Rajagiri Management Journal
Volume 12, Issue 1, December 2017

Installation of Solar Rooftop: A Viability and an Empirical Study

Dr. Jigna Trivedi[1] & Dr. Bindiya Kunal Soni[2]

Abstract

With conventional energy sources being limited in their availability, the search for alternativerenewable energy sources is inevitable. Solar energy is one of the mostpromising sources of renewable energy (RE). It is widely abundant and producesless greenhouse gas emissions relative to energy sources from fossil fuel.India is both, densely populated and has high solar insolation, providing an ideal combination for solar power generation. This research is an attempt to understand the financial viability in terms of cost savings for solar rooftop system for the residents of Ahmedabad and Gandhinagar city, Gujarat. In addition to that, the willingness and perceptions of the respondents were analysed to shed the light on the potential of adoption for such system. The findings suggested that respondents were willing to install the solar rooftop. The purchase of solar rooftop was backed by at least 40% subsidy. The recovery of investments was at most 3 years. Net present value of the project was also positive.

Keywords: Capital Budgeting, Feasibility, Solar Energy, Solar Rooftop, Subsidy

---

1 Director-I/c, Shri Jairambhai Patel Institute of Business Management and Computer Applications, Nr. Infocity, Koba-Gandhinagar Highway, City: Gandhinagar. Ph : 09979607566 (M), E-mail ID: jigna2804@gmail.com

2 Head of the Department andAssociate Professor, Anand Institute of Management, RamKrishna Seva Mandal, Opp. Town Hall, City: Anand. Ph : 09825039205 (M), E-mail ID: drbindiyasoni@gmail.com

1. Introduction

To address the global challenges of energy security, climate change and sustainable development, it is essential to accelerate the development of advanced clean energy technologies such as solar energy. Solar Photovoltaic (PV)is a key technology optionto realize the shift to a decarbonised energy supply (Sharma, 2011).Being a tropical country, India is endowed with vast solar energy potential having onaverage 300 sunny days in a year (Goel, 2016).According to the Government ofIndia's policy for the solar sector – Jawaharlal Nehru National Solar Mission (JNNSM)[1] – a target of 20 GW of solarinstallations by 2022 has been set (Meena *et al*, 2014). Withthe drastic fall in prices of solar (PV)modules and rising tariffs ofcertain consumer categories in India, grid-connected solar rooftop PV (RTPV)systems are becoming increasingly viableeconomically (Gambhir *et al*, 2012)

In grid interactive rooftop solar PV power systems, the direct current (DC) power generated from solar panel isconverted to alternate current (AC) power using power conditioning unit and is fed to the grid.The generated power during the daytime can be utilized fully by powering the building loads and excess can be fed to the grid as long as grid isavailable.In case, where solar power is not sufficient due to cloud cover or during the cloudy hours, the captiveloads are served by drawing power from the grid.The grid interactive rooftop solar system can work on netmetering basis wherein the beneficiary pays to the utility on net meter reading basis only (Prasanna *et al*, n.d.).In India, principally there are two major business models i.e. CAPEX model and Renewable Energy Service Company (RESCO) model. In the CAPEX model,the entire system is owned by the rooftop owners by making upfront payment. Under the RESCO model, a RESCO developer finances, installs, operates and maintains the rooftop solar power plant. The developer signs an agreement with the rooftop owner. The rooftop owners may consume the electricity generated, for which they have to pay a predefined tariff to RESCO developer on a monthly basis for the tenure of the agreement(Sukh and Mandavilli, 2016).Excess generation may be exported to the grid, subject to availability ofrequisite state regulations.

---

[1] *The Jawaharlal Nehru National Solar Mission was launched on the 11th January, 2010 by our former Prime Minister, Dr. Manmohan Singh. The Mission has set the ambitious target of deploying 20,000 MW of grid connected solar power by 2022 and aims at reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components and products. It has been envisaged to achieve grid tariff parity by 2022.*

There are two different types of metering arrangements that can be used for development of rooftop solar PV projects: gross and net metering. In a gross metering arrangement, the entire energy generated by rooftop solar PV system is fed directly into the electrical grid and the system owner is benefited by feed-in-tariff based on sale of power to the utility. In a net-metering arrangement, the focus is primarily on self-consumption of electricity generation by the consumer. The excess/surplus is either sold to or banked with the local utility. Net metering arrangements, thus, combine elements of captive consumption and exchange of power with the utility (TATA Power, 2014).

In the building sector, solar panels are primarily finding their way on the roofs ofcommercial, government and institutional buildings. With the advent of roof-mounted solar systems, retail electricity consumers are metamorphosing in to a dual role: an electricity consumer as well as a generator.There are only a handfulthat have opted for rooftop solar energy in the cities despite high environmentalawareness and access to technology and support (Chaudhri, 2016). In this context, the study is an attempt to understand the awareness, perceptions and concerns of residents of Ahmedabad and Gandhinagar city for installation of rooftop solar system. Besides, the study also explores the financial viability of the model by comparing the capital cost of this solar system with the cost saving resulting from the use of the system.

Literature Review

The history of solar energy is as old as humankind. Solar technology isn't new. Its history spans from the 7^{th} Century B.C., to today. Solar PV Program of India was conceivedin 1970s in response to the world oil crisis, as one of thelargest national programs in the world. In 2010, Jawaharlal Nehru National Solar Mission(JNNSM) was introduced as part of National Action Plan onClimate Change 2008, giving a target to install 20 GW solarcapacity by 2022. Since then, lots of research has been conducted in Indian context for use of solar energy. However, this section reviews the selected studies in relation to viability of setting up rooftop solar system.

In a conceptual study on residential solar rooftop PV in India, Arora (2013), advocated that considering the increase in demand of electricity in urban areas, residentialrooftop PV shall be economical than the grid supply afterachieving grid parity within three to four years. According to KPMG report (2015), the major disruption that will change the energy landscape may come from the solar rooftop business. As per their forecast, solar rooftop power, supported by net-metering policy and combined with storage, will be cheaper than grid power after 2022, for a large section of consumers. Similar to this report, Gambhi *et al* (2012) also emphasized on national policy of 'net-metering' toencourage in-situ generation primarily for self-consumption since this approach is socially equitable,economically viable and environmentallysustainable. Engelmeier *et al* (2014) also supported the contention of the above studies that a much largeremphasis should be given to the rooftop solar market, as it will providelong-term, organic growth drivers. Goel (2016) examined global growth in solar energy, world's major rooftop installed capacity countries' policies and solar rooftop policy instruments in India. She also discussed currentIndian goals, challenges in achieving them and trends in further development. The study reported that unlike thermal power plants, RTPV generation isconsumer dominated and therefore peoples' participation andacceptance are critical issues for its success.

