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Saga of Silicon Plate: An empirical analysis on the impact of Socio Economic factors of farmers on inception of solar plants

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Abstract : India, being the developing country, demand for energy is growing year by year beyond the generation capacity. India is the fifth largest power producer in the world and the current demand is 155 GW and it is estimated that demand for electricity reaches to 217 GW by the year 2021 – 22. Consumption of electricity is considered as of the indicators for the country's development. The per capita consumption of electricity is crossing 1,000 units in a year in India which means a good sign for the industrial development which may leads to the economic growth of the country. The other side 280 million Indian citizens still do not have access to electricity; this problem is more in rural areas. The problems involved in generation of conventional electricity, transmission and distribution and the week condition of the state electricity boards of the concerned states are also reasons for the current scenario. More over conventionally generated electricity is causing for the environmental pollution. In this context, generating electricity through renewable resources is an important alternative and it is eco friendly too. This empirical paper attempted to know the socio economic factors which are affecting the inception of solar plants either solar photovoltaic method or solar thermal among farmers in the state of Andhra Pradesh. Multiple Linear Regression Analysis (MLRA) was used to analyze the data.

Keywords : Solar Plant, Photovoltaic, Thermal routing, Socio economic factors, Renewable resources.

1. INTRODUCTION

Solar energy is the origin for all types of energy on this earth. The solar energy can be used in two forms either thermal route or photovoltaic route. In general in the thermal routing process the solar energy can be used for drying, heating and cooking and in photovoltaic method the solar energy will be converted into electrical power and the generated power will use for various purposes such as lighting, pumping, operating the machinery and for many other things just like the conventional electrical power. India, being the developing country, demand for energy is growing year by year beyond the generation capacity. India is the fifth largest power producer in the world and the current demand is 155 GW and it is estimated that demand for electricity reaches to 217 GW by the year 2021 – 22[1].

Consumption of electricity is considered as of the indicators for the country's development. The per capita consumption of electricity is crossing 1,000 units in a year in India [2] which means a good sign for the industrial development which may leads to the economic growth of the country. The other side 280 million Indian citizens still do not have access to electricity; this problem is more in rural areas. The

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problems involved in generation of conventional electricity, transmission and distribution and the week condition of the state electricity boards of the concerned states are also reasons for the current scenario[3].

More over conventionally generated electricity is causing for the environmental pollution. In this context, generating electricity through renewable resources is an important alternative and it is eco friendly too. By virtue India is a tropical country and receives adequate solar radiation almost 300 days per year *i.e* 3000 hrs which is equalent to more than 5,000 trillion KWh[4]. India is unable to tap that opportunity and failing to turn it into the electrical energy and still relying only on non renewable resources which may cause for pollution. The inadequate supply of power and increasing demand and the environmental pollution are the main reasons to think the governments towards the generating electricity through renewable resources. However the momentum is bit slow but some of the state governments taken initiation and started generating the solar energy by establishing solar plants in the concerned states[5]. State governments have been encouraging the private sector also to establish solar plants and the following Table:1 explains the installed solar power plants in the different states of India.

Table 1. State wise Solar power plants establishment and their Capacity details.

S.No	*State*	*Photovoltaic Capacity (MW)*	*Solar Thermal Capacity (MW)*
1.	Rajasthan	43	400
2.	Gujarat	722	45
3.	Maharashtra	133	-
4.	Karnataka	10	-
5.	Andhra Pradesh	20.5	-
6.	Uttarakhand	4	-
7.	Punjab	5	-
8.	Haryana	7.8	-
9.	Uttar Pradesh	11	-
10.	Jharkhand	16	-
11.	Chhattisgarh	4	-
12.	Madhya Pradesh	7.25	-
13.	Odisha	11	-
14.	Tamil Nadu	12	-
	Total	**1006.55**	**445**

2. STATEMENT OF THE PROBLEM

The role of solar power is becoming more significant year by year as the portion of generating power capacity under this sector is growing day by day. Both the union and state governments have been recognized the importance of solar power and continuously encouraging the entrepreneurs in that filed with many packages and incentives[6]. State government of Andhra Pradesh is also providing the various facilities, incentives and subsidies to the firms who will come forward to establish solar power plants. Government is giving leverage by providing exemption from electricity duty, exemption of Wheeling charges, transmission charges and Cross-subsidy charges, refunding VAT(Value Added Tax), refunding the stamp duty and registration charges for purchase of land to the concerned solar plants[6].

