Solar Residential Rooftop Systems (SRRS) in South Delhi: A Strategic Study with Focus on Potential Consumers' Awareness

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Abstract- Delhi, the capital of India is receiving 89 per cent of its power from thermal power plants. Due to rapid depletion of fossil fuels and environment pollution, government introduced Delhi Solar Energy Policy. The objective of the policy is to shift from thermal to solar power generation through installation of 2GW of solar rooftop systems by FY25. Accordingly, there is potential of producing 49 per cent of solar power through Solar Residential Rooftop Systems (SRRS). For achieving this, there is need of synergy between two major stakeholders i.e. government and potential consumers (owners of residential units). The major provision of the policy is to provide financial subsidies, technical support and generation based incentives to encourage residential roof owners for the installations of SRRS. Still the installations of SRRS are dismally low. Apart from the formulation of policy; the awareness factor plays pivotal role enabling roof owners to take informed quality decision. The main contribution of this research paper is to explore the awareness levels of potential consumers for the SRRS as well as about government subsidies towards SRRS installations. The average awareness score on a scale of 1 to 5 about SRRS has been found significantly low i.e. 1.99. This study revealed that there was no relationship between awareness level and demographic profile of respondents. The awareness of people towards government subsidy has also been found quite low. In view of the research outcomes, there is need to disseminate information (through strategic advocacy) about government incentives and SRRS, among residential owners for achieving the targets of the policy.

Keywords: Solar Energy, Solar Residential Rooftop Systems (SRRS), Consumer Awareness, Renewable Energy, Solar Policy.

Nomenclature

ANOVA	Analysis of Variance	**CFA**	Central Financial Assistance
BRPL	BSES Rajdhani Power Limited	**CPCB**	Central Pollution Control Board
BYPL	BSES Yamuna Power Limited	**DISCOM**	Distribution Company
CAPEX	Capital Expenditure	**EDMC**	East Delhi Municipal Corporation

FIT	Feed-in Tariff	**NAPCC**	National Action Plan on Climate Change
FY	Fiscal Year	**NCT**	National Capital Territory
GBI	Generation Based Incentive	**NDMC**	New Delhi Municipal Council
GW	Gigawatt	**RES**	Renewable Energy Sources
INR	Indian Rupee	**RESCO**	Renewable Energy Service Company
JNNSM	Jawaharlal Nehru National Solar Mission	**RPO**	Renewable Purchase Obligation
kW	Kilowatt	**SDMC**	South Delhi Municipal Corporation
kWh	Kilowatt Hour	**SECI**	Solar Energy Corporation of India Limited
MNRE	Ministry of New and Renewable Energy	**SRRS**	Solar Residential Rooftop Systems
MW	Megawatt	**TPDDL**	Tata Power Delhi Distribution Limited

1. Introduction

Quality and affordable power boosts economy of a country and provides the competitive edge for the industries. It can help to bring down the cost of various goods and services offered to domestic consumers and at the same time encourages rise in exports thus generating more revenue. Education, health facilities, availability of clean drinking water are highly dependent on reliable and affordable power [1].

There are various options for generation of power for addressing the power needs of Delhi such as thermal, hydro, solar, wind and many more. Thermal power generation involves use of coal, gas or diesel as a fuel. There is limited stock of fossil fuels on earth. Moreover, it has been observed that the thermal power causes lot of pollution and environmental degradation. Delhi is facing air pollution during most of the months in a year. The air quality index of the Central Pollution Control Board (CPCB) had touched the score of 487 on a scale of 500 indicating severe levels of pollution. This can raise various health issues and also causes difficulty in breathing. Therefore, there is a need to look for clean and renewable sources of power generation such as hydro, wind, solar etc. [2].

Hydro power plants are based on converting potential energy of water into electrical energy, which requires construction of large dams for the storage of water. They are a threat to ecosystem and wildlife. It requires displacement of people living in nearby areas and requires huge capital investment. The wind turbines used for generation of wind power are very large in size and cause lot of noise. There are very few arid regions in the country which can economically generate wind power. Wind power farms require huge land areas for installation of wind turbines [1].