Shanmugavalli and Vedamuthu (2015) conducted a field study of the energy consumption ofgroup housing schemesin two Chennai and Coimbatore in India.The study revealed that there is enoughrooftop for self-consumption in both the cities. However, theowners are not willing to invest in the RTPV scheme as majority of them were tenants and not owners. Engelmeier *et al* (2013) conducted an in-depth analysis of the potential for rooftop solar in Delhi. According to the report, residential buildings in the city had a solar potential of 1,242 MW, the largest among the commercial and government buildings. As per the study, the viable solar tariff fora residential consumer was Rs. 11.60 /kWh which was 81% higherthan the grid tariff of Rs. 6.4/ kWh and hence not financially viable for the residents. There was one more study for Delhi by Narula and Reddy (2015). They examined the financial viability of solar rooftop for residential consumers based on the current costs and applicable electricity tariff in Delhi, India. As per the findings, with the current costs, smaller systems (2.5 and 5 kWp) were suitable for self-ownership, but require theexisting 30% subsidy in order to be financially viable. However, the return on larger self-owned systems (10 kWp andabove) was sufficiently high and did not warrant the subsidy. On the other hand, third party ownership model was financially not feasible for smaller systems, but returns on larger systems (10 kWp and above) were sufficiently high.

Prasanna *et al* (n.d.)conducted the financial feasibility of 100 KW rooftop solar PV power for an education institute.The findings revealed that installing of 100KW solar PV power system with battery and without battery can be undertaken at an interest rate of 13%.One more study for education institute was conducted by Jha *et al* (2015). They analysed the feasibility of Grid Connected rooftop solar PV setup inBVUCOEP Campus, Pune. It was reported that the institute would be able to save Rs.95,81,250 in five years post installation of solar system.

Graziano and Gillingham (2014) empirically examined the diffusion of residential solar PV systems in Connecticut. They observed clustering of adoptions for such system. Smaller centres contributed to adoption more than larger urban areas. As per the study, the primary determinants of the patterns of diffusion of PV systems were spatial neighbour effects and built environment variables.

Carl (2014) produced a thesis on the potential for solar PV for residential rooftops in the town of Kailua Kona on Hawaii Island. The study estimated energy generation potential for rooftops of approximately 190,000,000 kWh annually, which was 17 % of the total electricity, the utility provided to the entire Island in 2012. A similar study was undertaken by MacDonald (2014) toestimate rooftop solar power potential for the City ofWaterloo. The findings suggested that under best case scenario, approximately 70% of Waterloo North Hydro's average demand could be met through rooftop solar powerinstallations.Chernyakhovskiy (2015) examined the effectiveness of policy incentives to increase residential solar PV capacity in the United States.The findings showed that financial incentives, solarspecific mandates and loan financing programs were important driversof residential PV capacity growth. Result indicated the importance ofenvironmental preference asa predictor of solar PV demand.

Based on the above mentioned studies, it may be observed that many attempts have been made by the researchers to understand the solar energy market at global and Indian level. However, studies based upon primary data addressing the willingness and perceptions of residents for adopting solar rooftop are few and far between. Besides, the researchers could not locate any such studies for Gujarat and specifically for Ahmedabad and Gandhinagar city.As per Vibrant Gujarat-2015: Renewable Energy Sector Profile, Gujarat has the highest solar generation potential in India –300 days of 5.6 to 6.0 kWh/sq.m/day solar radiation. In Gujarat, there is a potential of generating 10,000 MW from 0.1 percent of available wasteland. Gujarat has taken a lead over other states in renewable energy initiatives, particularly in solar power generation. It is the first state in India to achieve Renewable Purchase Obligation (RPO) target.

Government of India declared Gandhinagar as a Model Solar City setting example for Solar Cities throughout India and other nations. Considering this potential of the state and the city, it is believed that the findings of the study will further help the stakeholders in initiating and implementing suitable measures for the growth of solar energy.

Research Objectives

A set of following questions were deliberated at the inception of research. The critical thinking provided the roadmap for the entire research. The research questions provided clarity for setting the objectives.

Table 1: Snapshot on Research Questions, Context and Objectives

Research Questions	Research Context
Which are the renewable sources of energy?	Theoretical
What is the scientific process of electricity generation? Which are the different types of solar equipment available in the market?	Literature Review
Whether people are aware about the benefits of solar equipment in general? Are they aware about solar rooftop? Are they willing to set up a solar rooftop?	Empirical Study
Whether it would be feasible to replace non-renewable source of energy with renewable sources of energy in households?	Case-Let

(Source: Authors' Compilation)

Research Objectives

Based on the research questions, following research objectives were kept as under:

1. To identify the renewable sources of energy.
2. To identify the process of electricity generation and availability of solar equipment.
3. To check out the awareness for usage of solar equipment and solar rooftop for selected households.
4. To evaluate the feasibility of replacing non-renewable sources of energy with renewable sources ofenergy in the households.

Research Methodology

The research methodology is divided into two major parts viz., Empirical work and Case-Let.Firstly, the empirical work tests the awareness of respondents (households) on solar equipment's and solar rooftops. The awareness is studied through a structured questionnaire. The willingness to install solar rooftops on one's households leads to the inquisitiveness on the investments required and the viability for the same. Thus, the second limb of the research is conducted through a case-let. In the case-let the cost of the solar rooftop is taken into consideration and the investment decision is evaluated through various capital budgeting analysis techniques.

Table 2:Outline of Research Methodology

Parameter	Empirical Study	Case-Let
Research Design	Descriptive	Exploratory
Sub-Type of Research Design	Single Cross Sectional	Case-Study
Nature of Study	Qualitative and Quantitative	
Sampling Procedure	Non-Probability	
Sampling Technique	Convenience	Judgemental
Sample Size	200	1
Sample Size Determination	$n = Z^2 * p * q / e^2$, i.e. $(1.96)^2 * (0.5)(0.5) / (0.07)^2$	Expert Opinion
Sampling Duration	January, 2017 to April, 2017	
Sampling Extent	Ahmedabad and Gandhinagar	Not Applicable
Sampling Area	Bapunagar, Calico Textile Mills (CTM), Gomtipur, Sector-1, 23 and 26	Not Applicable
Sampling Unit	Households	Office
Sampling Element	Individual	Government Approved Solar Dealer
Research Approach	Survey	Articulation
Contact Method	Personal Visit	Telephonic Conversation

