An Economic Analysis of Determining Factors of Solar Energy Consumption of Rural Household in Villupuram District of Tamil Nadu

Dr. *S.Chinnammai*[1], S. Abdul Kareem[2]

[1] Associate Professor, Department of Economics, University of Madras, Chepauk, Chennai-600 00, Tamil Nadu,India

[2] Ph.D. Research Scholar, Department of Economics, University of Madras, Chepauk, Chennai-600 005, Tamil Nadu, India

Abstract: Growing consumption of energy has also resulted in the country becoming increasingly dependent on fossil fuels such as coal, oil and gas. Rising prices of oil, gas and coal and potential shortages in future lead to concerns about the security of energy supply needed to sustain our economic growth. Photovoltaic converts solar energy in to electricity that can be used for myriad purposes such as lighting, pumping and generation of electricity. This study focused determinants factors for adopting solar energy in the selected villages in the study area. Based on the comprehensive energy survey 300 households in Villuppuram district, researchers present the structure of rural household solar energy consumption in the study area. The study has been conducted with pre-structured interview schedule. Present study elaborated the benefits and difficulties faced by the respondents for using solar energy in Villuppuram district**.**

Keywords : Energy, Solar Energy, Electricity, Consumption and Determining Factors.

I. INTRODUCTION

The economic development plans implemented since independence have necessarily required increasing amounts of energy. As a result, consumption of energy in all forms has been steadily rising all over the country. This growing consumption of energy has also resulted in the country becoming increasingly dependent on fossil fuels such as coal, oil and gas. Rising prices of oil, gas and coal and potential shortages in future lead to concerns about the security of energy supply needed to sustain our economic growth. Increased uses of fossil fuels have also caused environmental problems both locally and globally. Against this background, the country urgently needs to develop a sustainable path of energy development.

II. RENEWABLE ENERGY SOURCES IN INDIA

India is gifted with rich natural and renewable resources of energy like solar, wind and biomass. India has ranked the second position for the renewable energy attractiveness index in the world. According to the statement, India continued its upward trend in the index to second position with the government's programme to build 175 GW in renewable energy generation by 2022 and to have renewable energy account for 40 per cent of installed capacity by 2040. The country has added more than 10 GW of solar in the last three years from 2.6 GW in 2014. It may be necessary to continue with subsidies in the case of socially oriented programmes to

meet the energy requirements in rural areas, particularly interior villages in India.

III. SOLAR ENERGY IN INDIA

Solar energy is basis for all forms of energy. It can be made use of in two ways i.e. using heat for drying, heating, cooking or generation of electricity through the Photovoltaic route. Photovoltaic converts solar energy in to electricity that can be used for myriad purposes such as lighting, pumping and generation of electricity. This energy is very attractive energy source because its pollution free nature, virtually inexhaustible supply and global distribution. Under National Solar Mission, the target for setting up solar capacity increased from 20 GW to 100 GW by 2021-22. Target of 10,500 MW, set for 2016-17 which will take the cumulative capacity to 17 GW end of March 2017. Overall in India 34 Solar Parks of capacity 20,000 MW have been sanctioned which are under various stages of execution. A target of 40 GW grid connected solar rooftops to be achieved by 2022 has been set. So far, about 500 MW have been installed and about 3,000 MW has been sanctioned which is under installation. All major sectors i.e. Railways, Airports, Hospitals, Educational Institutions, Government Buildings of Central/State/PSUs are being targeted besides, the private sector.

IV. OBJECTIVES AND METHODOLOGY

- To study the socio economic conditions of solar energy users in the study area.
- To determine the factors influencing the adoption of solar energy in the study area.

V. HYPOTHESIS OF THE STUDY

- There is no significance relation between income and willingness to pay of the respondents in the study area to adapt solar device

VI. SAMPLE SIZE AND METHOD OF DATACOLLECTION

Besides the sources of secondary data, this study has attempted to strengthen the analyses by collecting primary data. This study has selected Viluppuram district of Tamil Nadu for primary data collection. Viluppuram has the highest rural populated district and also more number of installation of solar panel (Green Houses Scheme) in rural area of Tamil Nadu. This study belongs to installation of solar panel in rural household sector hence researcher selected this district is suitable in nature for the study. Researcher visited 30 villages in Villuppuram districts for primary data collection and 10 samples collected in each village, so totally 300 samples are taken for this study. For selection of samples, the purposive sampling technique has been adopted. Purposive sampling has been deliberately used in the place of popular methods such as multi-stage stratified random sampling technique. Personal investigation method was used to collect the primary data. The study has been conducted with pre-structured interview schedule. The study elaborates the benefits and difficulties faced by the respondents for using solar energy in the study area.