Solar power can be generated by installation of solar panels thus converting solar energy into electrical energy. This is clean, renewable and noiseless form of power generation. Land is scarce resource in Delhi and setting up of power plants (thermal, wind, hydro etc.) require large chunks of land. Solar rooftop systems also addresses this major bottleneck i.e. scarce land in Delhi as solar power systems can be installed on roofs of residential houses, industries, commercial buildings etc. thus requiring no extra land for the power plant.

Among various renewable forms of power generation, solar rooftop systems are one of the most suitable options for generation of power in Delhi as

- Availability of sun for most part of the year
- No fuel cost
- Proper utilization of rooftop space in Delhi
- Clean source of power generation
- Low gestation period
- Reduction in power bills
- Reduced outages/power cuts leading to enhancement in power availability hours
- Reduction in transmission and distribution losses
- Reduction in power purchased from energy exchanges during the times of peak power requirement.

Delhi offers a huge potential for solar rooftop systems. It is estimated that the Delhi has roof space of 31 sq. km for installations of solar rooftop systems. Therefore governments both central and state are putting lot of reliance for the installation of solar rooftop systems. This roof space could be used for installation of 2,500 MWp of solar rooftop systems, which can generate about 3500 million kWh (units) of electricity a year [3].

As per Delhi Solar Energy Policy the highest potential for these solar rooftop systems lies in the residential sector.

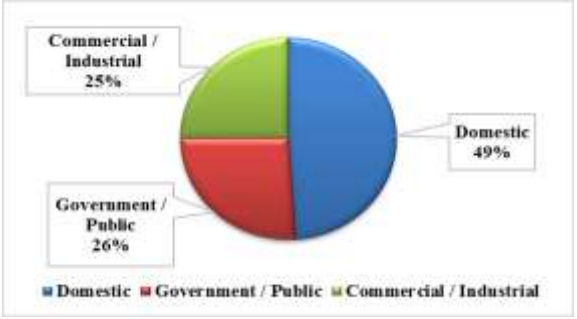

Fig. 1. Solar rooftop systems installation potential [3]

The major chunk of solar rooftop potential 1225 MWp i.e. 49 per cent lies with domestic sector (figure 1). This can be translated into generation of about 3,500 million kWh (units) annually. Government/public sector and commercial/industrial sector have an estimated potential of 26 per cent and 25 per cent towards solar rooftop systems respectively [3].

Administratively Delhi has been trifurcated into North Delhi Municipal Corporation (NDMC), South Delhi Municipal Corporation (SDMC) and East Delhi Municipal Corporation (EDMC) [4]. In this paper the study has been undertaken of the residents of South Delhi (area under South Delhi Municipal Corporation).

There are lot of studies available about the technology, financial implications for Solar Residential Rooftop Systems. Apart from technology, systems and financial implications; resident rooftop owners are one of the major stakeholders for the installations of SRRS in order to achieve goal of 2 GW of installed solar power capacity by FY 25. Therefore, SRRS installations are possible when people have awareness about the SRRS and the government incentives/schemes effectively.

The focus of this study is to find the awareness about SRRS among residents of South Delhi. The research also includes to identify the awareness about subsidies provided by government towards installation of SRRS among residents of South Delhi.

2. Literature Review

India is going to play a crucial role in the energy sector in the world as India has fourth largest electricity generation capacity in the world. Moreover, the demand for power in India is on a rise with increasing population resulting the need for creating additional generation capacity. At this stage, decision regarding adoption of coal or solar power generation for addressing the power needs is going to have a huge impact on the environment and therefore it needs to be revised. Worldwide, cumulative installed solar capacity has increased from 3.7 GW in 2004 to 177 GW in 2014. Jawaharlal Nehru National Solar Mission (JNNSM) was introduced as a part of National Action Plan on Climate Change having target of 20 GW solar power capacity by 2022. Government of India revised target to 100 GW installed solar capacity by 2022 of which 40 GW is to be achieved through solar rooftop systems. Consumer awareness about solar residential rooftop systems and affordability of SRRS are the key challenges that need to be addressed for large-scale deployment of SRRS [5].

