ANALYSIS OF PURCHASE BEHAVIOR OF RESIDENTIAL SOLAR ROOF TOP PV ADOPTERS

Kausar Suraiya Quraishi

Research Scholar, Department of Business Administration, Aligarh Muslim University,
Aligarh, India

***Dr. Salma Ahmed PhD**

Professor, Department of Business Administration, Aligarh Muslim University, Aligarh, India

*Corresponding Author

ABSTRACT:

Residential Solar Roof Top PV (RSRTPV) is a nascent technology and though India is a sun kissed land, yet the PV technology has not gained momentum by way of installations of roof tops in the residential sector.

The objective of this study is to get an insight into the purchase behavior of the residential solar roof top adopters in the city of Chennai, South India.

The study is based on primary data which was collected using a questionnaire. This RSRTPV adopter centric research of 105 respondents was conducted in the city of Chennai in South India. A structured, undisguised, questionnaire with 46 preselected questions was adopted after pilot testing. The length of the survey questionnaire was kept optimum with close-ended questions based on Likert scale to elicit quick responses, by the sampled adopters.

The demographic variables of the respondents indicate the green profile of a PV adopter. The study reveals their domestic consumption details like the nature of RSRTPV system, its size, type of installation, roof top area, type of dwelling and the financial option of the consumers etc. reflecting the characteristic status of RSRTPV installations. The study concludes that consumers' experience, purchase behavior, knowledge of technology, its beneficial effects, accessible information on installations and customized financing options are vital inputs for aggressive market development of RSRTPV. The study also concludes that residential solar roof top segment remains the least developed, with its small transaction size, lower tariff and less third-party ownership.

The study identifies the need for consumer awareness to translate into interest in and adoption of RSRTPV. Chennai has 8.69 million population, while it has only 350 MW of roof top solar, which implies that the offtake is poor owing to loans and subsidies, not being attractive to induce adoption. Research points the need for

bringing about local laws mandating solar with net/gross metering regulations/relevant tariff rules for uptake of solar installations.

Key words: Climate change, carbon emission, greenhouse gases, grid, feed in tariff laws.

Cite this Article: Kausar Suraiya Quraishi and Dr. Salma Ahmed, Analysis of Purchase Behavior Of residential Solar Roof Top PV Adopters, International Journal of Management, 10 (5), 2019, pp. 28–37.

<http://iaeme.com/Home/issue/IJM?Volume=10&Issue=5>

1. INTRODUCTION

India's geographical location gives it ample sunlight nearly 300 hours per day and around 5000 trillion kWh per year energy with most parts of India receiving 4-7 kWh per sq. per day. Hence it is not surprising that India launched the ambitious Jawaharlal Nehru National Solar Mission (JNNSM). It calls itself 'Suryaputras', heading the International Solar Alliance (ISA) -a conglomerate of 122 member countries of the world.

It's a laudable effort on the part of the Indian government to raise its presence in the world of solar; ranking second after China in its annual capacity addition, leaving behind all the developed countries of the world and the first movers of solar energy like USA, Germany and Japan. Though the industrial and commercial segments of solar have shown tremendous growth, yet the residential segment is still languishing, as it has not been given the required thrust and support by the Central/State Governments.

Policy and regulatory aspects play a significant role in the evolution of PV markets. Projections done by NITI Aayog, show that the electricity consumption in residential buildings is expected to increase tenfold in the near future and the residential sector will become the largest consumer of electricity in the country with a 39% share of total electricity consumption. India being a tropical sunshine country, the roof tops on every household can serve as electricity generating units, providing citizens, the opportunity to become prosumers of electricity instead of consumers and helping move towards a clean, green economy.

2. LITERATURE REVIEW

Extensive literature is available on residential solar roof top PV and its contribution in combating climate change, reduction of pollution, greenhouse gases and carbon emissions and on the technical aspects of solar PV development, levelized cost of electricity, net metering challenges, feed in tariff laws, financing options and support policies for solar PV in different countries. The barriers and uncertainties in adopting solar PV and the task of governmental governance in developing solar PV in countries like Germany, Spain, Italy, France, USA, Japan, China, Australia makes interesting reading.