Research Instrument	Questionnaire	Interview Schedule
Type of Questions	Open- Ended, Close- Ended, Multiple Choice	Open-Ended Numbers Oriented
Type of Scale	Comparative and Non-Comparative	Scenario Development
Scale Measurements	Nominal, Ordinal, Interval, Ratio	Scenario I: Full Solar Power Consumption Scenario II: Partial Self Consumption and Partial Sale ofSolar Power
Theme of Questions	Demographic, Power-Supply, Environmental Awareness, Awareness and Usage of Solar Equipment and Rooftop	Discounting Factor: (A) State Bank of India (SBI)'s Fixed Deposit Interest Rate (B) Interest Rate on SBI's Home LoanAs per the period of survey
Data Collection	Primary and Secondary	Secondary
Sources of Secondary Data	Online and Offline Journals	Leaflets and Broucher
Tools for Secondary Data Collection	Internet and J-Gate	Internet
Data Processing and Management	Excel and SPSS 17	Excel
Data Analysis	Frequency Distribution and Tabulation	Tabulation and Capital Budgeting Techniques
Descriptive Statistics	Mean (X), Median (M), Mode (Z), Standard Deviation (SD), Minimum (Mini.), Maximum (Maxi.) and Range (R)	Basic Mathematical Calculation
Inferential Statistics	ANOVA Test and Fisher's Exact Test	Not Applicable
Tools for Financial Feasibility	Not Applicable	Net Present Value (NPV), Internal Rate of Return (IRR), Modified Internal Rate of Return (MIRR), Pay Back Period (PB), Discounted Payback Period (DPB) and Profitability Index (PI)

(Source: Authors' Compilation)

It is very imperative to note that the capital expenditure incurred in installation of solar rooftop cannot be evaluated on the arbitrary figures, so the engineer approved by Gujarat Energy Development Agency (GEDA), who is authorized to deal in installation of solar rooftop in the households. Thus, the expert advice and guidance of solar engineer was an important support in conceptualization and preparation of the case-let. In fact the practical experience and knowledge of subject domain of the expert assisted in executing the case-let. A direct and face-to-face interaction was done with the expert, even at the time of preparing the questionnaire. Based on the expertise and advice of the engineer the questionnaire was modified three times and once the content validity of the questionnaire was validated by the expert from the layman's perspective, it was used for the survey. Moreover, the questionnaire was translated into Gujarati for better understanding of questions and for appropriate receipt of answers, which eliminated the need for pilot testing.

Hypothesis Testing

Hypothesis is based on specific attributes rated by the respondents in the questionnaire. These set of attributes are tested through a specific statistical test, which is based on the definite rules of test administration.The premise of hypothesis, statement of hypothesis, type of test administered, nature of test and justification of applied test is discussed in Table 3.

Table 3:Construct of Hypothesis

Attributes Used for Hypothesis	Premise	Scale	Null Hypothesis Statement	Test Administered	Nature and Justification of Test
Usage of Solar Equipment	Usage of solar rooftops leads to the environmental and financial benefits.	Strongly Agree (5) to Strongly Disagree (1)	There is no significant difference between the respondents of various locations and their opinion on advantages and	One Way ANOVA	Parametric: As there are more than two groups, significant variance in groups is tested.

			problems of solar equipment on usage		
Education and Installation of Solar Rooftop	Educated people would easily understand the benefit of solar rooftop and will successfully complete the documentation process of availing subsidy.	Dichotomous (Yes=1, No=0) and Nominal (Up to Graduation =1, Above Graduation = 2)	There is no association between education and installation of solar rooftop.	Fisher's Exact Test (2*2 matrix)	Non-Parametric (Avoids the redundancy of Chi-Square Test Condition): To evaluate the effect of education in understanding the benefits of installation of solar rooftop.

(Source: Authors' Compilation)

Data Analysis and Findings

Data analysis is divided into two sections viz., Section-I highlights the Empirical Analysis and Section-II presents the Capital Budgeting Analysis.

Section-I Empirical Analysis

The set of questions framed in the questionnaire can be clubbed under various heads. The section throws light on the following parameters such as demographic, power-supply, environmental awareness, awareness and usage of solar equipment and rooftops.

Power Supply, Average Annual Light Bills and Centralized Power Saver Equipment

A question was probed to the respondent to know the source of power supply. The territory of Torrent Power Ltd. to supply electricity is in major cities like Agra, Ahmedabad, Gandhinagar and Surat.Thus, by default in the survey, it was noted that all the (100%) respondents were customers of Torrent. The secondary sources of information indicated that the power is also distributed by Gujarat Vij Company Ltd- GVCL (created due to unbundling of erstwhile Gujarat

Table 4: Demographic Analysis

Parameters	Observed Statistics	Interpretation
Location	Ahmedabad: Bapunagar (20), CTM (20), Gomtipur (20); Gandhinagar: Sector-23 (20), Sector-1 (20) and Sector-26 (20)	Identical number of 20 samples each were taken from 3 areas of Ahmedabad and 3 areas of Gandhinagar. Quota sampling technique was adopted in the survey, for getting fair result.
Education	Secondary School Certificate-SSC (4%), Higher Secondary School Certificate- HSC (13%), Graduate (38%) and Post-Graduate (46%).	Most of the respondents were post graduate and graduate, which is a fundamental education.Couple of respondents who do not admire studies have failed to attain basic education.
Family Members (Numbers)	X= 4, Z= 4, R= 5, Mini.=2, Maxi.=7	The respondents who were having 7 members in the family represent joint family and up to 4 members represent nuclear families. The energy/electricity consumption directly varies with the number of members in the family.
Monthly Household Income (in Rs.)	Rs.20,000-Rs.30,000 (4%);Rs.30,000-Rs.40,000 (4%);Rs.40,000-Rs.50,000 (58%) and Rs.50,000+ (33%)	Income plays a vital role in decision of installation of solar rooftops. People with higher income would easily install it as funds would not be a constraint for them. People with lower income group would carry out the investments in order to be financially economical. The common motive of both the income-groups would be to save environment and minimize on the regular light-bills.
Type of House	Row House Type Tenement (18%) and Bungalows (83%)	Bungalows and Tenementwere selected so that solar Rooftop can be installed. Row house or tenements and bungalows have the facility of private terrace, which couldbe utilized for installation of rooftops. In flats there is a common terrace, in which such arrangement is difficult, due to non-consensus amongst the members.
Ownership of House	Rented (8%) and Self-Owned (92%)	The decision of installing solar rooftop could be easy if the house is owned and it would be difficult if rented as they have to ask their landlords. The owner of the house has his own veto and flexibility. In a rented house, the transition of solar rooftops is difficult during the house shifting.

(Source: Authors' Compilation)

Electricity Board and it is subsidiary of Gujarat Urja Vikas Nigam Limited) in rural areas of Gujarat. The work of GVCL has been bifurcated according to the zone such as Uttar Gujarat (UGVCL), Madhya Gujarat (MGVCL), Daskhin Gujarat (DGVCL) and Paschim Gujarat (PGVCL).In the qualitative discussion, it was learnt that respondents bore a perception of lower cost per unit of electricity in the case of GVCL when compared to Torrent Power Ltd. The power consumption varies according to the seasons, which leads to difference in the bill-amount.

Table 5:Average Yearly Bill (in Rs.)