VII. ANALYSIS AND DISCUSSION

Table-1 and chart-1 shows age details of the respondents, among the overall respondents 64.33 percent belonged to the male and 35.67 percent are female. Also from the table-1, 47 respondents

are belonged to the age group of less than 30 within that 27.66 percent are male and 72.34 percent are female and 94 respondents are belonged to the age group of 31 to 40, within that 64.89 percent are male and 35.11 percent female. Out of 300 respondents 134 are belonged to the category of 41 to 50, within that 74.63 percent are male and 25.37 percent are female. In the age group of more than 60 and all 6 respondents belonged to the male. In overall data most of the respondents (134) belonged to the age category of 41 to 50.

Table-1: Age Details of the Respondents

S.No	Age Details	Male	Female	Total
(1)	(2)	(3)	(4)	(5)
1	Less than 30	13 (27.66)	34 (72.34)	47 (100.00)
2	31 to 40	61 (64.89)	33 (35.11)	94 (100.00)
3	41 to 50	100 (74.63)	34 (25.37)	134 (100.00)
4	51 to 60	13 (68.42)	6 (31.58)	19 (100.00)
5	More than 60	6 (100.00)	0 (0.00)	6 (100.00)
	Overall	**193 (64.33)**	**107 (35.67)**	**300 (100.00)**

Note: Parenthesized figures are row wise percentage to the total. Source: Compiled by researcher from collected data.

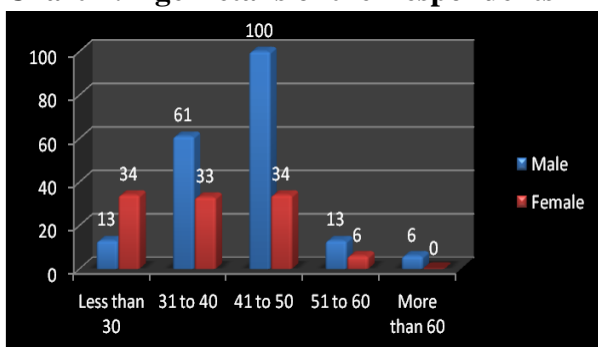**Chart-1: Age Details of the Respondents**

Table-2: Education Details of the Respondents

S.No	Education Details	Gender Details		Total
		Male	Female	
(1)	(2)	(3)	(4)	(5)
1	Illiterate	25 (12.95)	9 (8.41)	34 (11.33)
2	Primary Education	63 (32.64)	41 (38.32)	104 (34.67)
3	High School	81 (41.97)	30 (28.04)	111 (37.00)
4	Higher Secondary	12 (6.22)	24 (22.43)	36 (12.00)
5	Diploma	7 (3.63)	0 (0.00)	7 (2.33)
6	Collegiate	5 (2.59)	3 (2.80)	8 (2.67)
	Overall	**193 (100.00)**	**107 (100.00)**	**300 (100.00)**

Note: Parenthesized figures are column wise percentage to the total. Source: Compiled by researcher from collected data.

Table-2 shows education details of the respondents, out of 300 respondents, most of them completed (111) only the high school level followed by primary education category is 104, 36 respondents belonged to the higher secondary and 7 and 8 respondents are completed diploma and collegiate level of education. For female respondents most of them are completed primary education (41) followed by high school level (30) and 24 respondents completed higher secondary. Interestingly no one went for the diploma level education for their studies. For male category most of them completed at high school (81) followed by primary education (63), Illiterate (25), diploma (7) and collegiate (5).

Table-3: Occupation Details of the Respondents

Gender (2)	Self Agriculture (3)	Casual Labour in Agriculture (4)	Others (5)	Total (6)
Male	25 (12.95)	119 (61.66)	49 (25.39)	193 (100.00)
Female	8 (7.48)	56 (52.34)	43 (40.19)	107 (100.00)
Overall	**33 (11.00)**	**175 (58.33)**	**92 (30.67)**	**300 (100.00)**

Note: Parenthesized figures are row wise percentage to the total. Source: Compiled by researcher from collected data.
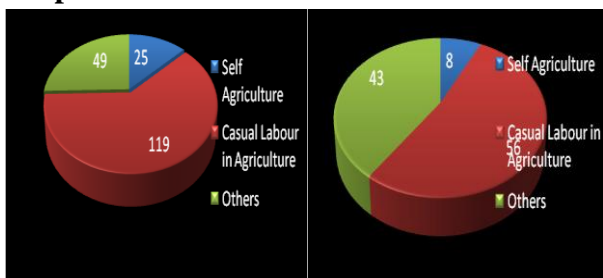
Chart-2: Occupation Details of the Respondents

Table-3 clearly shows occupation details of the respondents, out of 300 respondents most of them belonged (175) to the casual labour in agriculture followed by other jobs category its included driver, sweeper, hotel server etc. and 33 respondents belonged to the self agriculture work. Out of 193 male respondents, 61.66 percent belonged to the casual labour in agriculture, 25.39 percent belonged to the others category and 12.95 percent are doing in self agriculture. Table-3 also shows out of 107 female respondents 52.34 percent belonged to casual agriculture labour, 40.19 percent belonged other jobs category and 7.48 percent belonged to self agriculture work.