The present study focuses on adopters' purchase behavior hence literature review is focused on the perceptions, behavior, attitudes, norms, socio-economic, cultural and financial factors guiding decision making on purchase of RS RTPV and study of the theories influencing purchase behavior of solar PV adopters.

Rai & Beck., (2016) have studied purchase behavior guided by the Theory of Planned Behavior (TPB) framework. Investigating attitudes, norms, perceived behavior control, (PBC) i.e. behavior of individuals determined by intentions, attitudes, formed from beliefs which are positive and negative consequences of behavior. The subjective norms of behavior, viewed by others are also discussed.

Household level heterogeneity was analyzed by **Rai et al., (2015)** and the study reveals that household level heterogeneity is important for estimating demand. The study concludes that

besides the salient motivational factors, the role of peers also affects the decision to buy RS RTPV.

West et al., (2010) have explained that the perceptions of cultural theory, describing the social rules and norms. It is based on individualistic, hierarchist and egalitarian views viz- responsibility, trust in the government and suggested role of government. Individualistic approach determines a healthy environment with low carbon technology favoring competitive markets; hierarchist approach focuses on the role of institutes and regulatory authorities in determining the need for renewable energy in the near future and how the government needs to play a lead role. The egalitarian approach throws light on social equality which focuses on the urgent need for mass deployment of renewable energy for environmental reasons and the need for equity in renewable energy planning. The technological constraints, over reliance on market-based approach planning systems, pro and anti-environmental attitudes and the factors like governance, technology upgradation, landscape aesthetics, issues of participation, reducing power inequality, awareness building and dissemination of information are factors that can enhance RS RTPV adoption. They have also discussed on the continuing public antipathy towards renewable energy- NIMBY-Not in my backyard, narrow self-interest which focuses on local issues.

A study was undertaken in in the city of Texas (USA) **by Stigka et al., (2013)** with the objective of determining the profile of a green energy consumer. The study concludes that a green consumer is educated, affluent, over 55 years of age, a member of environmental agency and willing to support environmentally friendly energy policies.

Stigka et al., (2013) and Karytsas & Theodoropoulou, (2014) have pointed out that Green energy has lower social costs, ensures sustainable development and is penetrating into the energy mix. The study also reveals that the willingness to pay (WTP) is dependent upon the disposable income and the economic contribution a person is willing to offer to maintain environmental good. The correlation of key socio-economic and demographic characteristics of households, namely, gender, age, educational level, household members employed, membership of environmental organization with willingness to pay, all this will help in the social acceptance of renewable energy-

Behavioral factors, location factors, peer effects and spark events can all help in promoting renewable energy. **(Rai et al., (2015))** Their study concludes that advertisements through print media, radio and TV, online social media, door to door campaigns, direct marketing of solar, cut in electricity rates, seeing neighbours install PV and engaging in conversations with neighbours who have installed PV helps in the promotion and uptake of PV.

S. Wee, (2016) in his research work throws light on the fact that perceptions towards renewable energy systems are measured in terms of convenience, comfort to society and contribution to economy with proper sales and service to consumers. A study conducted in Hawaii, which has the highest number of PV installations per capita nationwide, reveals that PV is considered as home improvement. Installation of PVs also reflect an increase of home sales prices nearly by 5.4%, The value of PV exceeds total average installed costs as electricity circuits have reached legal limits for PV installations, so that technically additional PV capacity cannot be installed.

Hossain et al., (2015) explain the importance of motivational awareness which needs to be developed by policy makers to make this new technology more acceptable.

Higher degree of public participation in local energy planning and socio- demographic characteristics are primarily responsible for installing PV in homes. **(Rogers et al., (2008))** PV installation, as per the study, is considered as landlord's responsibility with, tenants not having to invest on rented property. More reactive than pro-active forms of involvement are expected,

preferred local action and global concern for better public health and future sustainability is also stressed in the study.

Y. Zhao, (2001) has pointed out that small PV kits ranging from 10 kWp to 100 kWp are available in the market in China and that the development of Renewable Energy is the State Energy development strategy with a view to encourage energy saving, energy efficiency and development of renewable energy.