There is a lot of unutilized space on commercial, industrial & residential rooftops that can be used for generating solar power to address power needs. There are various benefits and incentives offered by central and many state governments for installation of solar rooftop systems. The cost of setting up of 100 kW solar rooftop system on the rooftop of an educational building works out to be INR 88 lac approx. (without battery backup) and INR 96 lac approx. (with battery backup) [6].

Solar rooftop systems offer a great opportunity for institutions, industries and residential houses using diesel generators, inverters or other power backup units. Solar rooftop systems is one of the key areas the MNRE draft policy document stresses upon. Different state governments have designed respective state policies for solar rooftop systems. The Gujarat solar policy is based on Feed-in Tariff (FIT) whereas some of the southern states are offering upfront capital subsidy for installation of solar rooftop systems. The study revealed that the solar rooftop system can be connected to the local grid supply network and both of them can work in conjunction. The solar rooftop system can supply electricity during day-time and night-time (if solar rooftop system is installed with battery backup) and the power from grid can be used for rest of the period [7].

Ministry of New and Renewable Energy (MNRE), India launched pilot scheme for grid connected solar rooftop systems. The scheme being implemented by solar Energy Corporation of India (SECI). In India, electricity tariffs are based on various categories of consumer namely commercial, industrial, agricultural and residential consumers. Generally the industrial & commercial category of consumers are charged higher tariff in comparison to residential and agricultural consumers who often get subsidized electricity. As the tariff is lower for residential set of customers, achieving grid parity would take a longer time in comparison to industrial and commercial consumers. MNRE is giving Central Financial Assistance for installation of solar power systems [8].

Solar radiation is one of the major factors impacting power generation from solar rooftop systems. A sudden dip or rise in the power generation can impact healthiness of transmission and power infrastructure. Among various technologies available for power generation, solar power generation is becoming more popular because it is environmental friendly and various benefits offered by governments. The battery storage system can help to maintain healthiness of transmission and power systems as there would be regulated and fixed power supply to the grid and household. One of the critical factors to be considered for battery backed solar rooftop system is the capacity of the battery. The capacity of battery should be judiciously selected so that adequate power can be stored and supplied [9].

The solar power generation is dependent upon factors such as solar radiation, module temperature etc. Therefore, there is variation in solar power generation and it can affect electrical grid. The battery storage system can also help to use the stored power during peak demand time resulting in savings to consumer and utility [10].

Solar power generation is set to increase manifolds across the globe. The integration of solar rooftop systems with the main power grid is challenging. There are more issues associated with integrating solar rooftop systems having no inverter backup in comparison to systems having inverter backup [11].

SRRS are required to feed quality power to electric grid. In order to feed quality power to grid, Harmonic resonance

plays significant role. It is dependent on various factors such as nature of load, power control devices, strength of grid etc. Capacitors can help to address the harmonic resonance issue. The capacitor bank requires automation so that it switches depending upon the variation in load. The optimal sizing of capacitor bank is crucial at the time of designing the plant, as it is dependent on type of load connected with the system [12].

The generation of power from solar rooftop systems is highly influenced by weather conditions. Even cloud movement is relevant for forecasting power from solar PV systems [13].

Solar radiation affects the generation from solar power systems. As the radiation varies, there is fluctuation in power generated from solar power systems. To maintain grid stability there is requirement of maintaining stable and steady solar power injection [14].

The sun is the main source of energy and solar power systems use solar radiations to generate electricity. Data mining is required to analyze the metrological data and can help to predict generation from solar PV systems. The predicted generation could help in setting future generation targets and to perform cost benefit analyzes of the solar PV system [15].

Various factors such as environment pollution, depletion of fossil fuels are driving the solar power market. There is a requirement of economic dispatch of power for fulfilling the power needs and at the same time to supply electricity at affordable price [16].

The cost of solar panels is decreasing due to advancement in technology resulting in continuous improvement in efficiency. This has made solar power systems more cost effective. In fact, the generation from existing solar PV systems could maximized through power point tracking [17].

Solar radiation is vital for solar power generation and is only available during day-time. Energy storage systems can be used to store power, which can be used during night-time [18].

Consumer buying behavior is dynamic. People nowadays are looking for environmental friendly products. The respondents are conscious about the environment. People are of the view that there are plenty of natural resources available on earth for our needs, we just need to develop them. Moreover, all living creatures' humans, plants and animals have equal right on environment and existence. People are aware about green products and are ready to buy these green products. People even encourage others to buy such green products [19].

