ISSN: 2347-7431
EPRA International Journal of Climate and Resource Economic Review
-Peer Reviewed Journal
Volume: 10 | Issue: 2 | March 2022 || SJIF Impact Factor (2021): 7.254 || Journal DOI: 10.36713/epra1213

A STUDY OF USE OF SOLAR ENERGY IN SOCIETY BASED ON STATISTICAL METHODS

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ABSTRACT----------
Solar energy has experienced phenomenal growth in recent years due to both technological improvements resulting in cost reductions and government policies supportive of renewable energy development and utilization so it is inexhaustible freely available and clean source of energy generation. In this paper we study the data collected through questionnaires contains several attributes and the collected data are analyzed by applying various statistical tools and techniques our study shows that the power (in Watt) of solar panels in rural area is not identical to urban area and maximum number of user take benefit of subsidy for use of solar energy.

KEYWORDS: ***Solar Energy, Renewable Energy , Graphical Representation,Testing of Hypothesis,Level of significance*** ----------

INTRODUCTION

We all know that our natural resources such as petroleum, coal, and others are going to end someday. Hence, saving our natural resources is the biggest concern we all are going through. One of them is saving electricity and using alternatives like Solar Energy that are long-lasting as well as cheaper in comparison. Solar energy is the best alternative one can use to generate electricity in our daily lives. It is radiant light and heat from the Sun that is harnessed using a range of ever evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power.[1] Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy[2]. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air. The large magnitude of solar energy available makes it a highly appealing source of electricity[3]. The United Nations Development Programme in its 2000 World Energy Assessment found that the annual potential of solar energy was 1,575–49,837 exa joules (EJ). This is several times larger than the total world energy consumption, which was 559.8 EJ in 2012. In 2011, the International Energy Agency said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits[4]. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating global warming, and keep fossil fuel prices lower than otherwise. These advantages are global. Hence the additional costs of the incentives for early deployment should be considered learning investments; they must be wisely spent and need to be widely shared"[5].

Solar Heating

Being an excellent tool for heating, solar thermal collectors allow people to harness PV for heat and energy. Rather than converting solar light into electricity, these solar installations use the heat generated by the sun to increase the temperature of water or fluid flowing through pipes in the collector. One can easily use hot water for swimming pools, showers, laundry, and other applications later. In case of prolonged cold temperatures or cloudy weather, the heating system has a traditional gas or electric utility connection that heats the water.

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Generate Electricity

We use electricity for lighting as well as to run several home appliances daily. However, it costs a bomb when we see our electric bill at the month-end. With the use of solar panels, one can do everything with the generated electricity normally and can save themselves from the heavy electricity bills. This makes solar energy not only useful and cheap to use but environment-friendly too.

Cooking

Apart from other things, solar energy is highly useful for daily cooking too. You can easily use solar energy to cook a meal. You'll need a box, aluminum foil, pan, duct tape, a cooking bag, styrofoam insulation, and a thermometer to make your solar cooker. However, you can always keep yourself away from the hassles of making a solar cooker and can buy a solar cooker from an authorized solar products dealer.

Charging Batteries

You can always charge a device that is battery operated with solar energy. The photo-electric solar panels generate DC, which is the same form used in most batteries. One can easily plug in cell phones, pad devices, and laptops for direct charging with the help of any basic solar panel kits with connection port. Apart from this, you can also plug in the chargers for other batteries by adding a simple inverter that converts DC to 120-volt AC with solar energy. What's more! These are highly inexpensive and easy to use as well.

Solar Transportation

One of the biggest concerns today is the end of petroleum in the future. It's interesting to know that solar energy in many cities across the globe is being used for transportation purposes. To create a brighter future for all, introducing solar energy into the transportation sector can help solve the environmental issues related to pollution. The all-electric vehicles, hybrids, and vehicles that run on photovoltaic (PV) energy can use solar energy to move and this can be done daily. Since solar energy is so useful, low cost, environment-friendly and never-ending source of energy, everyone should choose to go environment-friendly by getting solar panels installed at the rooftop of their buildings. These solar panels are not only long-lasting but also low maintenance.There are many solar panel manufacturers and solar panel suppliers such as HVR Solar who have expertise in the installation and maintenance of these solar panels. Being the leader in the industry, HVR Solar is also the manufacturer and supplier of several solar equipments. So, don't wait! Become a responsible human towards the environment.