R. Haas et al., (1999) in another prominent study concludes that the motives for investing in PV systems are attributed to environment protection, better alternative to nuclear power and technological interest. The study concludes that the key factors for further dissemination of PV systems are financial incentives, reduction of investment costs, increase in reliability, dissemination of information and enhancement of environmental awareness.

P.P. Singh & S. Singh, (2009) undertook a study with the objective of determining the generation cost of solar electricity. The study suggested financing options like graduated payment loans rather than equated payment loans, the escalation in loan instalment to be kept equal to the estimated inflation rate of grid electricity and also, the loan period to be close to the working life of the PV system.

3. NEED FOR THE STUDY

RSRTPV is the best option to generate electricity, as it has the least greenhouse gas generating option, mitigating the effects of pollution, global warming and climate change. India is a land of sunshine and has the potential of tapping the sun's energy to produce electricity for free. India is the least cost destination for solar and has embarked on its National Solar Mission of installing solar capacity of 100 GW by 2022. It is also heading the International Solar Alliance. Therefore, it is an opportune moment to analyse the purchase behavior of PV adopters with a need for creation of more awareness and uptake of residential solar roof tops. RSRTPV can be encouraged in India with a view to progress towards a clean, green and sustainable energy development option.

4. LIMITATIONS OF THE STUDY

The survey was limited to Chennai region in the State of Tamil Nadu and included early adopters who had installed residential solar PV. Different states have different solar energy policies and thrust towards RSRTPV; hence this locational survey can offer its own limitations.

5. RESEARCH QUESTIONS

- What is the demographic profile of the RSRTPV adopter?
- What are the domestic and socio-economic characteristics of RSRTPV adopters?
- What is the purchase behavior influencing RSRTPV adopters?
- Why do RSRTPV adopters seek self-finance instead of loans?

6. OBJECTIVES FOR THE STUDY

The objective of the study is to analyze the purchase behavior characteristics of adopters of RSRTPV with a view to enhance adoption of PV in Indian homes. These can be broken into sub-hypotheses as:

- The study of demographic profile of a RSRTPV adopter
- The study of domestic and socio-economic characteristics of a RSRTPV adopter.
- The study of purchase behavior influencing RSRTPV adopters.
- The study of self-financing aspect of RSRTPV adopters.

7. RESEARCH METHODOLOGY

The present study aims to understand the general profile of the PV consumer and the purchase behavior characteristics influencing the adopters of Residential Solar Roof Top PV. The survey was carried out in the city of Chennai-Tamil Nadu State. The study was based on primary data which was collected based on a questionnaire.

The research instrument was a questionnaire which was developed by the researcher. It comprised of 46 questions. The questionnaire was administered personally to adopters of RS RTPV. Convenience sampling was employed. The sample size was 105 randomly chosen from a population of adopters of RS RTPV in the Chennai region of the State of Tamil Nadu.

Data collection: A pilot study was conducted with 40 respondents. Those facing the pilot study had difficulty in understanding technical terms. Hence a full glossary of technical terms and their definitions was added as an Annexure for ease of answering the questionnaire. The final instrument was prepared, deleting irrelevant and repetitive questions, rephrasing and making minor modifications to the questionnaire to elicit responses. This was intended to spur the respondent's interest and avoid answering lengthy and uninteresting questions enabling the respondents to complete answering the questionnaire within a brief period of 30-45 minutes.

Data for demographic variables comprised of nominal scale while for other variables ordinal scale was used. The questions framed were close ended, to elicit quick responses (ranging from- 1 to 5 on the Likert Scale -i.e. Strongly Agree, Agree, Neither Agree nor Disagree, Disagree and Strongly Disagree) to help in ease of answering and also to enable easy coding for data analysis and interpretation.

The sources of secondary data were libraries, research articles, renewable energy journals, magazines, periodicals, books on solar energy development, internet, newspapers and electronic media. Websites of IREDA, TEDA, MNRE, SECI and NISE.