Table-4: Annual Income details of the Respondents

S. No (1)	Gender (2)	Annual Income in Rupees			Total (6)
		Less than 50000 (3)	50000 to 100000 (4)	More than 100000 (5)	
1	Male	55 (28.50)	96 (49.74)	42 (21.76)	193 (100.00)
2	Female	22 (20.56)	63 (58.88)	22 (20.56)	107 (100.00)
	Overall	**77 (25.67)**	**159 (53.00)**	**64 (21.33)**	**300 (100.00)**

Note: Parenthesized figures are row wise percentage to the total. Source: Compiled by researcher from collected data.

Table-4 explains annual income details of the respondents, out of 300 respondents most of them (159) belonged to the income category of Rs.50000 to 100000 followed by Rs. less than 50000 (77) and more than Rs.100000 (64). Out of 193 male respondents, 49.74 percent come under the category of Rs.50000 to 100000 followed by 28.50 percent in less than Rs.50000 and 21.76 percent in more than Rs.100000. Table-4 also shows out of 107 female respondents 53.00 percent belonged to Rs. 50000 to 100000, 25.67 percent belonged to the income group of less than Rs.50000 and 21.33 percent belonged to more than Rs.100000.

Table-5: Annual Expenditure details of the Respondents

S. No (1)	Household Size (2)	Annual Expenditure in Rupees			Total (6)
		Less than 50000 (3)	50000 to 100000 (4)	More than 100000 (5)	
1	Less than 3	9 (18.00)	40 (80.00)	1 (2.00)	50 (100.00)
2	3 to 5	8 (4.15)	149 (77.20)	36 (18.65)	193 (100.00)

3	More than 5	0 (0.00)	14 (24.56)	43 (75.44)	57 (100.00)
	Overall	**17 (5.67)**	**203 (67.67)**	**80 (26.67)**	**300 (100.00)**

Note: Parenthesized figures are row wise percentage to the total. Source: Compiled by researcher from collected data.

Table-5 clearly explains annual expenditure details of the respondents, out of 300 respondents most of them (203) belonged to the expenditure category of Rs.50000 to 100000 followed by more than Rs.50000 is 80 and less than Rs.100000 is17respondents. Out of 193 respondents in the family size of 3 to 5, most of them (77.20 percent) belonged to Rs. 50000 to 100000 expenditure category followed by 18.65 percent of the respondents belonged to the expenditure category of more than Rs.100000.In the family size of more than 5 members, 75.44 percent of the respondents spent more than 1lakh and rest of them spent between 50000 to 1lakh

Table-6: Income-wise Willingness to Pay details of the Respondents

Willingness to Pay (Rs.)	Annual Income in Rupees			Total
	Less than 50000	50000 to 100000	More than 100000	
(2)	**(3)**	**(4)**	**(5)**	**(6)**
Less than 1000	68 (34.17)	108 (54.27)	23 (11.56)	199 (100.00)
More than 1000	9 (8.91)	51 (50.50)	41 (40.59)	101 (100.00)
Overall	**77 (25.67)**	**159 (53.00)**	**64 (21.33)**	**300 (100.00)**

Note: Parenthesized figures are row wise percentage to the total.
Source: Compiled by researcher from collected data.

Hypothesis Testing

H0 : There is no significance relation between income and willingness to pay of the respondents to adapt solar device

H1 : There is a significance relation between income and willingness to pay of the respondents to adapt solar device

Table-7 : Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.313[a]	2	.000
Likelihood Ratio	44.621	2	.000
Linear-by-Linear Association	42.052	1	.000
N of Valid Cases	300		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 21.55.

As shown in Table-7 calculated value of χ^2 is 43.313 at 2 degree of freedom and critical value is 18.47 at 1 % level of significance. The critical value is lesser than the calculated value. The researcher has strong evidence to reject the null hypothesis and concluded that there is a significant relationship between willingness to pay and income of the respondents. Table-6 shows nearly 34.17 percent of the lower income (less than 50,000) respondents, 54.27 percent of middle income (Rs.50000 to 100000) of respondents willing to pay minimum amount (less than 1000) only. Also from the table-6 nearly 40.59 percent of higher income groups (more than 100000) have willingness to pay more than Rs.1000. Inference of this table shows the lower income of the respondents willingness to pay lower the amount and higher income group willing to pay higher the amount. So there is a significant difference

between income of the respondents and willingness to pay for adoption of solar energy.