OBJECTIVES

- To study independence between area and gender.
- To study the independence between education and the reason for which use of solar panel.
- To study the independence between space occupied by n and types of house.
- To study the effectiveness of companies in rural and urban area by using H test.
- To study randomness in use of solar energy according to season or everyday by using Run test.
- To study randomness of use of solar panels in village and city by using Run test.
- To study equality in power of solar panels in rural and urban area.
- To study the government can helps for use of solar energy.

STATISTICAL SOFTWARE

MS – EXCEL
MS – WORD

STATISTICAL TOOLS

Graphical Tools: Bar Diagram, Pie Chart, Multiple Bar Diagram
Test: Chi-Square Test, Run Test, Krushal Walls (H-Test), Mann-Whitney Test

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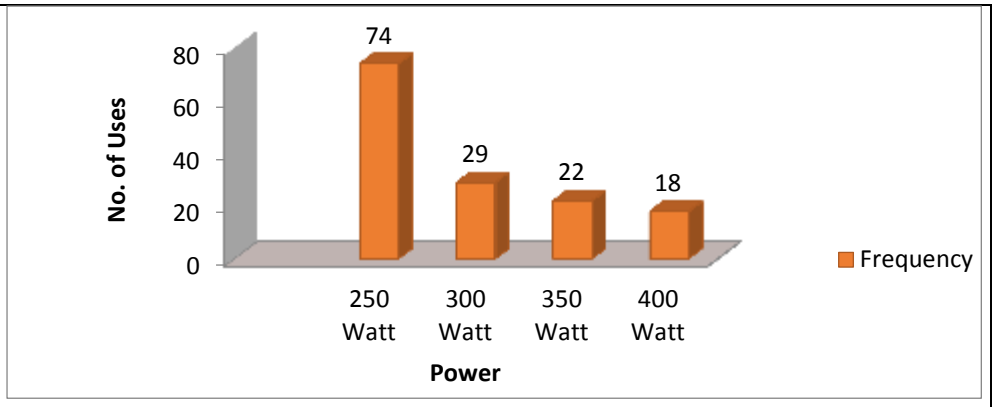
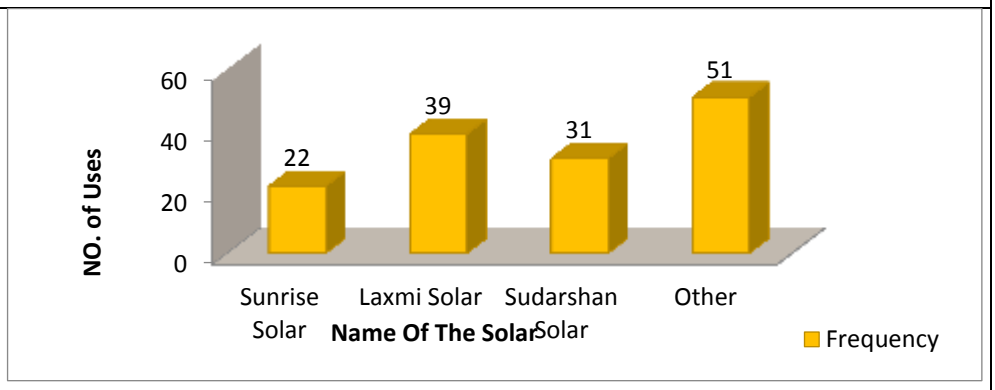
GRAPHICAL REPRESENTATION