Though the central government and state governments of the concerned states have been providing various benefits and perks, the momentum of inception of solar plants is very low. Agriculture is the backbone to Indian economy, not only this rural Indian population is mostly relying on the agriculture and agriculture related occupations. The Indian agriculture sector is using 20 percent of the total production of the electricity. The interruptions in transmission, scarcity of the power, the disequilibrium between the demand and supply of electricity and the poor maintenance of the state electricity boards caused for the frequent power cuts in the agriculture sector and the supplying power is inadequate [7]. Hence it is required to set up the solar plants by the farmers in their fields, so that they can't be relying on the conventional electricity. This paper aimed to understand the different socio economic problems of the farmers in the state of Andhra Pradesh in inception of the solar plants. Further this paper aimed to provide the adequate answers to the following research questions.

3. RESEARCH QUESTIONS

1. To explore the conditions in the state of Andhra Pradesh to establish the solar power plants.
2. To understand the various social and economic factors of the farmers which may help to incept the solar power plants ?
3. To analyse the data empirically *i.e* the impact of socio-economic factors over inception of solar power plants in Andhra Pradesh

4. THEORITICAL FRAMEWORK

Energy or the consumption of electricity is considered as the vital component for economic development and improving the quality of life [8]. The nature provided both conventional and non-conventional sources to produce the electricity. By nature the conventional sources are fast exhausting and scarcity may arise, in order to meet the future demand for electricity the renewable energy resources are the suitable ways [9]. Among the other renewable resources solar energy is consider as an important and sustainable sources. The potentiality of the solar energy is more reliable because theoretically it has been proved that a small fraction of the solar energy is enough to meet our current needs. In fact it is also depicted that we can use a meager portion of 5% of the total emitted solar energy and that concerned portion will be equal to 50 times that what the world receives. Fortunately India is one of the leading countries which having good Direct Normal Irradiance (DNI) because of the various favorable conditions such as geographic location, earth-sun movement, tilt of earth's rotational axis.

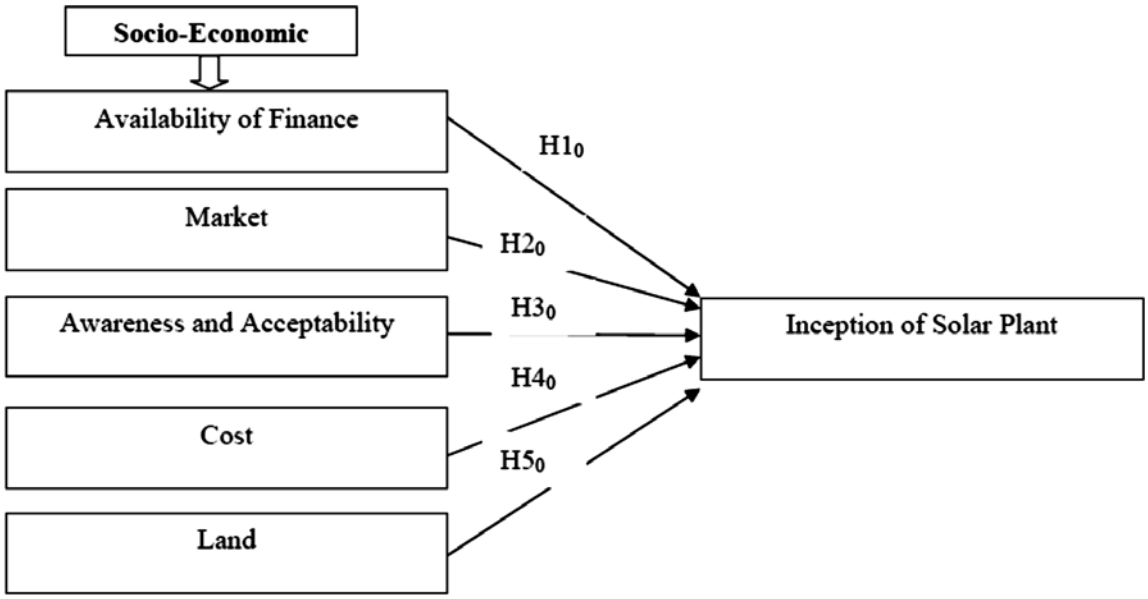

Fig. 1. The proposed model for assessing the impact of Socio-Economic factors on Inception of Solar plant.

It was estimated that there is a potential to produce 5000 trillion KWh of electricity through the solar energy in one year[10]. The current capacity of solar energy in India is 2.2 GW including inclusive of grid and off grid installation and it was aimed to raise the solar power production to 22GW by 2022 [9]. To achieve this task is not much easy to India until and unless there is no clear roadmap or to understand the basic problems in inception of the solar plants. Hence this paper aimed to understand the socio-economic factors of the farmers which may give the solution to accelerate the establishment of solar power plants in Andhra Pradesh. This study explores the socio-economic factors such as Availability of Finance, market, awareness and acceptability, cost and land and believed that these factors show impact on the inception of solar power plants. Hence this study proposed a model given in figure - 1 to assess the impact of socio-economic factors on inception of solar plants.

