ADOPTION AND UTILISATION OF DOMESTIC SOLAR ENERGY DEVICES IN SELECTED HOUSEHOLDS IN COIMBATORE CITY

Thesis Submitted in Partial Fulfillment of the Degree of

Master of Philosophy (M.Phil)

by

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DECLARATION

I hereby declare that the Dissertation entitled "Adoption and Utilisation of Domestic Solar Energy Devices in Selected Households in Coimbatore City" submitted to Avinashilingam Institute for Home Science and Higher Education for Women for the degree of Master of Philosophy (M.Phil) is a record of research work done by me during the period August 2016 to July 2017 under the guidance of Dr.K.T.Geetha, Professor and Head, Department of Economics, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore and has not formed the basis for the award of any Degree/ Diploma/ Associate Ship/ Fellowship or in this university or any other university or other similar institutions of higher learning.

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Signature of the Supervisor

CERTIFICATE

I hereby declare that the Dissertation entitled "Adoption and Utilisation of Domestic Solar Energy Devices in Selected Households in Coimbatore City" submitted to Avinashilingam Institute for Home Science and Higher Education for Women for the degree of Master of Philosophy (M.Phil) by Rahamath Nisha.A is the record of original research work carried out by her during the period August 2016 to July 2017 under my guidance and supervision and that this work has not formed the basis for the award of any Degree/ Diploma/ Associate Ship/ Fellowship or other titles in this university or any other university or other similar institutions of higher learning.

Signature of the Supervisor

Signature of the Head of the Department

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CHAPTER I
INTRODUCTION

Energy is arguably an important element in the development process. It has been argued that without energy, it is almost impossible to attain sustainable development. Energy is the prime mover of economic growth and is vital to sustaining a modern economy and society. Energy has been recognized as one of the most pertinent contributors of economic growth and human development universally. There is a strong two-way relationship between economic development and energy consumption. On one hand, the growth of an economy hinges on the availability of cost-effective and environmentally benign energy sources, and on the other hand, the level of economic development relies on the energy demand. Future economic growth therefore significantly depends on the long-term availability of affordable, accessible and secure sources of energy. "Since access to modern energy lies at the heart of human development, it is evident that in order to meet the MDGs (Millennium Development Goals), substantial improvements are needed in the type of energy services that the poor have access to" (GNESD, 2007). The WHO and UNDP, asserts that the Millennium Development Goals (MDGs) can be attained if energy issue is well addressed in terms of the quantity and quality. It provides that "the global target date for achieving the Millennium Development Goals is only 6 years away. While there is no MDG on energy, the global aspirations embodied in the goals will not become a reality without massive increases in the quantity and quality of energy services" (WHO and UNDP, 2009).

Energy is surely an important aspect of socio-economic development that touches almost every sphere of human life, and an essential requirement for human development. Improved household energy technologies for the very poor can prevent almost 2 million deaths a year attributed to indoor air pollution from solid fuel use (WHO and UNDP, 2009). The argument that energy is essential for human development and livelihood transformation is also given by FAO, (2000) which see energy as a catalyst which can spur peoples' livelihood transformation in the sense that it improves different socio-economic activities at household level such as agriculture, health care and education. The fact that expanded provision and use of energy services strongly associated with economic development reveals how important energy is and an essential factor in socio-economic development. It is believed therefore that modern standard of welfare, education and health cannot be maintained without sufficient energy (Baston et al, 2013). Tarujyot (2012) stresses modern energy not only as important, but a basic human need in the same category of water and food for development of societies. He provides this by looking at rural electrification. A number of recent studies provide insight into how rural electrification helps in the betterment of rural society in various ways" (Tarujyot, 2012). The same argument is stressed by the ESMAP (2002) report which views modern energy as important as the likes of education, health, and water. The Tanzania Energy Policy (TEP) sees and recognises energy as important for development and an element which can determine either success or failure of any society depending on the status of availability and quality (MWEM, 1992). Manas and Satyabrat (2013) perceive energy to be a driving force to foster economic, social and health conditions and that it affects all the dimensions and support pillars of sustainability.