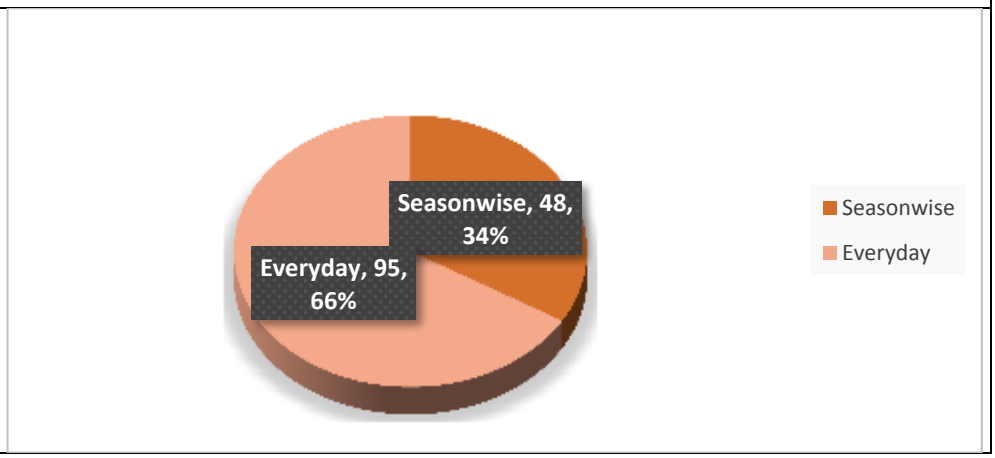
Power Of Solar Panel	NO. of Families
250 Watt	74
300 Watt	29
350 Watt	22
400 Watt	18



Solar Name	No. of Families
Sunrise Solar	22
Laxmi Solar	39
Sudarshan Solar	31
Other	51



Use solar	No. of Families
Seasonwise	48