Technology of solar power systems has changed a lot resulting in the increase of efficiency of Solar Residential Rooftop Systems (SRRS). Technology advancement brings revenue when the product is sold to customers. Therefore, along with technological up-gradation, potential customers are required to be motivated. Motivation plays significant role for promoting such products, which is possible through appropriate customer motivation strategies. Customer motivation is a mix of forces that direct people to act for purchasing the product. Motivation is a mental process which influences decision making of an individual/group to act or not to act, when, where, how to act or to act in favor or against product. Depending on the type and intensity of motivation, along with appropriate awareness levels direct potential customers for the purchase of product [20].

3. Objectives

- To identify the awareness about Solar Residential Rooftop Systems (SRRS) among residents of South Delhi (area under South Delhi Municipal Corporation).
- To identify the awareness about subsidy provided by government towards installation of Solar Residential Rooftop Systems (SRRS) among residents of South Delhi (area under South Delhi Municipal Corporation).

4. Research Methodology

The study is based on collection of both primary data and secondary data. The primary data was collected from residents of South Delhi (area under South Delhi Municipal Corporation). Structured questionnaire was prepared for understanding the demographic profile and awareness among the respondents. Selection of samples was based on random sampling. The questionnaire got filled from 129 respondents, out of which 120 were found suitable for the purpose of analysis. Analysed the collected data using SPSS Statistics. The representation and analysis of the collected data has been done using frequency table, percentage table, bar charts etc. ANOVA (at 5 per cent level of significance) has been used for testing of hypothesis i.e. to understand association and non-association between certain variables. Secondary data has been collected from various journals, conference proceedings, industry reports, various government publications, websites and others.

5. Power Scenario in Delhi

Delhi is majorly dependent on thermal power for addressing its power requirements (figure 2). Thermal power (6,899 MW) accounts for major chunk i.e. 89 per cent of the total power capacity for Delhi [21].

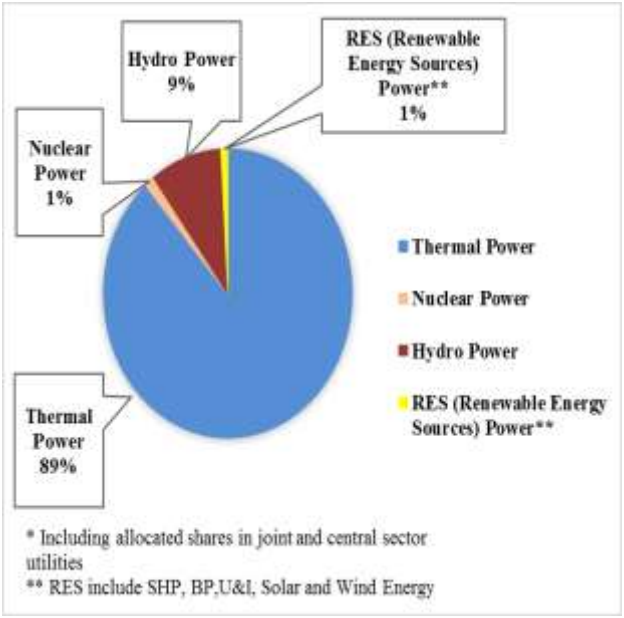

Fig. 2. Delhi's power capacity [21]

RES power (71 MW) which includes small hydro, wind, solar power plants etc. account for just 1 per cent of the total power capacity for Delhi.

Table 1. SRRS installations status [22]

S. No	Discom	Total grid connected SRRS capacity installed (MWp)	No. of SRRS systems installed
1	BYPL	0.04	4
2	BRPL	0.27	28
3	TPDDL	0.02	1
4	NDMC	0.01	1
Total		0.33	34

6. Delhi Solar Energy Policy

Delhi Solar Energy Policy is for the period 2016-2021 and has target of achieving 2 GW solar rooftop installations by FY25. The policy is applicable for solar energy generating system with a capacity of 1 kWp or more. This policy is relevant to all electricity consumers under all electricity tariffs in Delhi and all entities that setup and operate power plants in Delhi. The policy would be monitored on annual basis on actual performance, market conditions and consumer experience. Delhi is blessed with almost 300 sunny days a year [3].