Although 80 percent of the world's population lives in the developing countries, their energy consumption amounts to only 40 percent of the world's total energy consumption. The high standards of living in the developed countries are attributable to high-energy consumption levels. In industrialized countries, people use four to five times more than the world average and nine times more than the average for the developing countries inevitable for human life; and a secure and accessible supply of energy is crucial for the sustainability of modern societies (Asif and Muneer, 2007). In the developing world, access to reliable, safe lighting continues to be an issue. About 1.5 billion people worldwide lack access to electricity (IEA, 2009), which severely impedes economic development (Barnes, 2007). Electricity is important for income generating activities, provision of health services, and educational outcomes (through allowing students to study at night). Electricity can also enhance social connectivity through shared experiences such as with television and radio, and for charging of cellular phones (Jacobson, 2007). A large percentage of households throughout Africa, Latin America and Asia have unreliable or no access to an electricity grid, and instead employ kerosene lanterns, candles, or other forms of expensive and dangerous fuels for their lighting needs.

In India, access to energy is a challenge for many households. In rural locations 55 percent of populations have access to electricity, whereas that number is 93 percent for urban populations. Overall, 67 percent of the population has access to electricity. Access to electricity may also be overstated due to biases in the data and frequent power outages (Census, 2011). An estimated 27 percent of the country's power gets lost through theft and technical failure, while blackouts reduce the country's GDP by 15 percent annually. Overall, an estimated 300 million plus people are not connected to the grid in India and demand for power is anticipated to double by 2020 (Kanellos M, 2014).

Today, India can well be identified as an energy guzzler. The demand for power in India is growing exponentially and the scope of growth of this sector is immense. In an effort to meet the demands of a developing nation, the Indian energy sector has witnessed a rapid growth (Ministry of New and Renewable Energy [MNRE], 2011). The electricity consumption per capita in India is just 566 KWh, which is far below most other countries or regions in the world. Electricity consumption in India is expected to rise to around 2280 kWh by 2021-22 and around 4500 kWh by 2031-32 (Garg, 2012). India is heavily dependent on fossil fuels for most of its demand. It is evident by the fact that coal accounts for almost 55 percent of the country's total energy supplies and about 75 percent of the coal in the country is consumed in the power sector. Coal is followed by crude oil and natural gas in terms of usage in the power sector. Continued use of fossil fuels is set to face multiple challenges: depletion of fossil fuel reserves, global warming and other environmental concerns, geopolitical and military conflicts and of late, continued and a significant increase in fuel price. Renewable energy is the solution to the growing energy challenges as they are abundant, inexhaustible and environmentally friendly (Asif and Muneer, 2006).

Accelerating the use of renewable energy is also indispensable if India is to meet its commitments to reduce its carbon intensity. The power sector contributes nearly half of the country's carbon emissions. On an average, every 1GW of additional renewable energy reduces CO_2 emissions by 3.3 million tons a year. Investing in renewable energy would enable India to develop globally competitive industries and technologies that can provide new opportunities for growth and leadership (Sargsyan et al., 2010). As per the Ministry of New and Renewable Energy, India is the fourth largest country with regard to installing power generation capacity in the field of renewable energy. The wind, hydro, biomass and solar are the main renewable energy sources in India. The country has an estimated renewable energy potential of around 85,000 MW from commercially renewable energy, which is around 17 percent of India's total power generation capacity (Abdullah, 2011).

SOLAR POWER IN INDIA

If we try to look at all the renewable energy sources, it is seen that India is among the top five destinations for solar energy development in the world as per Ernst and Young's renewable energy attractiveness index (MNRE, 2011c). Because of its location between the Tropic of Cancer and the Equator, India has an average annual temperature that ranges from 25°C to 27.5 °C. This means that India has a huge solar potential (Meisen, 2006). Most parts of India have 300 - 330 sunny days in a year, which is equivalent to over 5000 trillion kWh per year— more than India's total energy consumption per year. India is expected to have installed solar energy capacity of 20,000 MW by 2022 (MNRE, 2011d). Thus, if we look at the renewable energy potential, solar energy provides a great opportunity for India to have a sustainable energy scenario.

The Rural Electrification Program of 2006 was the first step by the Indian Government in recognizing the importance of solar power. It gave guidelines for the implementation of off-grid solar applications. However, at this early stage, only 33.8MW (as on 14-2-2012) of capacity was installed through this policy. This primarily included solar lanterns, solar pumps, home lighting systems, street lighting systems and solar home systems. In 2007, as a next step, India introduced the Semiconductor Policy to encourage the electronic and IT industries. This included the Silicon and PV manufacturing industry as well. New manufacturers like Titan Energy Systems, Indo Solar Limited and KSK Surya Photovoltaic Venture Private Limited took advantage of the Special Incentive Scheme included in this policy and constructed plants for PV modules. This move helped the manufacturing industry to grow, but a majority of the production was still being exported. There were no PV projects being developed in India at that stage. There was also a need for a policy to incorporate solar power into the grid.