5. HYPOTHESES DEVELOPMENT

Availability of Finance

The set up cost for solar plant is high, though it is one time investment and it may sustain for almost 25 years, the entrepreneurs are not willing to invest on solar plants [14] & [18]. It is also observed that very much limited access to affordable credit [13] & [17] and the project financing is also difficult [19]. More over there are difficulties related to banding of the project related agreements and weak industry networks [16] & [23]. Hence we may conclude that availability of finance has the impact over inception of solar plant.

$H1_0$: Availability of Finance will not influence the inception of solar plants

Market : The Indian market is very dynamic, volatile and complex too. Especially in the context of solar power plants the degree of rigidness is bit high because the product is new to the market. Moreover the existence of informal and unqualified Photo Voltaic (PV) manufacturers and operators is a major hurdle [21]. There are many difficulties in dissemination of technology and inadequate market infrastructure is also a major cause for the slow growth rate of solar power plants [19]. Furthermore the supply and quality of silicon is a question mark in the market. These prevailing conditions are also considered the major obstacles for the expansion of solar market in India. Hence we consider the market conditions as one of the important factors which effect the establishment of solar plants.

$H2_0$: Market conditions will not influence the inception of solar plants

Awareness & Acceptability : The typical electricity consumers are habituated to the conventional electricity in India. They don't have awareness regarding the power generation through renewable resources. Even there is no accessibility also for the common users and the experiments and installations of solar plants are not reached to the usual citizens. Lack of awareness existed not only in consumers but all in all the stake holders [20]. Political instability in the state governments and the lack of attention by the policy makers is also another factor for lack of awareness regarding solar power plants [12] & [22]. Hence awareness and acceptability also consider as the important factor in installations of solar plants.

$H3_0$: Awareness & Acceptability will not influence the inception of solar plants

Cost : The major hurdle in the establishment of solar plant is the pre-investment cost [19] because the farmers may feel that the investment cost is too high and they may not come forward to establish the solar plants. The opinion of unit manufacturing cost of renewable is high comparatively with the fossil fuel [11] & [19]. Hence the cost incurring while establishing the solar plant is considered as one of the influencing socio-economic factors and it was hypothesized as follows.

$H4_0$: Cost will not influence the inception of solar plants

Land : Availability of land is very much difficult in the newly formed state like Andhra Pradesh, as there is much booming in the real estate development land has become crucial. The farmers are not ready to spare much land to generate the solar power [22]. Hence the factor of availability of land is considered as an important factor and hypothesized as following.

$H5_0$: Land will not influence the inception of solar plants

6. RESEARCH METHODOLOGY

Simple random survey technique was used to collect data from 265 farmers in Tenali and Guntur region in Andhra Pradesh in India. The customers were approached with the request to participate in the study and were assured the data collected would be used for purely academic purpose. The respondents were first qualified to ensure that they have owned some agricultural land and interested to set up the solar plants for the cultivation purpose.

7. RESULTS

Profile of Respondents

Appendix 1. Descriptions of the Respondents.

Variable	*Description*	*Frequency*	*Percent*	*Mean*	*S.D*
Gender	Male	245	92.5		
	Female	20	7.5		
Age	20-30 years	92	35.1		
	30-40	98	37.1	35.7	11.045
	40-50	43	16.2		
	50 & above	22	2.6		
Marital Status	Married	241	90.9		
	Un-married	24	9.1		
Education	SSC/Diploma	234	88.3		
	Graduation	24	9.1		
	PG & above	7	2.6		
Acres of Land	1-2 Acres	17	6.4	3.07	0.92
	3-4 Acres	52	19.6		
	1-5 Acres	89	33.6		
	>5 Acres	107	40.4		
Annual Household Income	1-2 Lacks	6	2.3		
	3-4 Lacks	162	61.1		
	> 5 Lacks	97	36.2		
Type of crop	Paddy	198	74.7		
	Pulses	24	9.1		
	Vegetables	37	14.0		
	Others	6	2.3		

Source : Primary data.