Factor Analysis

Factor Analysis is a statistical procedure used to uncover relationships among variables. This allows numerous variables to be condensed into fewer dimensions called factors. In the context of this study, the variables are the encouraging factors of merit factors of the respondent adopt the solar panel in their houses. The method of factor analysis has been adopted in the study to distinguish the relationship between various patterns that go to say. The various statements have been sub-divided into various factors by grouping statements of similarity into a single group based on which FACTOR ANALYSIS has been computed.

Aim : To analyse the factors encouraging for adopt the solar energy

There are 12 strongest reasons for adopting solar energy opined by the respondents. These reasons are given in table 8 below which are reduced into fewer factors by analyzing correlation between variables (difficulties).

Table -8 Encouraging Factors by Respondents Adopting Solar Energy

Statement	Statement Number
Subsidy	S1
Space in House	S2
Easy to Operate	S3
Less Laborious Work	S4
Electricity Scarcity	S5
Economical	S6
Inspiration of Others	S7
Pollution Free	S8
High Electricity Bills	S9
Electricity Rate not Moderate	S10
Low Maintenance Cost	S11
High Efficiency	S12

Source: Computed by the researcher from the collected primary data

The following table-8.1 clearly shows the KMO value is very high at (0.623). Similarly the Barlett's test rejects the null hypothesis; 'the variables are not related' as the approximate chi square value is 1103.985 at 66 degree of freedom which is significant at 1 percent level. And accept the alternative hypothesis that these variables are strongly related to the determinants of solar energy in the study area.

Table-8.1 KMO and Bartletts's Test

Description	Value
KMO measure of sampling adequacy	0.623
Bartletts's Test of Sphericity App Chi Square Value	1103.985
degrees of freedom	66
Significance	.000

Source: Computed by the researcher

The results of the Principal Component Analysis to extract the number of variables are given in the following table.

Table-8.2 Principal Component Analysis

	Initial Eigen Values		
Factors	Eigen Value	Percentage of Variance	Cumulative Percentage
1	3.435	28.629	28.629
2	1.755	14.626	43.255
3	1.538	12.818	56.073
4	1.269	10.576	66.650
5	1.135	9.461	76.111

Source: Computed by the researcher

From the table-8.2 it is clear that the 5 factors can be extracted together which accounts for 76.111 percent of the total 12 variables. Hence, 12 variables are summated to five factors. The following table represents Rotated Component Matrix table by using Varimax Method which is used to assign factors and which have higher loadings.

Table-8.3   Rotated Factor Matrix

Factors	Damage	Factor Scores
Economic Factors	S1	.905
	S9	.862
	S11	.834
Operational Factors	S3	.827
	S7	.816
Efficiency Factors	S12	.805
	S4	.800
	S6	.796
Environmental Factors	S8	.787
	S2	.783
Energy Factors	S5	.714
	S10	.703

Source: Computed by the researcher

From the above table 8.3 it is inferred that factor 1 is a combination of 3 original variables such as subsidy from the government (S1), high electricity bills (S9) and low maintain cost (S11) which is named as **Economic Factor.** Factor 2 is a combination of 2 original variables such as easy to operate (S3) and inspiration of others (S7) which is named as **Operational Factor.** Factor 3 is a combination of 3 original variables such as, high efficiency (S12), less laborious work (S4) and economical in nature (S6) which is named as **Efficiency Factor.** Factor 4 is a combination of 2 original variables such as pollution free in nature (S8) and house size (S2) which is named as **Environmental Factor.** Factor 5 is a combination of 2 original variables such as electricity scarce (S5) and electricity tariff not moderate (S10) which is named as **Energy Factor.**

From table 8.3 it can be seen that S1 has the highest loadings of 0.905, S9 0.862, S11 0.834 and S3 0.827. Of these, S1 has the highest loading which states that government subsidy is the biggest impact for adapting solar panels in the study area opines by respondents.

VIII.   CONCLUSION

It can be seen that the solar energy technology is a natural endowment available freely and abundantly in the nature. At the time of increasing energy crisis, its full utilization will not only benefit tothe people but also helps to preserve the environment. Besides, it will be a contributing factor for improving the quality of life. Definitely, in future solar energy technology will become more popular and the development of this energy will drastically reduce the consumption of commercial sources of energy.

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