Seasons	X	M	Z	SD	Mini.	Maxi
Summer	6017	7000	7000	1776	3000	10000
Non-Summer	2625	3000	3000	725	1500	5000

(Source: SPSS Output)

The electricity bill were high during summer due to 24*7 use of fans and longer hours usage of ACs and coolers in order to safeguard one's self against the scorching heat of summer. During the bitter cold days of winter, heaters and geyserswere used more but not 24*7, as people often sat in sunlight to receive natural heat and vitamins.

All 100% respondents admitted that they had not installed any centralized power saver system in the house. Power savers are a small device, which is to be plugged in any of the Alternate Current (AC) sockets in the house. Power savers works on the principle of surge protection technology. It straightens the unstable electric current to provide smooth and constant output. Power savers are generally used in residential homes to save energy and to reduce electricity bills. Companies claim that power saver saves upto 40% of the energy. It protects the appliances against the sudden rise in power, which may destroy the appliances(Electrical Notes and Articles, 2012).

Specific Features, Types and Usage of Electrical Appliances

A question was asked to the respondents to elicit the response for which type of features do they look at pre-purchase. Power Saving (79%) and Light Emitting Diodes-LED (21%) were the main features targeted by the respondents before its purchase.Power saver device improves the power factor that results in lesser Kilo Volt Ampere Hours (kVAh) (energy supplied by utility) per Kilowatt-hour kWh (energy used by appliances). It does so by reducing the electrical current drawn from the utility(Bijli Bachao, 2016). LEDs are directional light sources, which mean they emit light in a specific direction, so it is considered more efficient. Star ratings are introduced by Bureau of Energy Efficiency-BEE, Ministry of Power. More is the number of star, more efficient is the appliances. Big label is used for refrigerators, air conditioners (ACs), geysers and washing machine. Small labels are used for ceiling fans, tubelights, laptops/computers and television etc. These ratings are taken into consideration as the equipment purchased are going to stay in the house for 8-10 years and cost of using(bills) will continue till the life of the assets(Bijli Bachao, 2016). Every house has electronic gadgets for ease of life. The number of electrical items and the frequency of its usage directly correlate with the power bills.

Table 6: Types and Usage of Electrical Items

Number Counts				**Frequency of Usage**				
Items	**Z**	**Mini.**	**Maxi.**	**Daily**	**Weekly**	**Fortnightly**	**Monthly**	**Total**
TV	1	1	2	100	-	-	-	100
Refrigerator	1	1	1	100	-	-	-	100
Washing Machine	1	-	1	92	-	-	-	92
A.C.	2	-	3	8	-	63	13	84
Microwave	1	-	1	-	19	-	64	83
Electric Motors	1	1	1	100	-	-	-	100
Lights	10	7	15	100	-	-	-	100
Fans	4	1	6	100	-	-	-	100
Computers/Laptops	1	1	3	100	-	-	-	100
Portable Low Speed Food Grinding Machine	1	1	1	6	94	-	-	100
Steam Iron	1	1	2	8	92	-	-	100
Electric Instantaneous Water Heater	-	-	1	3	-	-	9	12
Total				717	205	63	86	**1071**
Percentage (%)				67	19	6	8	**100**

(Source: SPSS Output)

It may be understood that white goods such as TV, refrigerator, lights, fans, iron, computers/laptops are basic necessities now-a-days. Appliances such as washing machines and electric motors are considered facilitator appliances. AC, mirco-wave, grinding machine and water-heaters are luxurious equipment. Number of lights and fans depends on the light-points fixed in a house, considering its areas. More than 1 AC represented either the status of luxury or requirement in a joint family. Water-Heaters were not popular as it was dangerous to use, due to the rod being directly placed in the bucket full of water. Water being the good conductor of electricity leads to electric shock if not handled carefully.

As per table 6, 67% respondents used the primary equipment daily. 19% used them on weekly basis, 6% used them on fortnightly and 8% used on monthly basis. Thus, it may be inferred that basic equipmentswere used on daily basis. In the qualitative discussion, it was noted that some families were very meticulous in fixing schedule of preparing baked dishes, grinding of grains, ironing of clothes only once a week, so the usage of the appliances were accordingly. Handful of respondents admitted that they used AC on daily basis, only at night, during summer.Further, it was noted that usage of AC on fortnightly or monthly basis were either done for just testing purpose during odd season or respondents were found stingy to use it.

Power Cuts Frequency, Duration and Mode of Intimation

There is a high market reputation of Torrent Power Ltd,which symbolizes regularity, for its uninterrupted power supply in the cities. 100% respondents admitted that they face the problem of power-cuts either due to repairs in feeder or maintenance. On elaboration of reply it was very positive to note that 90% respondents explained that power cuts were a rare event and 10% respondents expressed that it happened once in a month. It was learnt from the respondents that longer duration power cuts were made to carry out the major repairs. Rare power cuts just signalled the minor repairs and maintenance in the power lines. The minimum power cut just lasted for 5-10 minutes and maximum for 9 hours. Maximum number of times (Z) the power cut was for 6 hours. The SD with respect to duration of power cuts was 1.74 hours indicating no consensus in the reply of respondents. 71% and 29% respondents respectively conveyed the prior intimation and non-intimation of power-cuts. Torrent Power Ltd, informed all its customers well in advance about the power-cuts. Sometimes the respondents might have either forgotten about the power cuts or failed to view the notice board, because of which the reply was negative. Respective 25% and 46% respondents stated that they were informed prior about the power-cuts through Short-Message-Service (SMS) or through a notice on the Notice Board. Prior notices were given so that it facilitated the residents in planning their schedules. It is mandatory to have prior power cuts notice, so that arrangements of water-storage could be made in advance in skyscraper flats.

Hike in Power Tariffs and its Mitigation

All the 100% households were worried about the constant rise in power tariffs.

A rise in recurring electricity cost would depress the financial budget of the households and it would tighten the purse's string. Respondents were posed to rank the question on ways to mitigate the power tariff hike, with 1 being the highest rank and 5 being the lowest rank. Respondents replied that they would try to fully use appliances which run on renewable sources of energy (Σfiwi= 230, 1st rank); try to minimize the usage of appliances which consumed high power (Σfiwi= 305, 2nd rank); try to partly use appliances which run on renewable sources of energy (Σfiwi= 305, 3rd rank); stop the usage of appliances which consumed high power (Σfiwi= 430, 4th rank) and irrespective of the bill, continue the usage (Σfiwi= 495, 5th rank). In order to combat the rising fuel cost, it is important to switch over to the appliances which run on renewable sources of energy.

Awareness on Environmental Issues

A five- point likert scale question on a continuum of Strongly Agree (5) to Strongly Disagree (1) was asked to the respondents to check their awareness on environmental issues. The statements were jumbled on the theme of global warming, electrical appliances and usage of renewable sources of energy. The gravity of global warming could be tested through awareness on environmental issues. The burning problem of global warming can be addressed by switching over to the renewable sources of energy and growing more number of trees.