The Generation Based Incentive (GBI) scheme, announced in January 2008 was the first step by the government to promote grid connected solar power plants. The scheme for the first time defined a feed-in tariff (FIT) for solar power (a maximum of Rs. 15/kWh). Since the generation cost of solar power was then still around Rs. 18/kWh, the tariff offered was unviable. Also, under the GBI scheme, a developer could not install more than 5MW of solar power in India, which limited the returns from scale. One of the main drawbacks of the GBI scheme was that it failed to incorporate the state utilities and the government in the project development, leaving problems like land acquisitions and grid availability unaddressed. As a result, despite the GBI scheme, installed capacity in India grew only marginally to 6MW by 2009. In June 2008, the Indian government announced the National Action Plan for Climate Change (NAPCC). A part of that plan was the National Solar Mission (NSM). The NSM guidelines indicated that the government had improved on the shortcomings of the GBI scheme. It aimed to develop a solar industry, which was commercially driven and based on a strong domestic industry. The extra cost of generation of solar power was being borne by the federal government under the GBI scheme.

Solar power has so far played an almost non-existent role in the Indian energy mix. The grid-connected capacity (all PV) in India now stands at 481.48 MW as of 31st January 2012. However, the market is set to grow significantly in the next ten years, driven mainly by rising power demand and prices for fossil fuels, the ambitious National Solar Mission (NSM), various state level initiatives, renewable energy quotas including solar energy quotas for utilities as well as by falling international technology costs.

Encouraging the spread of solar power generation (both CSP and PV) and aiming for grid-parity (currently at around RS.5/kWh) by 2022 and parity with coal power generation (currently at around RS.4/kWh) by 2030, is a key element in India’s comprehensive, long term energy supply strategy. Keeping in view the solar annual insulation, solar power could therefore easily address India’s long-term power requirements. However, it has to be cost-competitive. As of December 2011, solar power generation in India costs around RS.10/kWh, or over 2.5 times as much as power from coal. Importantly, it is crucial that the industry receives the right policy support to ensure that projects are executed and performed up to the mark.

From less than 12 MW in 2009, solar-power generation in the country grew to 190 MW in 2011. By March 2013, it is expected to grow fivefold to 1,000 MW, but the country has a long way to go to reach its goal of increasing solar-power generation to 20 gigawatts by 2020. Across India, there are still thousands of villages with plenty of sun but not enough power. India has a great potential to generate electricity from solar energy and the country is on course to emerge as a solar energy hub. The techno-commercial potential of photovoltaic in India is enormous. With GDP growing in excess of 8 percent, the energy ‘gap’ between supply and demand will only widen. Solar PV is a renewable energy resource capable of bridging this ‘gap’. Most parts of India have 300 – 330 sunny days in a year, which is equivalent to over 5000 trillion kWh per year – more than India’s total energy consumption per year. Average solar incidence stands at a robust 4 – 7 kWh/sq. meter/day. About 66 MW of aggregate capacity is installed for various applications comprising one million industrial PV systems – 80% of which is solar lanterns, home/street lighting systems and solar water pumps, etc. The estimated potential envisaged by the Ministry for the solar PV programme, i.e. solar street/home lighting systems, solar lanterns is 20 MW/sq. Kilometre.

The Jawaharlal Nehru National Solar Mission aims at development and deployment of solar energy technologies in the country to achieve parity with grid power tariff by 2022. The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India’s energy security challenge. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change. The objective of the National Solar Mission is to establish India as a global leader in solar energy, by creating the policy conditions for its diffusion across the country as quickly as possible. The aim would be to protect Government from subsidy exposure in case expected cost reduction does not materialize or is more rapid than expected. The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralized and decentralized level. The main features of the National Solar Mission are:

1. Make India a global leader in solar energy and the mission envisages an installed solar generation capacity of 20,000 MW by 2022, 1, 00,000 MW by 2030 and of 2, 00,000 MW by 2050.
2. The total expected investment required for the 30-year period will run is from Rs. 85,000 crores to Rs. 105,000 crores.
3. Between 2017 and 2020, the target is to achieve tariff parity with conventional grid power and achieve an installed capacity of 20 gigawatts (Gw) by 2020.
4. 4-5GW of installed solar manufacturing capacity by 2017.
5. To deploy 20 million solar lighting systems for rural areas by 2022.