Everyday	95



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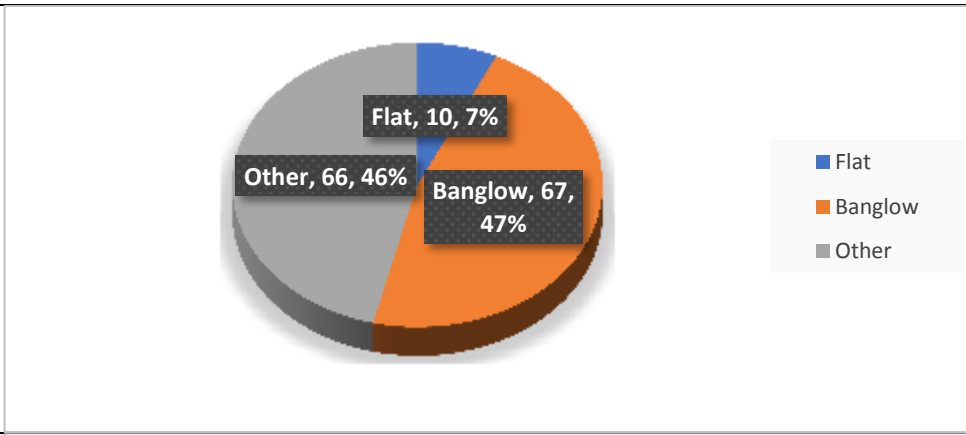
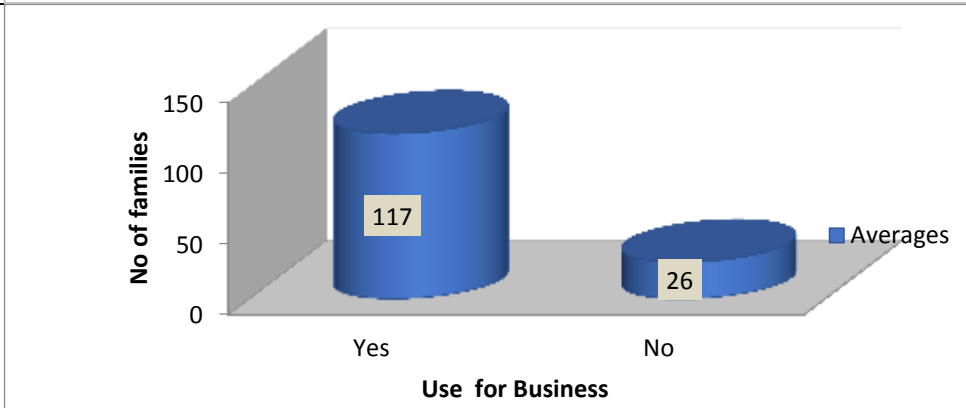
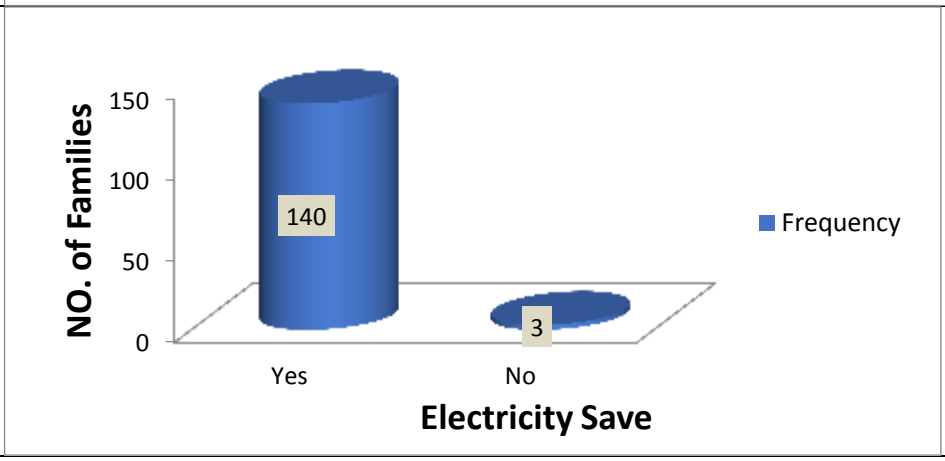
Type Of House	No. of Families
Flat	10
Banglow	67
Other	66