Appendix 2. Exploratory factor analysis of measurement scales (factor loadings < | 0.5| are not shown)

Name of the construct & Source	*Measures of the construct*	*Factor Loadings*	*Vari-ance*	*Coeffi-cient 'α'*	*Mean c*	*SD*
Availability of Finance Roger (2012) Byrnes L (2012)	High initial cost Limited access to affordable credit Difficulty in availing finance Transaction cost is high Weak industry networks Rigid policies to procure the funds	0.839 0.838 0.798 0.782 0.773 0.739	17.14 %	0.866	5.712	0.944
Market Taele BM (2012) Ghosh D (2002)	Existence of informal and unqualified PV manufcturers Difficulties in technology dissemination Infrastructure, sales and service networks Lack of community participation	0.901 0.844 0.758 0.611	15.65 %	0.944	5.681	0.856
Awareness & Acceptability Nalan CB (2009) Zhang X (2012)	Lack of technology awareness Lack of attention by the policy makers Political instability at different levels Unwillingness to adopt innovative approaches	0.899 0.879 0.815 0.766	12.43 %	0.856	5.868	0.835
Cost Mezher (2012)	Risk related to pre-investment cost Preference towards centralized source of energy generation Import tariff High cost of the materials are pulling back factor	0.899 0.861 0.834 0.734	12.13%	0.788	4.806	1.369
Land Zhang (2012)	Lack of land availability Complex are zoning Lack of data on potential sites No ease of right Inadequate installation space and service infrastructure	0.832 0.803 0.770 0.756 0.752	11.47 %	0.757	5.986	0.876
Inception of Solar plants	Solar plants are useful Solar plants are effective Solar plants are cost effective Solar plants are added value for the cultivation Timely operations is possible Solar plants are enriches the cultivation	0.823 0.804 0.768 0.756 0.740 0.690	10.49	0.854	5.244	1.154

(*a*) Extraction Method : Principle Components Analysis, Rotation Method: Varimax with Kaiser Normalization, total variance explained 79..335 %, $p = 0.001$;

(*b*) Items were measured on 1-7 scale.

The descriptions of the sample of 265 respondents shown in Table 4 indicated that 92.5% were male and mean age was 36 with ages ranging from 21-68 years. Interestingly, majority of the respondents (91%) were married and a meager, only 9 percent of the respondents were un married. The major chunk of the respondents (88.3 %) had SSC/Diploma as their educational qualification, 9 percent of the respondents were graduates and only 3 percent were post graduates. The aggregated

mean cultivating land is 3.07 acres, majority of the respondents (40.4%) of the respondents had more than five acres of land and 33.6% percent of the farmers had 4-5 acres of land, 19.6% of the participants had 3-4 acres of land only 6.4 % of the respondents had 1-2 acres of land and 61 percent of respondents had 3-4 lacks of income per year. Majority of the respondents are cultivating paddy (74.7%), 14 percent of the respondents are raising vegetables and only 9 percent of the farmers are yielding pulses. The details were showcased in Appendix – 1.

Measures

The survey instrument was a structured questionnaire consisting of two sections. Section1 consisted of questions that frame the respondent's demographic variables such as gender, age, education, annual income, acreage and type of crop they are yielding. For measuring demographic variables, dichotomous question and multiple choice questions with determinant choice approach were employed.

Section 2 consisted of questions that measured respondents' socio and economic factors associated with inception of solar plants. All of the items in Section 2 of the questionnaire were based on previous literature and were measured on the seven-point Likert scale where I stands for "strongly disagree" and 5 "for strongly agree". Necessary diagnostic tests were applied to examine the reliability and validity of survey instrument. Table 4 presents scale items, their sources, factor loading, Cronbach's alpha reliability coefficients, composite reliability and average variance extracted for each factor. The resulting scale scores were determined by taking the average of the individual scale items. The results were shown in Appendix – 2.

8. HYPOTHESES TESTING

For testing hypotheses H1-H5, stepwise multiple linear regression approach (MLRA) was used. The resulting regression models for dependent variable was shown in Table-2 and their significance including distinct predictors at varying 'α' levels presented in Table 3.

Table 2. Regression model summaries for the affect of Socio Economic factors on inception of solar plants.

Model Summary									
Model	***R***	***R Square***	***Adjusted R Square***	***Std. Error of the Estimate***	Change Statistics				
					R Square Change	***F Change***	***df1***	***df2***	***Sig. F Change***
1.	0.686[a]	0.470	0.468	0.84163	0.470	233.465	1	263	0.000
2.	0.749[b]	0.561	0.558	0.76771	0.091	54.083	1	262	0.000
3.	0.757[c]	0.573	0.568	0.75892	0.012	7.106	1	261	0.008
4.	0.762[d]	0.581	0.574	0.75292	0.008	5.176	1	260	0.024
(*a*) Predictors: (Constant), Availability of Finance									
(*b*) Predictors: (Constant), Availability of Finance, Cost									
(*c*) Predictors: (Constant), Availability of Finance, Cost, Land									
(*d*) Predictors: (Constant), Availability of Finance, Cost, Land, Market									