There has been an average rise of 6.9 per cent per year in conventional power tariffs in Delhi. The solar energy tariffs, on an average got declined between 6 - 8 per cent per year. Moreover, there has been a decline of 75 per cent in solar module prices till January, 2018.

As per Delhi Solar Energy Policy, the target for solar power generation for each fiscal year is as follows

Table 2. Delhi's solar rooftop targets fiscal year wise [3]

Fiscal Year	New Solar Energy (MW)	Cumulative Solar Energy (MW)
FY 16	30	35
FY 17	84	119
FY 18	193	312
FY 19	294	606
FY 20	385	991
FY 21	285	1275
FY 22	228	1503
FY 23	187	1690
FY 24	161	1850
FY 25	145	1995

The policy aims at achieving around 1 GW (991 MW) and 2 GW (1995 MW) of cumulative solar energy by FY 20 and FY 25 respectively.

6.1. Objectives of the Delhi Solar Energy Policy

- Reduce Delhi's reliance on conventional energy while increasing its energy security and lowering average energy prices in the long term. Promote rapid growth of rooftop solar power via a combination of generation targets, regulations, mandates and incentives.
- Encourage market-based approaches and public-private partnerships to drive demand and adoption, with minimal use of State Government subsidies. Develop initiatives to raise public awareness of solar energy in Delhi.
- Ensure fairness for all stakeholders in the solar ecosystem, including roof top owners, DISCOMS, investors, consumers of non-solar power, technology and services providers.
- Use regulatory mechanisms to drive demand and adoption, such as mandating solar plant deployments on Government rooftops, requiring in-state solar RPO targets for DISCOMS, modifying building bylaws to facilitate solar plant deployment, specifying responsibilities for the inspection/certification of solar plants, aggregating demand for solar projects, and more.
- Promote net metering/gross metering and grid connectivity for all solar plants by simplifying and streamlining processes and methods.
- Generate employment in the solar energy sector through skill development especially for youth. Establish core technical competence of professionals in the NCT of Delhi to initiate and sustain effective management of solar projects and infrastructure.
- Provide Generation-Based Incentives for the domestic segment where solar power costs are yet to achieve parity for most users, as well as tax exemptions and waivers for all consumers.

- Promote a robust investment climate that enables multiple financial models, from self-owned (CAPEX) to third-party owned (RESCO) models. Also facilitate access to loans at preferential interest rates through various schemes that may be introduced from time to time, whether through public or private channels.

- Establish policy implementation, monitoring and compliance framework to make sure that efficient execution and periodic review of the policy takes place.

- Develop solar energy as part of an overall strategy of providing affordable, reliable, 24X7 Power to all citizens, incorporating demand side management, energy conservation, energy efficiency initiatives, quality assurance and longevity of projects, distributed renewable energy generation, and smart grid development.

Source: [3]

6.2. Generation Based Incentives (GBI)

The state is offering GBI (Generation Based Incentive) for promoting installations of solar rooftop systems for domestic/residential segment only. GBI of INR 2 per kWh (unit) towards the gross solar energy generated is being offered for the period of 3 years from the date of taking effect of Delhi Solar Energy Policy. The GBI may be extended for another 2 years depending upon various factors such as economics of solar energy, solar energy adoption rates in domestic/residential segment. To encourage early adoption of solar rooftop systems among residential/domestic segment, GBI will be paid on first-come-first-served basis until the funds earmarked for GBI run out [3].

GBI also encourages the optimal operations of Solar Residential Rooftop Systems (SRRS). As per the policy, the solar residential rooftop system must generate minimum 1,100 kWh (units) per annum per kWp capacity of the installed SRRS. The upper limit for GBI has been capped at 1,500 kWh (units) per annum per kWp [3].

6.3. Group Net Metering

The policy encourages group net metering in order to promote solar rooftop systems installations. If the electricity generated by solar rooftop system installed at a building (location 1) by a consumer is much more than the electricity consumed by the consumer of that building, the balance energy is fed into the grid. If the same consumer is having another connection (location 2) in the territory of Delhi and has the same DISCOM servicing there (location 2) also, the excess energy fed into the grid by the solar rooftop system installed at (location 1) is offset against the consumption made at another location (location 2) and consumer is billed for the balance units consumed through the grid if any. This group net metering policy encourages consumers with multiple buildings and service connections towards installation of solar rooftop systems [3].