Table 7:Awareness on Environmental Issues

Statement	X	SD	Statement	X	SD
Rise in earth's temperature due to global warming	4.88	0.33	More usage of electrical appliances do not increase the atmosphere's heat	1.63	1.12
Equipment in stand-by mode leads to global warming	1.42	0.87	Stoppage of thermal power plants on non-availability of coal	4.71	0.46
Tress cutting do not decrease global warming	4.29	1.06	Rise in heat and cold forces one to buy AC and heaters	4.42	1.12
Carbon-di-oxide plays a major role in global warming	4.38	1.04	Reduction in energy consumption will reduce carbon-di-oxide and mitigate climate change	4.79	0.41
Renewable sources of energy should not be used for electricity generation	4.58	0.87	---	---	---

(Source: SPSS Output)

The mean values above (3) indicate that respondents agreed to the statements and vice-versa. The SD of less than 1 depicted that the respondents were thinking in the similar way and their responses were deliberate to match the societal acceptable response. A SD more than 1 showed that there was no consensus in the response. Conventional electricity not only depletes the resources but it also leads to increase in earth's temperature, due to which people face unbearable heat and sun-strokes.

Awareness on Solar Equipment

On a continuum of five point scale from Never Heard of (1) to Know Very Well (5), the respondents were asked to test their awareness on various solar equipment. Solar equipment not only saves the conventional power, but it also promotes green-environment, as there is noemission of carbon. Awareness on solar equipment will motivate for its usage.

Table 8: Awareness on Various Solar Equipment

Appliances	X	SD	Appliances	X	SD
AC	1.38	0.49	Charger	1.54	0.71
Calculator	1.58	0.87	Cooker	1.58	0.71
Dryer	1.38	0.57	Fan	1.33	0.47
Inverter	1.46	0.71	Lamp	1.33	0.47
Radio	1.42	0.50	Refrigerator	1.42	0.50
Watch	1.42	0.71	---	---	---

(Source: SPSS Output)

It was very surprising to note that awareness of different types of solar equipment wasobserved to be very low among the respondents. It may be inferred that all the values lies between 1 and 2 which means the respondents have either never heard of or heard of only. The SD was less than 1 in all cases, which meant there was a strong consensus in the reply. First step to sell the solar products would be to primarily create the awareness and provide information on its advantages.

Advantages and Problems of Solar Equipment

A five- point likert scale question on a continuum of Strongly Agree (5) to Strongly Disagree (1), was asked to the respondents to assess the pros and cons on usage of solar equipment. Solar equipment's are pocket-friendly and eco-buddy gadgets. As the equipment's run on heat and light of the sun, it invariably changes with the change in season. Sunlight is often interrupted during monsoon and it is less sunny during winter.

Table 9: Advantages and Problems of Solar Equipment

Statement	X	SD	Statement	X	SD
Decreases electricity bills	4.67	0.47	Saves money	4.67	0.47
Saves resources	4.67	0.47	Protects environment	4.71	0.46
Curtails global warming	4.67	0.47	Stores the power	4.63	0.57
Operational difficulty in monsoon	4.50	0.50	Low maintenance cost	4.46	0.50
Bulky equipment occupies more space	4.42	0.50	One time investment with good return	4.42	0.50

(Source: SPSS Output)

As the mean values were greater than or equal to 4 and SD was less than 1, respondents positively admitted the advantages of usage of solar equipment and their reply was also unanimously consistent. Respondents shared the same consensus with respect to the problems of usage of solar equipment.

The opinions of residents (Bapunagar, CTM, Gomtipur, Sector-1, 23 and 26) with respect to advantages and problems on usage of solar equipment were assumed to be similar. The same opinion was tested through ANOVA. H_{01}: There is no significant difference among the respondents of various locations and their opinion on advantages and problems of solar equipment on usage. H_{11}: There is a significant difference among the respondents of various locations and their opinion on advantages and problems of solar equipment on usage. To assess the business potential on fixing solar rooftop in various localities, the opinion of the respondents were tested on the parameters of advantages and problems on usage of solar equipment.

As the Sig. P-value was found to be more than 0.05 in all cases, $H_{01}$was not rejected for all the parameters, i.e. there is no significant difference among the respondents of various locations and their opinion on advantages and problems of solar equipment on usage. It could be inferred that residents of different areas have a common view with respect to the advantages and problems that would occur on the usage of solar equipment.Adoption of a common sales tactics and strategies across different locations, would be treated as best practice for selling the solar products.

Table 10:Statistics for ANOVA Test

Parameters	Mean Square		F	Sig.
	Between Group	Within Group		22
Advantages:				
Decreases electricity bills	0.01	0.23	0.06	0.99>0.05
Saves money	0.01	0.23	0.06	0.99>0.05
Saves resources	0.01	0.23	0.06	0.99>0.05
Protects environment	0.00	0.22	0.04	0.99>0.05
Curtails global warming	0.01	0.23	0.06	0.99>0.05
Stores the power	0.04	0.33	0.11	0.99>0.05
Low maintenance cost	0.05	0.26	0.18	0.97>0.05
One time investment with good return	0.03	0.25	0.13	0.99>0.05
Problems:				
Operational difficulty in monsoon	0.02	0.26	0.08	0.99>0.05
Bulky equipment occupies more space	0.03	0.25	0.13	0.99>0.05

(Source: SPSS Output)

Willingness to Purchase Solar Equipment

A multiple choice question was raised to the respondents on purchase of solar equipment without the support of subsidy. The analysis of positive response showcased that respondents were ready to buy certain solar equipment such as solar charger (16%), solar calculator (14%), solar dryer (10%), solar-powered fan (9%), solar lamp (9%), solar-powered radio (12%), solar powered watch (14%) and solar cooker (16%), without the receipt of governmental subsidy. The costs of such items are not that high, so no subsidy is declared by the government with respect to the purchase of items. It is indeed positive to note that people are ready to buy the equipment without subsidy support.

Awareness on Subsidy Availability and Willingness to Purchase Solar Rooftop

GEDA offers subsidy on installation of residential solar rooftop plant. The subsidy rate is 40-44%. A question was put forth to check the awareness on subsidy availability from GEDA. 83% respondents were aware about the receipt of subsidy from GEDA on the purchase of solar rooftop. It is indeed positive and easy to guide and convince them for installation of solar rooftop. 17% respondents absolutely had no idea on the GEDA's support in purchase of solar rooftop.

88% respondents exhibited their willingness to go for installation of solar rooftop. 12% were adamant to install the solar rooftop. 12% respondent who did not wish to go for solar rooftop installation, in the qualitative discussion highlighted that they did not have faith in solar energy as they were sceptical on the capacity of solar power to electrify the entire house. Respondent also stated that supply would be often disrupted due to unfavourable weather condition and the terrace space gets completely occupied. It may be inferred that people would like to avail the subsidy benefit and support in the noble cause of saving the mother earth from extreme situation of global warming. Subsidies are provided by government to encourage people to switch-over to the non-conventional sources of energy and at the same time it assisted in financial support to buy the costly asset, thereby leading to considerable cost reduction in the purchase price of the equipment. Thus, the marketers would hit a good conversion ratio in the surveyed set of sample of respondents. Overall, it would turn out to be positive considering the sky-rocketing electricity cost and hottest weather conditions.