In addition to government support for solar energy, the demand for energy and affordable, reliable lighting in India is high. The off grid energy access market in India includes 114 million households who are at the Base of the Pyramid (BoP) earning less than $2 per day, according to the World Resources Institute (WRI). It is estimated that India’s rural BoP consumers spent INR 224 billion (US$4.86 billion) per year on their energy needs. There is thus a large market opportunity in providing BoP households with access to energy solutions, particularly including cooking and lighting needs. For solar lanterns specifically, the WRI estimates the market to be INR 855 million (US$18.58 million). Of rural households, an estimated 56 percent still rely on kerosene as their primary lighting fuel. Given the potential market, a growing number of companies have targeted BoP households to purchase solar lighting solutions.

SOLAR POWER IN TAMIL NADU

Tamil Nadu is India's sixth most populous state with a population of over 72 million people and has emerged as a major hub for renewable energy over the last decade. Compared with the national average of 12 percent, renewable energy accounts for 44 percent of the power consumption in Tamil Nadu, and of this, 90 percent comes from wind. Tamil Nadu leads in wind power generation in the country with over 7,000 megawatts (MW) and has a wind power season from May to October.

While approximately 300 million still lack access to electricity through India, Tamil Nadu has a relatively reliable electricity supply, which attracts many industries to the state. According to GOI Census data in March of 2015, Tamil Nadu is considered to have 100 percent of its 15,049 villages 'electrified'(Smith, 2015). Census data from 2011, says that 93.4 percent of households use electricity as their primary source of lighting. Despite this high access to electricity, energy access remains intermittent and very unreliable.

The electricity demand-supply gap is an issue as energy demand increases. In 2014 the gap between peak demand and supply was over 8 percent, with an unmet peak demand of more than 1,000 MW. The Tamil Nadu Electricity Board imposes power cut demands and energy quotas for heavy power users. In 2015 the government imposed a 20 percent demand restriction on industrial and commercial electricity users. In peak usage hours, this restriction can be up to 90 percent of demand, resulting in severe shortages that contribute to this unreliable and intermittent energy access challenge (WRI, 2015). In the last several years Tamil Nadu has faced severe power shortages that last from 8 to 10 hours. In rural areas, these power cuts can last 14 hours or more. Issues with electricity connection and power outages are not specific to Tamil Nadu in India. A survey conducted of 1919 households in 240 villages in 16 districts of 8 states of India, revealed trends of electricity connection. The villages which had 20 to 24 hours of supply are in the state of Kerala, Gujarat and Haryana, while those getting less than 12 hours of supply are in the state of Maharashtra, Uttarakhand and Karnataka and villages which were getting less than 8 hours of supply or no supply are in the state of Odisha and Jharkhand.

Despite this market opportunity, a variety of barriers exist in regards to adoption of solar technology in India. Challenges at the micro (consumer) level to adoption of solar products include:

1. User doesn't know about product (awareness)
2. User cannot afford product (affordability)
3. User cannot access microfinance (affordability)
4. User cannot always find product in stores, variable inventory (availability)
5. User lacks confidence in performance, perhaps due to poor past products (acceptability) (Frey,et.al; 2015)

Cost is a critical barrier to adoption in Tamil Nadu that needs be addressed, as prices of solar products remain too expensive for those living in poverty, particularly without financing options. Despite these barriers, as aforementioned, there remains immense opportunity in the solar market. Companies that offer solar products need to understand these challenges, and more, understand their BoP target consumers including their needs, wants, and preferences in regard to these products. In Tamil Nadu specifically, as the kerosene subsidy has been largely removed in towns that are '100 percent electrified', there can be greater market opportunity. This paper seeks to make a contribution to the technology adoption literature by exploring the determinants of such investments, which can include households' socio-economic characteristics, attitudes towards solar devices, households' knowledge about their energy consumption, performance of the technology and the determinants of satisfaction in using the technology.