7. Data Analysis and Interpretation

In view of the meagre installations of SRRS as displayed in table 1 and looking into government policy for increasing the contribution of solar energy through SRRS; this study was undertaken to understand the awareness levels of public for both the product (SRRS) and government subsidies through collection of primary and secondary data. The data collected has been analysed and interpreted in the following sections.

7.1. Demographic Profile

There are about 38.3 per cent respondents in the age group of '40 years but less than 55 years' followed by respondents who are in the age group of '55 years and above' and are having a share of 34.2 per cent. Most of the respondents (38.3 per cent) are having education level as 'Graduate'.

Table 3. Demographic profile of respondents

Description		Frequency	Percentage
Age	Less than 25 years	10	8.3
	25 years but less than 40 years	23	19.2
	40 years but less than 55 years	46	38.3
	55 years and above	41	34.2
	Total	**120**	**100.0**
Education Level	School Level	10	8.3
	Graduate	46	38.3
	Professional	32	26.7
	Post-graduate	26	21.7
	Doctorate	6	5.0
	Total	**120**	**100.0**
Occupation Status	Student	4	3.3
	Homemaker (Family Management)	29	24.2
	Service	43	35.8
	Business/Self-employed	37	30.8
	Retired	7	5.8
	Total	**120**	**100.0**
Family Income (Per Annum)	Less than INR 10 lac	21	17.5
	INR 10 lac but less than INR 20 lac	34	28.3

	INR 20 lac but less than INR 30 lac	47	39.2
	INR 30 lac and above	18	15.0
	Total	**120**	**100.0**

The occupation status of majority of people is 'Service' which constitute about 35.8 per cent of the total respondents. A large chunk of respondents (39.2 per cent) are having family income (per annum) of 'INR 20 lac but less than INR 30 lac'.

7.2. Accommodation Details

As per table 4, 53.3 per cent of the total respondents are residing in a rented accommodation.

Table 4. Nature & type of residential accommodation of respondents

Description		Frequency	Percentage
Nature of Residential Accommodation	Rented	64	53.3
	Self-owned	56	46.7
	Total	**120**	**100.0**
Type of Residential Accommodation	Independent House	32	26.7
	Independent Floor	61	50.8
	Apartment (Flat)	27	22.5
	Total	**120**	**100.0**
Roof Rights of Residential Accommodation	Yes	37	30.8
	No	83	69.2
	Total	**120**	**100.0**

'Independent floor' dominated the type of residential accommodation as it accounted for a share of more than 50 per cent. About 69.2 per cent of the respondents are not having roof rights for their residential accommodation.

7.3. Vacant Roof Space

SRRS can be installed on the vacant roofs of around 76.7 per cent of the total respondents (figure 3). Moreover majority of respondents have vacant roof space area of '30 sq. mtr. and more'. This offers a huge potential for installations of SRRS on residential roofs.

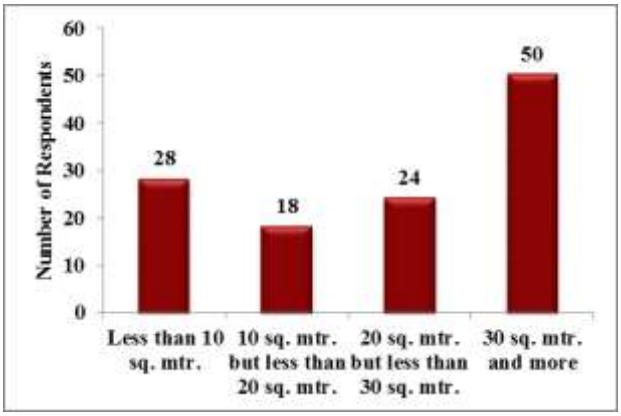

Fig. 3. Vacant roof space - residential accommodation

7.4. Solar Residential Rooftop Systems (SRRS): Installation Status

As per figure 4 there are only 8 per cent of the total respondents, having solar residential rooftop systems installed on their roofs, which is significantly low.