It is a common assumption that convincing highly qualified people for installation of solar rooftop would be easy than the counterparts. The same notion was tested through Fisher's Exact Test. The education level of Below SSC, HSC and Graduation was clubbed as Upto Graduation. H_{02}: There is no association between education and installation of solar rooftop. H_{12}: There is an association between education and installation of solar rooftop. A cross-tabulation of education and installation of solar rooftop would provide an absolute positive count for installation decision. Respondents who were not ready for installation could be guided and convinced for the installation of solar rooftop.

Table 11: Statistics for Fisher's Exact Test

Education Level	Installation of Solar Rooftop		
	Yes	No	Total
Upto Graduation	57	8	65
Post-Graduation	48	7	55
Total	105	15	120
Fisher's Exact Test (Sig. Value)	0.95>0.05		

(Source: SPSS Output)

As the Sig. P-value (0.95) was found to be greater than 0.05, $H_{02}$was not rejected, i.e. There is no association between education and installation of solar rooftop. As noted earlier, the respondents across different locations shared a common view on the advantages and problems that might accrue on the usage of solar equipment, so it could be understood that the solar rooftop could be targeted to any prospective customer. Adoption of common sales technique would be appropriate tool.

Awareness on Nitty-Gritty of Solar Rooftop Installation

Fixing solar rooftops not only saves money, but it also helps in earning extra notional income provided there is surplus units of power. A multiple choice question was asked to the respondents in order to seek the response on various types of nitty-gritty. Cost, benefit and technical understanding on solar rooftop would help the respondent to take the correct purchase decision.

Table 12:Nitty-Gritty of Solar Rooftop Installation

Technicalities	Specifications	Yes Response (%)
Capacity of residential rooftop solar plants	1 KW	21
Initial Cost of 1 KW Rooftop	Rs.69,000	22
Subsidy Availability (Central + State)	Rs.30,700	20
Electricity Generation from 1 KW	120 Units	20
Excess Solar Power in the grid (Surplus Units)	Is Credited in the next bill amount	17

(Source: SPSS Output)

It may be inferred that awareness on the above mentioned points justifies easy convincing for installation of solar rooftop.

Reasons for Endorsement of Solar Appliances

In an ordinal question the respondents were asked to rank the reason for endorsement of solar appliances, in which, 1 was the highest rank and 4 being the lowest rank. The rank analysis depicted the reasons for endorsement such as Save Earth (Σfiwi= 100, 1st rank), support go-green initiative (Σfiwi= 500, 2nd rank), support make in India move (Σfiwi= 550, 3rd rank) and clean energy campaign (Σfiwi= 600, 4th rank). It is positive to note that respondents were worried about the burning issue of global warming and they were socially supporting in the cause of saving the Earth for future generation.

Expectation of Governmental Support

A multiple choice question was asked to the respondent in order to identify their expectation in terms of support from government. The analysis of positive response depicted that respondents expected subsidy on purchase (73%), subsidy on installation (18%), initiative to create and spread awareness (6%) and supporting free installation (3%). Respondents' primarily insisted on subsidy support from government. Availability of subsidy on purchase is a positive factor to induce the purchase of solar equipment. Subsidy on installation will boost the tempo of purchasing the solar equipment.

Section-II Capital Budgeting Analysis (Viability Study)

In order to check out the financial feasibility of installation of solar rooftop, capital budgeting technique was adopted. One of the government approved Solar Rooftop dealer was contacted to avail the necessary information.As per the discussion with the approved solar rooftop dealer, the cost of the solar rooftop during the study period was Rs.69,000. The subsidy available was Rs.30,700. Thus, net cost of Solar Rooftop was Rs.38,300. Installation charges was assumed to Rs.1,500. Therefore, the cost of Solar Rooftop was considered to be Rs.39,800. In other words, the outflow of Rs.39,800 is necessary for installation of Solar Rooftop. 5% of the total cost was assumed as a salvage value, receivable at the end of 5^{th} year. Thus, Rs.3,450 (5% of Rs.69,000) was treated as salvage value.It was understood that a household would require a minimum space of 110 square feet to install a Solar Rooftop of minimum size of 1 KW. Conventionally, it was understood that 1Kwh represents 1 unit. The matrices of various size of KW solar rooftop and the corresponding capacity of the rooftop to generate solar power were understood from the printed leaflet of the approved dealer. The size of 1 KW Solar Rooftop would generate 1,800 Kwh i.e. units of solar power in a year.Two different scenarios and two different discounting rates were taken into consideration for implementation of capital budgeting technique.

Scenario-I was developed assuming that the entire solar power is used for self-consumption. As per the information documented in the broucher of the approved solar rooftop dealer, it was stated that a savings of Rs.900 per month in conventional light bills would occur, due to usage of solar power. So, the yearly savings will be Rs.10, 800. Thus, a yearly savings of Rs.10, 800 was considered as notional income (cash inflow), which remains constant for all the four years. In the 5^{th} year, a notional income of Rs.10, 800 plus realization of scrap of Rs.3, 450 i.e. Rs. 14,250 was considered as the cash inflow.

Scenario-II was developed assuming that 56% power is used for self-consumption and 44% solar power was either sold or rebate was claimed for the same in the existing bill. In other words, out of the 1,800 units of solar power generated in a year, 56% units i.e. approximately 1,010 units after round-off was self-consumed in a year and rest 790 units were either sold or rebate was claimed in the bill at the commercial rate. From the secondary data,it was understood that on an average monthly 50 units would be the minimum consumption in any house. The researcher has taken the higher side and has assumed the consumption of solar power as 84 units in a month. The commercial rate for sale of surplus units as per slab system is- for first 50 units it is 320 paisa per unit, for next 150 units it is 390 paisa per unit and for remaining units it is 490 paisa per unit. Thus, the sale of surplus 790 units, as per slab system would grossly fetch Rs.5,937.

It was noted that before the advent of Goods and Service Tax (GST), the power generating units were eligible to pay the effective service tax at 10.3%. Thus, from the yearly revenue of Rs.5,937, a service tax amount of Rs.612 was payable.Therefore, yearly revenue net of service tax was Rs.5,325. So, in Scenario-II, the yearly savings Rs.10,800 as calculated in Scenario-I plus the Rs.5,325 i.e. Rs.16,125 was assumed to be the notional income (cash inflow). In the 5^{th} year a notional income of Rs.16,125 plus realization of scrap of Rs.3,450 i.e. Rs. 19,575 was considered as the cash inflow.