The four evolved regression models for emotional loyalty shown in Table 2 contributed significantly and predicted 47 percent variation by model-1 with perceived value/benefits and total 58.1 percent variation by model-7 with all independent variables. The five emerged regression models indicated

that all independent variables were related to dependent variable (inception of solar plants) with their respective ANOVA values shown in Table 2 were significant (p = 0.000). The coefficient summary for four evolved regression models shown in Table 3 revealed that only four models were the significant (p = 0.000) predictors for inception of solar plants and the firth variable awareness was insignificant (p > 0.000). The β weights are standardised measures of the relative importance of independent variables such as Availability of Finance, cost, land and market were explaining the variation in the dependent variable, supporting an observation of β weights as a measure of relative importance. The positive sign of H1 – H4 beta estimates had shown that the greater the extent of attributes associated with inception of solar plants, the more significant inception of solar plants will be. Therefore, the hypotheses H1-H4 were proved valid and H5 was invalid. The following regression models were emerged from the summary of unstandardized beta coefficients shown in Table 3:

Table 3. Predictor effects and beta estimates for Socio economic factors of farmers on inception of solar plants.

Model		*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*
		B	***Std. Error***	***Beta***		
1.	(Constant)	0.456	0.318	...	1.436	0.152
	Availability of Finance	0.838	0.055	0.686	15.280	0.000
2.	(Constant)	0.354	0.290	...	1.220	0.224
	Availability of Finance	0.602	0.059	0.493	10.137	0.000
	Cost	0.301	0.041	0.358	7.354	0.000
3.	(Constant)	0.305	0.378	...	0.805	0.422
	Availability of Finance	0.563	0.061	0.460	9.286	0.000
	Cost	0.301	0.041	0.357	7.418	0.000
	Land	0.149	0.056	0.113	2.666	0.008
4.	(Constant)	0.639	0.403	...	1.585	0.114
	Availability of Finance	0.496	0.067	0.406	7.407	0.000
	Cost	0.285	0.041	0.339	7.006	0.000
	Land	0.133	0.056	0.101	2.383	0.018
	Market	0.156	0.068	0.115	2.275	0.024

(*a*) Dependent Variable: Inception

$$Y = 0.456 + 0.838\ X_1 \quad (1)$$

$$Y = 0.354 + 0.602X_1 + 0.301\ X_2 \quad (2)$$

$$Y = 0.305 + 0.563X_1 + 0.0.301X_2 + 0.149\ X_3 \quad (3)$$

$$Y = 0.639 + 0.496X_1 + 0.285X_2 + 0.133\ X_3 + 0.156\ X_4 \quad (4)$$

Where, Y = Inception of Solar plants;

X_1 = Availability of Finance;

X_2 = Cost;

X_3 = Land;

X_4 = Market

9. DISCUSSION AND IMPLICATIONS

The respondents of this study considered that availability of financing for establishment of solar plants is easy and they expressed that it is easy to establish with the help of either the government support or through funding agencies support. Here we can conclude that the efforts of both state governments and the central government are becoming effective as the respondents have clear idea that, where do they may get the finance to take up this project. Obviously it is a good sign and symptom for establishing the solar projects. Next to availability, cost of the solar project is the major impacting factor. The analysis revealed that the major chunk of the respondents is clearly known about the information about the cost analysis of the power projects. Thereafter another important factor land has a considerable impact over inception decision of solar plants and farmers are well known that they have to spare some land or they have to use the roof top effectively to generate the solar power. Finally it is also revealed that the farmers are aware about the market and marketing conditions of the solar plants in Andhra Pradesh. However the factor awareness & Acceptability was not significant in this study, it means that governments have to take steps to promote the solar energy, establishment of solar energy plants, their uses and benefits among the public to provide more awareness. So that more number of farmers can turn up to establish more solar plants. Finally, the study contributes to more "generalizable" knowledge by investigating the effect of socio-economic factors on inception of solar plants in Andhra Pradesh.

10. LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

The current study has certain limitations as this study is limited only for solar power plants. This study was conducted only in the region of Tenali mandal and in and around rural area of Guntur city only. Furthermore the sample size of the study is only 265 so that we can't generalize the results for the entire industry. This study focused only on the Socio-Economic factors only.The research can be conducted in the other renewable sectors such as wind, hydro and other aspects also. Moreover the research can be done in the technical factors, policy and regulation issues related to the establishment of solar projects in Andhra Pradesh.

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