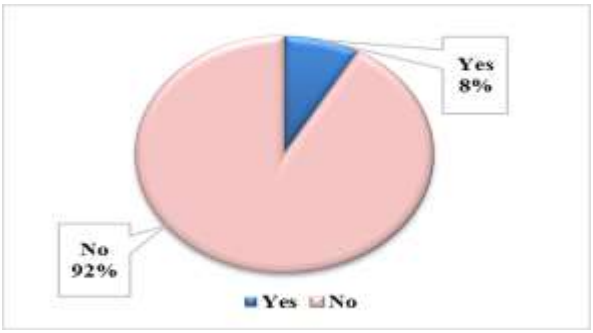

Fig. 4. SRRS installation status

7.5. Awareness about Government Subsidy

The majority of people are not aware about the subsidy, being provided by the government for installation of SRRS (figure 5). 16 per cent of the respondents believe that no subsidy is being provided. In fact, 72 per cent of the respondents acknowledge that they don't know about subsidy being provided by government for installation of SRRS. Just 12 per cent of the respondents are aware about subsidy being provided by government for installation of SRRS.

A large chunk of total respondents are unaware about the provision of subsidy available for the installations of SRRS.

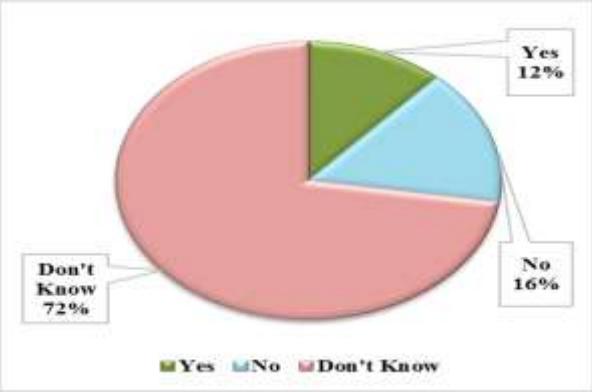

Fig. 5. Awareness about subsidy offered by government towards installation of SRRS

7.6. Awareness about Solar Residential Rooftop Systems (SRRS)

The Cronbach's Alpha for the set of questions designed to find out awareness about solar residential rooftop systems is .897. As per the interpretation of Cronbach's Alpha, the value .897 falls in the category identified as good [23].

Table 5. Cronbach's Alpha

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.897	0.898	5

The average awareness score of 120 respondents about SRRS is 1.99 on a scale ranging from 1 to 5 (1 refers to the lowest degree of awareness score and 5 indicates high degree of awareness).

Table 6. Awareness about SRRS

SRRS Awareness Score		
N	Valid	120
	Missing	0
Mean		1.99
Std. Deviation		0.964
Minimum		1
Maximum		5

7.7. Relationship between Age Group and Awareness about the Product (Solar Residential Rooftop Systems - SRRS)

Null Hypothesis (H0) - There is no significant relationship between age group and awareness about Solar Residential Rooftop Systems (SRRS).

Alternate Hypothesis (H1) - There is significant relationship between age group and awareness about Solar Residential Rooftop Systems (SRRS).

Table 7. ANOVA - Age group and awareness about Solar Residential Rooftop Systems (SRRS)

ANOVA					
Awareness Score					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.699	3	1.9	2.102	0.104
Within Groups	104.813	116	0.904		
Total	110.512	119			

As determined by ANOVA (table 8) at 5 per cent level of significance F (3,116) = 2.102, p = .104.

Hence null hypothesis is accepted i.e. there is no significant relationship between age group and awareness about Solar Residential Rooftop Systems (SRRS).

7.8. Relationship between Education Level and Awareness about the Product (Solar Residential Rooftop Systems - SRRS)

Null Hypothesis (H0) - There is no significant relationship between education level and awareness about Solar Residential Rooftop Systems (SRRS).

Alternate Hypothesis (H1) - There is significant relationship between education level and awareness about Solar Residential Rooftop Systems (SRRS).