RESEARCH GAP

Previous studies suggest that households' socioeconomic characteristics play a relevant role in technology adoption. Generally a positive correlation between income and the probability of investing in energy technologies was observed (Long1993; Millsand Schleich 2010; Sardianou and Genoudi 2013). A number of studies underline the importance of dwelling characteristics behind consumer choices. In particular, the ownership of the primary residence is an important driver of technology adoption (Davis, 2010). Attitudes and beliefs may also play a role as a motivation to invest in addition to pure monetary benefits and costs of an investment. Indeed, several studies found that people with strong environmental preferences are more likely to invest in energy conservation technologies (Olli et al 2001, Kollmuss and Agyeman 2002, Di Maria et al 2010). Households' energy use and energy conservation actions can also be shaped by habits, routines and social practices (Shove 2012). Finally, energy prices and a favourable policy context should also affect household technology adoption.

To date, as the literature review highlights energy research has not sought to understand the attitudes of householders to the new solar power technologies either with regard to their attitudes to the technology or their decision making processes when adopting the technology. If the attitude of householders could be understood, this could facilitate the achievement of targets set for the current policy of increasing the use of solar technologies. Further, there is a need to understand the awareness and satisfaction level of the end users, who are the beneficiaries of these renewable (solar) energy projects. The study also envisages understanding the impediments to implementing these initiatives from the perspective of the users and generating a framework for better acceptance and implementation of such programs and policies. The present study focuses on the attitude, satisfaction and impediments associated with solar energy usage from the stakeholders' perspective.

The present study differs from the earlier studies in that

- Not many studies have done to ascertain the consumer's perspective on the use of solar energy devices in Indian context.
- No attempt has been made to compare the perspectives of the adopters with that of non-adopters.
- The present study focuses on both adopters and non- adopters of solar energy to ascertain their level of awareness, utilization, benefits and problems in solar energy usage.

STATEMENT OF PROBLEM

Throughout history, humans have discovered ways to take various energy sources and use them to their advantage. From the simple task of burning wood for heat, to the monstrous amount of power created from nuclear energy, we have been determined to find the most efficient and economical ways to make our lives easier. In the present scenario, the world is dominated by the electrical energy and the electronic devices. The technological improvement in this field is vast and it plays a vital role in day to day lives of people. Solar energy being a renewable energy available in abundance as the natural source sun emits photovoltaic energy in the sun rays. With the invention of solar cells/solar panels used to grasp solar energy and converts into electrical energy for usage, many companies have come into the markets which are now fast growing in the commercial sales of solar energy based devices. In this aspect, it becomes necessary to find what impact this solar energy devices has made on the consumer and the study the customer's attitude towards solar energy devices.

OBJECTIVES

The specific objectives of the study are:

- To explore the profile characteristics of the adopters and non-adopters of solar energy devices.
- To examine the awareness about solar energy device among adopters and non-adopters.
- To analyse the extent of utilization of solar energy devices and the resulting financial savings for the users.
- To assess facilitating and inhibiting factors in the use of solar energy devices at the household level.
- To suggest policy measures for enhancing the use of solar energy at the household level.

HYPOTHESES

- The adoption behaviour of the respondents was independent of the selected socio-demographic, economic and locational factors.
- There were no differences in the amount spend on electricity consumption between adopters and non-adopters.
- Adoption of solar device was closely linked to cost or financial aspects of the system and the knowledge about the technology.
- Monetary gains, relative advantage, reliability and green life style were the major benefits of using solar devices as perceived by the respondents.
- The major issues facing the respondents irrespective of adoption are poor quality of after sales service, high investment cost, technical and infrastructural issues
- Relative advantage, compatibility, complexity and risk are the key factors affecting the level of satisfaction in using solar technology.

The findings and conclusions emerging from the present study will be of immense help to the policymakers and the government to formulate suitable policies and programmes to promote the use of solar technology at the household level and pave the way for ecologically sustainable growth and the achievement of millennium development goals.

CHAPTER II
REVIEW OF LITERATURE

The review of literature for the present study is discussed under the following heads:

I. Significance and Pattern of Energy Consumption

II. Adoption of Solar Energy at the Household Level

III. Problems in Using Solar Energy

IV. Related Studies

I. SIGNIFICANCE OF SOLAR ENERGY

Ravi C. Moorthy (1990) has made a comprehensive study on the aspects of Indian energy scenario and the consumption of various kinds of energy. According to him, modern society is totally energy based and energy resource is a key factor for economic growth and development. The awareness of the growing problems associated with its supply has raised its importance in national planning. In order to maintain the growth of Indian economy and tackle the menace of increasing the cost of liquid fuels and security of biomass, energy conservation is given priority in the national energy strategies.