Use For Business	No. of Families
Yes	117
No	26



Electricity Save	NO. of Families
Yes	140
No	3



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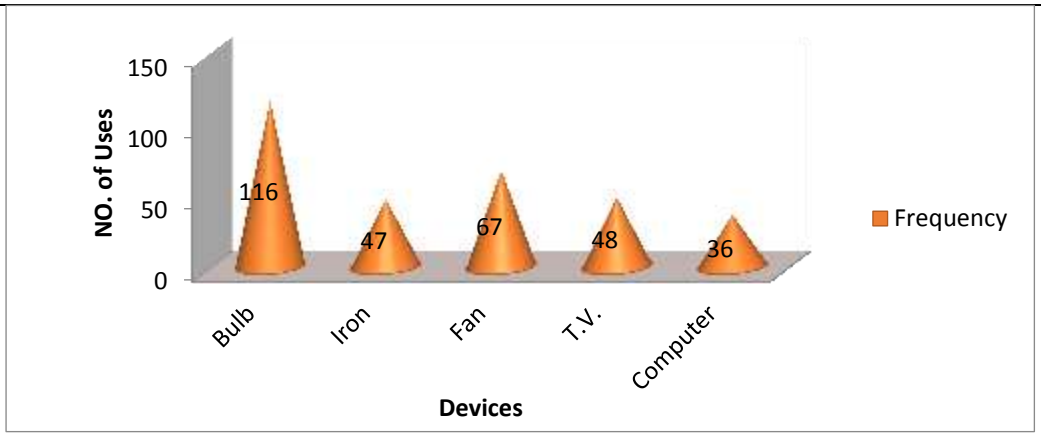
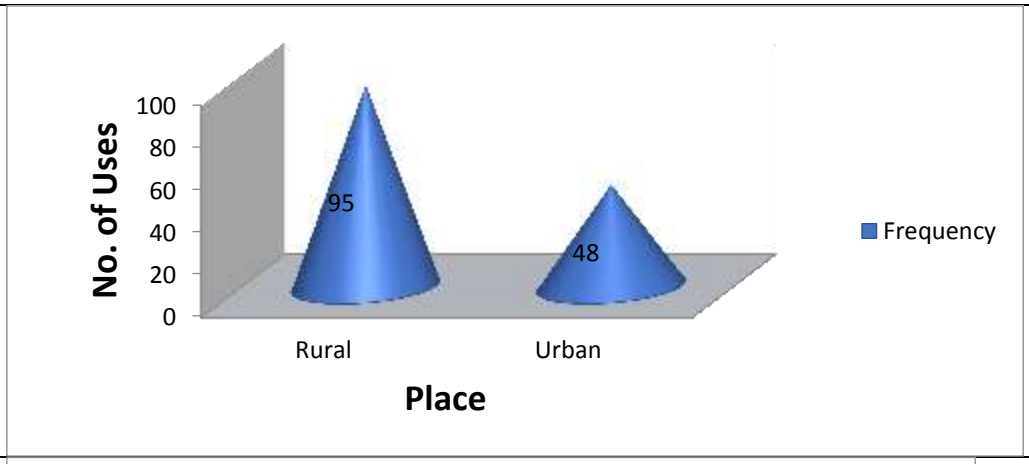
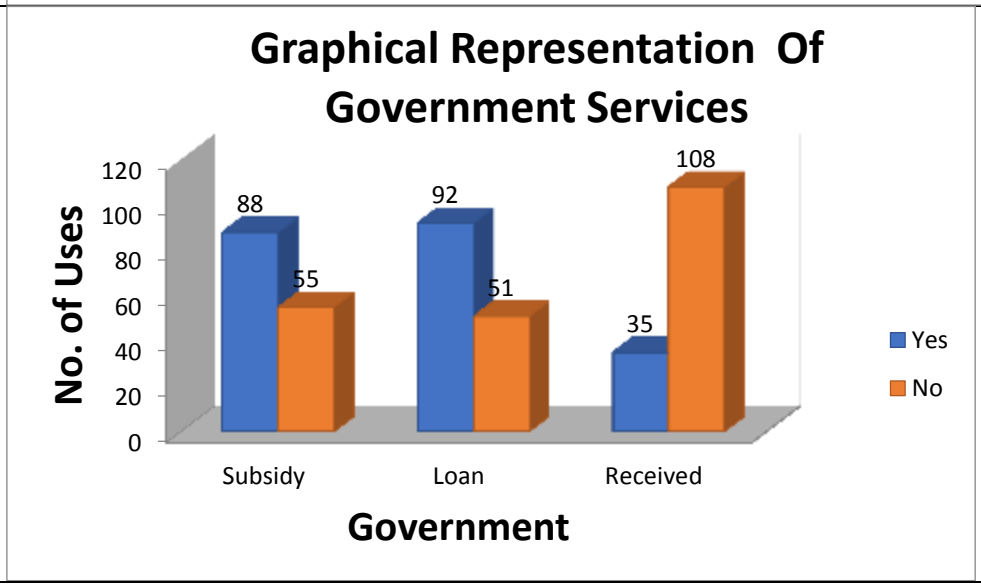
Devices	NO. of Families
Bulb	116
Iron	47
Fan	67
T.V.	48
Computer	36



Place	No. of Families
Rural	95
Urban	48



Government	Yes	No
Subsidy	88	55
Loan	92	51
Received	35	108



Testing of Hypothesis:

Chi-Square Test:

A] Test for Independence between Area and Gender.

Hypothesis:

H_0: There is independence between Area and Gender.

H_1: There is no independence between Area and Gender.

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Test Statistics:

$$\chi^2_{cal} = \Sigma(Oi^2/Ei) - N$$

$\chi^2_{cal} = 2.1551$

$\chi^2_{tab} = \chi^2_{\alpha,n-1}$ at 5% level of significance

$\chi^2_{tab} = 7.815$

B]Test for independence between Education and Use for Household Reason.

Hypothesis:

H_0: There is independence between Education and Use for Household Reasons.