8. ANALYSIS AND INTERPRETATION

Table1- Adopters' demographic characteristics

Demographic Segment of Respondents	Total No. of Respondents	Classification	Frequency	Percentage
Age	105	41-50 years	37	35.2
		51-60 years	68	64.8
Gender	105	Male	94	89.5
		Female	11	10.5
Marital Status	105	Unmarried	0	0
		Married	105	100
Educational Level	105	Diploma	6	5.7
		Graduate	99	94.3
		Post graduate	0	0
Annual Income	105	Rs 2.5 to 5 lakhs	102	97.1
		Rs 5 to 10 lakhs	3	2.9

Table 1 shows the demographic characteristics of respondents such as age, gender, marital status, educational level and annual income range.

8.1. Analysis with respect to Research objectives

i. The study of demographic profile of a RS RTPV adopter

64.8% of the respondents were in the age group 51-60 years, while 35.2% were in the age group 41-50 years.

Majority 89.5% were males, while only 10.5% of the respondents were females.

All the respondents were married.

Majority of the respondents-94.3% had education up to graduation level.

Majority of the respondents-97.1% had annual income ranging from Rs 2.5 lakhs to Rs 5 lakhs

From the survey findings, the demographic characteristics of the green profile respondent consumer is seen as a male, in the age group 41-60 years, married, educated up to graduate level, affluent, with home ownership status and an annual income of Rs 2.5 lakhs to 5 lakhs. Survey shows that the adoption of RS RTPV is seen as a pre-retirement option and as a stable management plan to reduce electricity bills, necessarily after acquisition of house property.

Table 2-Adopters' socio-economic characteristics:

RS RTPV segment	Total No. Of Respondents	Classification	Frequency	Percentage
Type of Residence	105	Own	103	98.1
		Rented	2	1.9
		Leased	0	0
No. of family members	105	4 to 6	95	90.3
		7 to 8	10	9.5
		Above 9	0	0
Type of Residential unit	105	Villa	2	1.9
		Apartment	3	2.9
		Street house	100	95.2
Type of RS RTPV system	105	On- grid	104	99
		Off-grid	1	1
RS RTPV size	105	1Kw	105	100

RSRTPV area	105	40 sq. ft 100 sq. ft	1 104	1 99
Grid connectivity	105	Yes No	104 1	99 1

Table 2 shows the adopters' residential type, unit, and number of family members, RSRTPV system, and type, size, and area and grid connectivity.

ii. The study of domestic and socio-economic characteristics of a RSRTPV adopter.

Majority of the respondents 98.1%, have home ownership status which provides ample enthusiasm and motivation to invest in PV thereby appreciating home market value. It is evident that people do not feel it is their incumbent responsibility as tenants to invest on their landlord's property. Hence home ownership status was evidently a precursor to adoption of PV as owners wanted to invest on PV to appreciate their home market value, and save on electricity bills. 95% of the survey respondents had a family size of 4 to 6 members.

Majority 95.2% of the survey respondents lived in street houses, while those in villas and apartments were 1.9% and 2.9% respectively. Data reveals that people living in villas and apartments should be sufficiently motivated for adoption of PV.

Majority of the respondents have gone in for on-grid RSRTPV, Chennai being a metropolitan city with good and stable grid connectivity.

100% of the respondents, have preferred adoption of 1kW system size on 100 sq. ft roof area- indicating the optimum demand size for PV installations.

These parameters can serve as useful and vital inputs for estimating and maintaining market demand and supply equilibrium.

Table 3-Adopters' purchase behavior characteristics

Influencing Purchase decision pf RSRTPV adopters	Total No. of Respondents	Classification	Frequency	Percentage
Awareness through medium of advertisements	105	Newspapers /Print Media	23	21.9
		Radio/Television	16	15.2
		Internet	57	54.3
		Building Contractor/Architect	7	6.7
		Others	0	0
Awareness of Government subsidy	105	Yes	102	97.1
		No	3	2.9

Availed Government subsidy	105	Yes No	43 62	41 59
Availed mode of finance	105	Cash purchase Bank loan	104 1	99 1

Table3 shows the purchase behavior characteristics that determine the decision making in adoption of RS RTPV -awareness through the various media of advertisements, government subsidy awareness, availing of government subsidy and the mode of financing adopted in the purchase and installation of RS RTPV system.

iii. The study of purchase behavior influencing RS RTPV adopters.