Table 8. ANOVA - Education level and awareness about Solar Residential Rooftop Systems (SRRS)

ANOVA					
Awareness Score					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.793	4	0.448	0.474	0.755
Within Groups	108.718	115	0.945		
Total	110.512	119			

As determined by ANOVA (table 10) at 5 per cent level of significance F (4,115) = .474, p = .755.

Hence null hypothesis is accepted i.e. there is no significant relationship between education level and awareness about Solar Residential Rooftop Systems (SRRS).

7.9. Relationship between Occupation Status and Awareness about the Product (Solar Residential Rooftop Systems - SRRS)

Null Hypothesis (H0) - There is no significant relationship between occupation status and awareness about Solar Residential Rooftop Systems (SRRS).

Alternate Hypothesis (H1) - There is significant relationship between occupation status and awareness about Solar Residential Rooftop Systems (SRRS).

Table 9. ANOVA - Occupation status and awareness about Solar Residential Rooftop Systems (SRRS)

ANOVA					
Awareness Score					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.242	4	0.31	0.327	0.860
Within Groups	109.27	115	0.95		
Total	110.512	119			

As determined by ANOVA (table 12) at 5 per cent level of significance F (4,115) = .327, p = .860.

Hence null hypothesis is accepted i.e. there is no significant relationship between occupation status and awareness about Solar Residential Rooftop Systems (SRRS).

7.10. Relationship between Family Income and Awareness about the Product (Solar Residential Rooftop Systems - SRRS)

Null Hypothesis (H0) - There is no significant relationship between family income and awareness about Solar Residential Rooftop Systems (SRRS).

Alternate Hypothesis (H1) - There is significant relationship between family income and awareness about Solar Residential Rooftop Systems (SRRS).

Table 10. ANOVA - Family income and awareness about Solar Residential Rooftop Systems (SRRS)

ANOVA					
Awareness Score					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.248	3	0.416	0.442	0.724
Within Groups	109.264	116	0.942		
Total	110.512	119			

As determined by ANOVA (table 14) at 5 per cent level of significance F (3,116) = .442, p = .724.

Hence null hypothesis is accepted i.e. there is no significant relationship between family income and awareness about Solar Residential Rooftop Systems (SRRS).

8. Conclusion

The findings of the study reveal that awareness of people is significantly low about solar residential rooftop systems. The findings further reveal that the residents with roof ownerships have limited awareness about government subsidies available for getting SRRS installed. It has been observed that only 12% of the respondents are aware about the subsidy provided by government and 72% of the respondents are not aware (don't know) about any subsidy. Interestingly, the awareness is not impacted by demographic profile of the respondents i.e. age group, education level, occupation status & family income.

In spite the fact that there is emphasis of government to pass on financial incentives, technology and consultancy to people for the installations of SRRS; the bridge of awareness which could connect people to government initiatives and spirit of the policy enabling them to make informed decision about SRRS installations on their roofs is invisible.

The lower awareness level of people towards SRRS and government incentives/support found in this study also manifests the extremely lower installations of SRRS in Delhi. The level of awareness factor of potential consumers is one of the critical parameters for achieving the desired SRRS installations as higher the factor, greater is the probability of installations, whereas lower awareness results in lesser installations.

The solar energy policy got introduced in Delhi with lot of benefits and incentives being offered for SRRS installations, but the poor awareness level of people found in this study, makes it imperative to address awareness gaps and challenges for the success of SRRS strategically in order to achieve the pre-determined targets of creating 2 GW capacity by FY 25.

9. Recommendations

It is not only important to design regulations aiming to provide incentives to the potential customers, but it is equally important to communicate the same to the targeted consumers. This will not only encourage more installations but would also help in bringing down the cost of the SRRS as per the concept of economies of scale.

There is need to create awareness among people towards the product (solar residential rooftop systems - SRRS) and also about various incentives provided by government towards installation of SRRS. In view of the research outcomes, there is need to disseminate information (by the strategic use of advocacy) with the optimum mix of communication tools about government incentives and SRRS, among residential roof owners for achieving the desired targets of the policy.

Integrated approach should be employed for promoting SRRS by including the resident welfare associations of the areas concerned. Government and industry should conduct joint regular workshops demonstrating the utility and benefits of SRRS in the community centers of the residential areas.

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