H_1: There is no independence between Education and Use for Household Reasons.

Test statistic:

$$\chi^2_{Cal} = \Sigma(Oi^2/Ei) - N$$

$\chi^2_{Cal} = 5.5921$

$\chi^2_{tab} = \chi^2_{(\alpha,n-1)}$ level of significance

$\chi^2_{tab} = 18.307$

C]Test for independence between Occupied Space and Type Of House.

Hypothesis:

H_0: There is independence between Occupied Space and Type Of House.

H_1: There is no independence between Occupied Space and Type Of House.

Test statistic:

$$\chi^2_{Cal} = \Sigma(Oi^2/Ei) - N$$

$\chi^2_{Cal} = -2.1830$

$\chi^2_{tab} = \chi^2_{(\alpha,n-1)}$ level of significance

$\chi^2_{tab} = 18.307$

***D]* Krushal-Walls (H-Test)**

Hypothesis :

H_0 : Independent samples are identically distributed.

Ie. $\mu_1=\mu_2=\mu_3=\mu_4$

H_1: Independent samples are not identically distributed.

Ie. $\mu_1\neq\mu_2\neq\mu_3\neq\mu_4$

H_0 : Use of solar panels of four companies in rural and urban Area are equally effective.

H_1 : Use of solar panels of four companies in rural and urban Area are not equally effective.

T_1= Sum of rank of sample Ⅰ

T_2= Sum of rank of sample Ⅱ

T_3= Sum of rank of sample Ⅲ

T_4 = Sum of rank of sample Ⅳ

$H = \frac{12}{n(n+1)} \sum_{i=1}^{k} \frac{T_i^2}{n_i} - 3(n=1)$

H =2.7083

Calculated H value = 2.7083

For tabulated values

K = 4

K-1= 4-1 = 3 d.f

Therefore, Calculated H value < Tabulated H value

E] Run Test :

1)To study randomness in use of solar energy according to season or everyday

H_0 : The given sequence is random / The use of solar energy In random manner.

H_1 : Use of solar energy is not random

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n = 143
n_1 = (no. of use according to season) = 48
n_2 = (no. of use solar energy everyday) = 95
r = 72
According to season (S) & Everyday (E)
Consider,
E(r) = $\frac{n+2}{2}$ = 72.5
V(r) = $\frac{n(n-2)}{4(n-1)}$ = 35.4982
Test Statistics is,
|z| = $\left|\frac{r-E(r)}{\sqrt{V(r)}}\right|$ = 0.0839
Critical value at 5% L.O.S. = $z_{\alpha/2}$= 1.96 $|z| < z_{\alpha/2}$

F] Mann-Whitney Test:
To test equality of means for use of solar panels in rural and urban area with their power.

Hypothesis:
H_0: The power (in Watt) of solar panels in rural area is identical to urban area.
H_1: The power (in Watt) of solar panels in rural area is identical to urban area.
R_1 = Sum of ranks of sample- Ⅰ
R_2 = Sum of ranks of sample- Ⅱ
Test Statistics,
$U_1 = n_1n_2 + \frac{n1(n_1+1)}{2} - R = 3.5$
$U_2 = n_1n_2 - U_1 = 12.5$
$U = \min(U_1,U_2) = 3.5$
$U' = \max(U_1,U_2) = 12.5$

Critical value: $U_{[(4,4),\ \alpha/2]} = U_{(4,4),\ 0.025} = 11$
$U_{cal} < U_{tab}$

Conclusion
- The attribute area and gender are independent to each other.
- The attribute education and the reason for which solar panel is used are independent to each other.
- The attribute space occupied by solar panel and types of house are independent to each other.
- Use of solar panels of four companies in rural and urban area equally effective.
- The collected respondent sequence about use of solar panels in the rural and urban area is not random.
- The collected respondent sequence about use of solar energy according to seasonal everyday is random.
- The power (in Watt) of solar panels in rural area is not identical to urban area.
- government gives facilities for use of solar energy.

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