54.3% of the respondents' purchase behavior is influenced by information and advertisements accessed through the internet search engines like Google, yahoo etc. Indicating that literacy enabled the adopters from search to final procurement and installation of PV.

Survey results show that only 15.2% of the respondents were influenced by advertisements on the social media like TV and radio. More advertisements and knowledge dissemination and education programs on the beneficial aspects and awareness of PV technology can create an impact on the users of radio and TV and enhance RS RTPV adoption.

Newspapers and other print media like journals and magazines have created only 21.9% impact on influencing adoption of RS RTPV. Solar agencies/developers/vendors need to place advertisements in daily newspapers and magazines for easy access, acceptance and adoption of PV by even the middle-class households

It is seen that only 6.7% of the survey respondents are influenced by builders/ architects, indicating that not much effort is evinced by the Central/State Energy Development authorities in formulating laws incentivizing the contractors/builders to promote PV while making new home constructions/renovations.

Though 97.1% of the respondents were aware of government subsidy scheme (Central Government Assistance, of 40% subsidy disbursed by MNRE based on the benchmark cost of PV), yet only 41% of the respondents availed subsidy. This indicates that there seems to be a lacuna in the system of effective disbursement of subsidy, reaching the end user. This can be due to respondents 'non-preferment of claim or not being aware of the procedural formalities or more so due to delay in the disbursement of subsidy claims by MNRE through local energy development authorities/state renewable energy departments.

Necessary steps will have to be taken by the government and solar vendors/agencies/developers to process claims of end users speedily.

Mandatory laws will have to be necessarily formulated to ensure that a proper machinery is put in place to incentivize the adopters and to ensure that the government subsidy reaches the rightful end user.

iv. The study of self-financing aspect of RS RTPV adopters.

Majority of the respondents 99% have resorted to self-financing, as PSU banks are allowing the cost of solar PV system as part of house construction cost or as home improvement loan. These loans have long drawn out EMIs running into long pay back periods and adopters having to offer huge collateral for these loans which often proves counterproductive and disproportionate to the loan amount. The rates of interest offered are on the higher side 9.3 % (PNB) to 16 % (IDBI). Loans up to Rs 10 lakhs are available for residential solar PV installations from

nationalized banks under Priority Sector Lending. Housing cum Solar loan, above Rs7.5 lakhs @8.6% rate of interest is available under retail lending scheme, offered by Canara Bank. Solar companies are partnering with IDBI to offer solar energy loans as part of home loan. Small solar loans have the potential to boost the residential segment if they are not cumbersome and have attractive rates of interest. An inclusive, rethought out, well designed direct loan scheme for RS RTPV installations is yet to become popular. Government has to focus on the residential sector by way of ease of finance through public sector and private financing. The aspect of crowd funding for RS RTPV can also be explored to make customized financing in India, a practical option.

9. IMPLICATIONS OF THE STUDY

- With the increasing demand for energy, RS RTPV is considered a viable energy option obviating the dependence on fossil fuels.
- It can benefit the market players by suggesting the right size of PV systems, discerning the owners' demand and the purchase behavior characteristics, provided from the study.
- It can create more awareness of PV technology among non-adopters, suggesting viable channels for popularizing knowledge and education of PV, highlighting beneficial aspects of this technology, thereby spurring RS RTPV growth.
- Loans for initial investment in solar PV systems with quick pay back periods, easy finance options and EMIs can encourage more Indians adopting RS RTPV.
- It can help foster similar research in other states as well, which will provide different inputs for market players owing to different solar energy policies impacting different states of India (energy being a state subject).

10. CONCLUSION

Due to climate change, the rise in energy demand and the issues of energy security, more countries are turning towards solar. PV is expected to play a significant role in energy development due to technological advances and significant decrease in PV manufacturing costs. India is surging ahead of the developed and first mover countries by adding solar capacity at the fastest rate since 2018. India is expected to become one of the largest solar markets overtaking China, USA and Japan. It has the fastest developing potential of solar power in the world and is the lowest cost producer of solar energy.

