own juices. Meats get very tender.
- Solar water pasteurization is a skill everyone should know for emergencies.
- When solar cooking, your kitchen stays cool on hot, sunny days.

3.6.3 Solar cookers are versatile and adaptable

- The simple technology is easily adapted to a wide variety of construction materials, cooking customs and climates.

3.6.4 Solar cookers are life-saving devices for those in sunny, fuel-scarce regions

- Solar cookers help two of the world's pressing problems — growing shortages of cooking fuels and the scourge of waterborne diseases. According to the United Nations, about one-third of us (two billion people) now suffer fuel wood

shortages. Women, and sometimes children, must carry fuel further distances, and spend more time doing so, than in the past. Some urban families spend 30-50% of their income on cooking fuel or must barter away food for fuel to cook the remainder. Families drop the nutritious foods that require lengthy cooking such as legumes from their diet, contributing to malnutrition. Many governments import and subsidize fossil fuels. With solar cookers families often reduce fuel woodened by half.

Pasteurizing water and milk in solar cookers can help reduce Cholera and other water borne diseases.

3.6.5 Solar cookers save trees and soil

In deforested areas, efforts to protect scarce trees fail when people have no alternatives to wood-fueled cooking. As a government administrator in Zimbabwe said, "When trees are gone, then follows erosion of the soil. ... The farmer is unable to use the land. ... The soil is washed into the river. Water needed for irrigation is no longer there. Then cotton and wheat are more expensive. ... This is a circle without end."

- Each solar cooker in sunny, arid climates can save one ton of wood per year.

3.6.6 Solar cookers help air quality

- Burning traditional fuels such as wood and gas pollutes the air and contributes to global warming. Solar cookers provide a pollution-free alternative.

4. CONCLUSION

It is clear that for environmental, economic, and health reasons, reducing dependence on firewood and conventional fuels, and increasing the use of free and renewable solar energy, are important goals. If reforestation plans are combined with solar cooking programmes that provide an affordable, renewable energy alternative, people will not need to cut down trees to cook, and reforestation efforts can be allowed to take root.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDICES

1. Volume of fire wood consumed daily =

Average per capita consumption X 70% of Mubi's population =

1.5 kg/day X (281,471, X 0.7) = 295.5 tones of fire wood per day

2. Cost of fire wood consumed daily=

Cost of fire wood/kg X volume of fire wood consumed daily =

N16.00/kg X 295,545kg = N4.7 million daily

* Survey carried out by the authors.

3. Cost of constructing a solar cook kit

Table for cost of constructing a solar cook kit

S/NO	Material	Quantity	Costs (N)
1	Aluminium foil	0.3×3 meters (1x10 feet)	150
2	Corrugated carton	0.9×1.2 meters (3x4 feet)	200
3	Glue (water based)	50 g	100
4	Paint brush	1	30
5	Knife	1	140
6	Ruler	1	20
7	Pencil	1	10
	Total		**650**

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/23623