In order to evaluate the feasibility of the installation of solar rooftop, a capital budgeting technique was applied.Capital budgeting technique is developed on two premises of discounted cash flow (DCF) method and non-discounted cash flow (NDCF) method to estimate the investment attractiveness opportunity. DCF analysis uses future free cash flow projections and discounts them to arrive at a present value estimate, which is used to evaluate the potential for investment. NDCF does not explicitly consider the time value of money. In other words, DCF adopts conservative approach and NDCF adopts avant-garde approach. Discounting factor or rate of 7% and 8.6% was taken for computation of capital budgeting technique under both the scenarios. 7% is the rate provided on Fixed Deposits (FDs) by SBI for a tenure of 2-10 years. It is assumed that the purchase of solar rooftop was funded through own-funds by discarding the decision of making FDs. SBI's home loan lending rate of 8.6% was taken as a discounting factor, assuming that the purchase of solar rooftop was carried out through,clubbing it under the head of additional expenses eligible for home loan. The rates on FDs and Home loan are in tandem with the duration of research, which may not tally with the current rates. Various discounted method like NPV, BCR, NBCR, IRR, MIRR, DPB and PI were used. Non-discounting method of PB was also applied. Capital budgeting techniques are benchmark rules for testing the financial viability of the project.

Table 13: Conceptual Note on Capital Budgeting Technique

Technique	Description
NPV	NPV of a project is the sum of the present values of all the cash flows positive as well as negative that are expected to occur over the life of the project. NPV is the difference between the present value of cash inflows and the present value of cash outflows.
BCR and NBCR	It shows the proposed relationship between cost and benefits of the project. It summarizes the overall value for money of a project.
IRR	The IRR of a project is the discount rate which makes its NPV equal to zero. It is the discount rate which equates the present value of future cash flows with the initial investment. Based on the trial and error method, various discount rates were tried and tested to equate the NPV to 0.
MIRR	MIRR assumes that project cash flows are reinvested at the cost of capital, whereas the regular IRR assumes that project cash flows are reinvested at the project's own IRR. Since reinvestment at cost of capital (or some other explicit rate) is more realistic than reinvestment at IRR. MIRR reflects better true profitability of a project.
PB and DPB	The payback period is the length of time required to recover the initial cash outlay on the project.Cash flows are converted into their present time values by applying suitable discounting factors and then added to ascertain the period of time required to recover the initial outlay on the project.
PI	PI, also known as profit investment ratio (PIR) and value investment ratio (VIR), is the ratio of payoff to investment of a proposed project.

(Source: Chandra,2011)

Scenarios were developed considering the different types of situation and the different mode of funding the installation. Different type of scenarios helps in evaluating the optimistic and pessimistic approach. The premise for computation and application of capital budgeting technique is as follows:

Table 14:Computational Note on Capital Budgeting Technique

	Scenario-I:100% Self Consumption of Solar Power	**Scenario-II:** PartialSelf Consumption (56%) and Partial Sale (44%) of Solar Power
	Funding: (A) Own Funds @ 7% (B) Borrowed Funds @ 8.6%	**Funding:** (A) Own Funds @ 7% (B) Borrowed Funds @ 8.6%
Year	**Cash Inflow**	**Cash Inflow**
2017	10,800	16125

2018	10,800	16125
2019	10,800	16125
2020	10,800	16125
2021	14,250	19,575
**Note: A Salvage value of Rs.3,450 is included in the last year, under both the scenarios.*		

(Source: Secondary Data)

The mathematical solution on the project evaluation of installation of solar rooftop was computed for both the scenarios. The computed values were compared with the benchmark numbers to evaluate the viability of the installation of solar rooftop. The analysis of various capital budgeting technique is as under:

Table 15:Analysis of Capital Budgeting Techniques

Premise	**Scenario-I: 100% Self Consumption of Solar Power**		**Scenario-II: 56%Self Consumption and 44% Sale of Solar Power**		**Parameter for Acceptance of Project**
	7%	**8.6%**	**7%**	**8.6%**	
NPV	+Rs.6,942	+Rs.4,932	+Rs.28,775	+Rs.25,861	Positive NPV
BCR	1.17	1.12	1.72	1.65	BCR is greater than 1
NBCR	0.17	0.12	0.72	0.65	NPBCR is greater than 0
IRR	13.06%	13.06%	30.52%	30.52%	Greater than Cost of Capital (7% and 8.6%)
MIRR	12.18%	12.18%	21.15%	21.15%	Greater than reinvestment rate of 4%* under both the scenarios
DPB	4 Years, 3Months and 8 Days	4 Years, 5Months and 7 Days	2 Years, 9 Months and 7 Days	2 Years, 10 Months and 8 Days	Period is reasonable to recover the investments
PI	1.44	1.44	2.11	2.11	PI is greater than 1
Non-Discounted Cash Flow Method (NDCF)					
PB	3 Years, 8 Months and 2 Days	3 Years, 8 Months and 2 Days	2 Years, 5 Months and 6 Days	2 Years, 5 Months and 6 Days	Period is reasonable to recover the investments
**Note: It is assumed that if there is any surplus, it will be deposited in the savings bank account, which will fetch interest at rate of 4% p.a. (rates as prescribed by SBI).*					

(Source: Computation from Secondary Data)

Conclusion

The surveyed respondents had their private terraces and sufficient income to execute the installation of solar rooftop. All the respondents used the electricity of Torrent Power Ltd, which is known for its uninterrupted power supply. They had not installed any centralized power saver system, which is capable of saving 40% of energy. Respondents preferred Power Saving and LED equipment. All the respondents were worried about the rise in power tariffs and global warming. In order to mitigate the skyrocketing power tariffs, they showed their willingness to switch over to appliances which run on the renewable sources of energy. Respondents strongly advocated the use of solar equipment on account of its favourable benefits like decrease in light bills, saving of money and resources, curtailing of global warming etc. Majority of the respondents were positive on the decision to install solar rooftop, with the due support of subsidy from government. Couple of respondents were sceptical to install solar rooftop, as they doubted the capacity of solar power to electrify the entire house, problems of power generation during monsoon and the complete occupancy of the terrace space.The financial viability of installation of solar rooftop was carried out by matching the notional cash inflow on account of savings in light bills, in case of 100% self-consumption or 56% self-consumption (and 44% Sale) of solar power, it revealed that the decision was financially viable. The net present value was derived positive, the payback period was at most 3 years and the IRR was at least 13%.

In spite of the economic feasibility of the system, national incentive of capital subsidy and other schemes at the state level; rooftop solar is yet to implemented in the same way as large-scale solar especially in the residential segment. The current non-adoption of solar rooftop among the residents may be due to lack of familiarity with the process,fear of bureaucratic red tape, insufficient knowledge regarding financial incentives, aperception that large upfront capital investment is required and ineffective implementation of net metering in various states.The government authorities should play a more proactive role in encouraging rooftop installations by engaging resident welfare associations and community groups to spread awareness and encourage people to adopt rooftop solar.