With Feed in Tariffs, Renewal Energy Certificates, Tax incentives, subsidies, economic encouragement, technical research and development, industrialized support and PV model projects, India can bring about speedy adoption of Residential Solar Roof Tops.

There has to be a proper mechanism for providing domestic manufacture of solar PV cells and modules. Though the domestic content requirement imposed by WTO delayed the vigorous implementation of 'Make in India', yet the initiative to boost domestic manufacturing in the solar segment has begun, as India has already set out around \$ 3 billion for developing the country's solar panel manufacturing industry.

All new capacity additions in future will be based on renewable energy and in a series of draft notifications, the Ministry of Environment, Forests and Climate Change (MoEFCC) has proposed integrating environmental conditions with building permissions granted by local authorities under state specific land laws which can augur well for RS RTPV in the near future.

India has to resolve to overcome some limitations like lack of awareness creation of PV technology, coordination and consistency in policy framework, lack of innovation in regional

policies, inadequate research and development, unhealthy financing and investment systems to increase ushering in of Residential Solar Roof Top PVs in Indian market.

REFERENCES

- [1] A. Chaianong and C. Pharino, "Outlook and challenges for promoting solar photovoltaic rooftops in Thailand," *Renew. Sustain. Energy Rev.*, vol. 48, pp. 356–372, 2015.
- [2] V. Rai and A. L. Beck, "Public perceptions and information gaps in solar energy in Texas," *Environ. Res. Lett.*, vol. 10, no. 7, 2015.
- [3] V. Rai and A. L. Beck, "Environmental Research Letters Public perceptions and information gaps in solar energy in Texas Public perceptions and information gaps in solar energy in Texas," *Environ. Res. Lett.*, vol. 10, 2015.
- [4] P. P. Singh and S. Singh, "Realistic generation cost of solar photovoltaic electricity," *Renew. Y. Zhao*, "Present status and future of photovoltaic in China," *Sol. Energy Mater. Sol. Cells*, vol. 67, no. 1–4, pp. 663–671, 2001.
- [5] Stigka et al., "Social acceptance of RE source-A review of contingent valuation application." 2013.
- [6] A. Hemalatha, Dr. Valsamma Antony and Dr. G. Sivanesan, "A Study of Brand Loyalty on Toilet Soaps Buying Behavior of Female Consumers in Tiruchirappalli", *International Journal of Marketing and Human Resource Management (IJMHRM)*, Volume 5, Issue 5, September – October (2014), pp. 11-21
- [7] Rogers et al., "Public perceptions of opportunity for country based Renewable energy projects", 2008.
- [8] Vijay.R.Kulkarni, "A Study of the Impact of Retail Front Line Sales Personnel Behavior on Customer Buying Experience in Convenience Stores in Organized Retail in India", *International Journal of Advanced Research in Management (IJARM)*, Volume 4, Issue 1, January- April 2013
- [9] Rai et al., "Overcoming barriers and uncertainties in the adoption of Residential Solar Roof Top PV", 2015.
- [10] Dr. Ronald Mani & Mr. Debasis Tripathy, "A Study on Consumer Buying Behavior Towards Two Wheeler Bikes in Context to Indian Market", *International Journal of Advanced Research in Management (IJARM)*, Volume 4, Issue 1, January- April 2013.
- [11] R.Haas, M. Ornetzeder, K. Hametner, A. Wroblewski, and M. Hübner, "Socio-economic aspects of the austrian 200 kwp-photovoltaic-rooftop programme," *Sol. Energy*, vol. 66, no. 3, pp. 183–191, 1999.
- [12] S. Karytsas and H. Theodoropoulou, "Socioeconomic and demographic factors that influence publics' awareness on the different forms of renewable energy sources," *Renew. Energy*, vol. 71, pp. 480–485, 2014.
- [13] M. F. Hossain, S. Hossain, and M. J. Uddin, "Renewable energy: Prospects and trends in Bangladesh," *Renewable and Sustainable Energy Reviews*, vol. 70, pp. 44–49, 2017.
- [14] S. Wee, "The effect of residential solar photovoltaic systems on home value: A case study of Hawaii" *Renew. Energy*, vol. 91, pp. 282–292, 2016.