References

Arora, P. (2013). Right Time to Reap Benefits from Residential Solar Rooftop PV in India - A Venture of Millions.*International Journal of Scientific and Research Publications.* 3(7).1-

6, Retrieved November6, 2017, fromhttp://www.ijsrp.org/research-paper-0713/ijsrp-p1969.pdf.

Bijli Bachao. (2016, April 22). *BEE Star Rating Program Explained*. Retrieved July 1, 2017, from Bijli Bachao: https://www.bijlibachao.com/general-tips/beestar-rating-program-explained.html.

Bijli Bachao. (2016, April 22). *Power Saver Devices or Capacitor Banks- Do They Really Save Electricity?* Retrieved July 1, 2017, from Bijli Bachao: https://www.bijlibachao.com/general-tips/power-saver-devices-or-capacitor-banks-does-it-really-save-electricity.html.

Carl, C. (2014). Calculating Solar Photovoltaic Potential on Residential Rooftops in Kailua Kona, Hawaii. A Thesis Presented to the Faculty of the USC Graduate School University of Southern California. Retrieved May 11, 2017 from http://spatial.usc.edu/wp-content/uploads/2014/03/CarlCarolineThesis.pdf

Chandra P. (2011). Financial Management. New Delhi: TataMcGraw Hill.

Chaudhri, J. (2016). Residential Solar Rooftop Systems Fail to Shine in India. Renewable Energy. Retrieved May 11, 2017 from https://scroll.in/article/815734/residential-solar-rooftop-systems-fail-to-shine-in-india

Chernyakhovskiy, I. (2015). Solar PV Adoption in the United States: An Empirical Investigation of State Policy Effectiveness. A Thesis Submitted to the Graduate School of the University of Massachusetts Amherst. Retrieved May 11, 2017 from https://pdfs.semanticscholar.org/ed69/4142ec8cc65ebdfb1c32f3ead5f127837027.pdf

Electrical Notes and Articles. (2012, February 9). *Analysis the Truth Behind Household Power Savers*. Retrieved July 1, 2017, from Electrical Notes and Articles: https://electricalnotes.wordpress.com/2012/02/09/analysis-the-truth-behind-household-power-savers/

Engelmeier, T., Anand, M., Khurana, J., Goel, P., Loond, T. (2013). Rooftop Revolution: Unleashing Delhi's Solar Potential. *GREENPEACE India*. Retrieved May 11, 2017 from http://www.greenpeace.org/india/Global/india/report/2013/Rooftop-Revolution.pdf

Engelmeier, T., Rustagi, V., Khurana, J., Goel, P., Chaudri, K., Jain, M. (2013). Beehives or elephants? How should India drive its solar transformation? Report produced by: BRIDGE TO INDIA Energy Private Limited. Retrieved May 11, 2017 from http://www.tatapowersolar.com/bti/Report_Beehives%20or%20elephants_September%202014.pdf

Gambhir, A., Dixit, S., Toro, V., Singh, V. (2012). Solar Rooftop PV in India. Prayas Policy Discussion Paper, Retrieved May 11, 2017 from http://www.prayaspune.org/peg/media/k2/attachments/Solar_Rooftop_PV_in_India.pdf

Ganga Prasanna, M., Mahammed, S., Hemavathi, G. (n.d.). Financial Analysis of Solar Photovoltaic Power plant in India. IOSR Journal of Economics and Finance, 9-15, Retrieved May 11, 2017 from http://www.iosrjournals.org/iosr-jef/papers/ICIMS/Volume-1/2.pdf

Goel, M. (2016). Solar rooftop in India: Policies, challenges and outlook. Green Energy & Environment, 1, 129-137. Retrieved May 11, 2017 from http://ac.els-cdn.com/S2468025716300231/1-s2.0-S2468025716300231-main.pdf?_tid=69ceb71a394c-11e7-8ee400000aacb361&acdnat=1494838781_9b33b6344b0abc729c18f827c189c528

Jha, A., Baba, A., Jagga, S., Sharan, S., Kulkarni, S. (2016). Feasibility Study of Grid Connected Rooftop Solar PV Setup in BVUCOEP Campus. International Journal of Engineering Science and Computing, 6(4). 4811-4813. Retrieved May 11, 2017 from http://ijesc.org/upload/b498567ca9ea1ab780825cf9637dd602.Feasibility%20Study%20of%20Grid%20Connected%20Rooftop%20Solar%20PV%20Setup%20in%20BVUCOEP%20Campus.pdf

KPMG (2015). The Rising Sun: Disruption on the Horizon. Retrieved May 11, 2017 from https://home.kpmg.com/content/dam/kpmg/pdf/2015/11/rising-sun-disruption-horizon-ENRich-2015.pdf

MacDonald, S. (2014). Quantifying Rooftop Solar Power for the City of Waterloo, Ontario. A thesis presented to Wilfrid Laurier University. Retrieved May 11, 2017 from http://scholars.wlu.ca/cgi/viewcontent.cgi?article=2740&context=etd

Meena, R., Rathore, J., Johri, S. (2014). Grid Connected Rooftop Solar Power Generation: A Review. International Journal of Engineering Development and Research. 3(1). 325-330. Retrieved May 11, 2017 from https://www.ijedr.org/papers/IJEDR1501059.pdf

Narula, K., Reddy, B. (2015). Will Net Metering Model for Residential Rooftop Solar PV Projects Work in Delhi? A Financial Analysis. International Journal of Renewable Energy Research. 5(2). 341-353. Retrieved May 11, 2017 from http://www.ijrer.org/ijrer/index.php/ijrer/article/viewFile/1970/6586

Shanmugavalli, K., Vedamuthu, R. (2015). Viability of Solar Rooftop Photovoltaic Systems in Grouphousing Schemes. *Current Science*, 108 (6), 1080-1085. Retrieved May 11, 2017 from http://www.currentscience.ac.in/Volumes/108/06/1080.pdf

Sharma, D. (2011). PerformanceofSolar Power Plants inIndia. Report Central Electricity Regulatory Commission. Retrieved May 10, 2017 from http://www.cercind.gov.in/2011/Whats-New/PERFORMANCE%20OF%20SOLAR%20POWER%20PLANTS.pdf

Sukh, N., Mandavilli, R. (2016). Financing the Solar Photovoltaic (PV) Rooftop Revolution in India. Working Paper. Retrieved May 11, 2017 from http://www.yesinstitute.in/Compendium/Working%20Paper%20-%20Financing%20Solar%20Photovoltaic%20Rooftop%20Revolution%20in%20India.pdf

TATA Power DDL. (2014). Rooftop solar Metering in India. Retrieved May 11, 2017 from http://www.peda.gov.in/main/pdf/Mr%20Ramkrishna%20net%20metering%20in%20india%20CII.pdf