Sanjay Kaml and Qian Lin (1992) made an attempt to study the rural household energy consumption in China. They found that the energy consumption per household accounted for 700-1200 kgce, 40-60 percent of which was used for cooking; 60-90 percent of the total household energy consumption was in the form of biomass. Data were collected by sample surveys of 540 households of 18 villages in six towns from each country. Relatively low per capita energy consumption was found in Jianyang and Changshu countries (239 and 265 kgce), intermediate values occurred in Kezuo, Hengnan and Huantai countries (405, 421 and 476 kgce), and a high value in Xiushui (823 kgce). It was noticed by the researchers that the per capita energy consumption did not increase as income increased in different areas. It was also reported that Changshu recorded a higher income at lower total energy consumption per capita than Huantai. Commercial energy consumption increased with income while non-commercial energy consumption was not affected by income increase. The investigation in Changshu showed that the correlative coefficient between energy consumption and per capita income was 0.6893; the income elasticity of energy consumption was 0.118, and, the income elasticity of per capita electricity consumption was 0.391.

Joshi (1993) articulates that in India, out of the total consumption of energy, 60 percent was met through commercial sources based on coal, oil, natural gas and hydel and 40 percent through non-commercial sources like firewood, cow dung etc. The share of renewable/non-renewable source of energy was yet to become perceptible. Conservation would mean more efficient use of energy as well as changing one's habits in such a way that one uses less energy. The future strategy for energy should be a flexible and rational one considering available energy sources, conservation, environmental protection and needs of economic growth.

Balamurugan (1993) observes that the energy sources play an important role in the life of the rural people to meet household and economic energy demands. Without this energy saves it was impossible for them to earn their livelihood. Hence energy is an indicator of rural development. Dharmarajan (1993) observe that the rural population suffers most due to the shortage of energy, their main source there being electricity. The rural energy sources could be biogas, solar photo voltaic, agro waste, drought, animal power and wind. Ramasamy and Tamilzh Chelvam (1994) have revealed that energy is considered as an index of economic development of a nation because there was a positive relationship between aggregate economic performance and total commercial energy consumption.

Lakshmi and Karthikeyan (1995) remark that, the consumption of energy has increased enormously and the demand for it has widened. To meet the increasing demand for energy, efforts have been made to improve the existing technology and to develop new devices. In rural India about 80 percent of the energy demand was met from fuel wood, cow dung and other organic matter. This reflects the fact that we are cutting down valuable trees and plants to obtain fuel wood. In most rural areas, besides participation in household activities, women have to provide for the cooking fuel, also. The collection of firewood from the forest is becoming extremely difficult since there is a drastic reduction in the forest cover day by day. They also conclude that awareness of the uses of biogas plants must be created among the people through various means especially through mass media to make the scheme a successful one.

Lalitha Balakrishnan and Meenu Mishra (1996) find that 80 percent of the world's commercial primary energy was supplied by fossil fuel. In 1990, 40 percent of the commercial worldwide energy consumption was provided by oil. However, there was increased awareness of several constraining factors like fuels, quality of their end products, logistics of transportation, long gestation periods and cost over runs of conventional power plants and environmental pollution. Women bear the brunt of 50-80 percent of all agricultural production and are totally responsible on an average for the support of nearly 30 percent of all rural families.

Ibrahim Hafeezur Rehman (2002) found that in India, over 40 percent of the total energy consumption was on account of biomass fuels like fuel wood, crop residue and dung cake. The household sector is the most energy consuming sector accounting for 75 percent of the total energy consumed. At the household level, cooking was the largest energy consuming end use. It accounts for nearly 90 percent of household energy; lighting and space heating consume the rest. In the context of rural energy it is also important to consider the fact that of the 28 states in the country, only 13 have been declared 100 percent electrified.

Lakshmi and Jajamala (2004) observe that, solar energy is a viable substitute for non-renewable sources of energy such as electricity especially for domestic applications such as water heating. This study carried out in Tamilnadu observes that solar water heaters are an efficient means of saving electricity and other fuels. Thus solar water heater is one of the advanced technical innovations, which fulfil the needs of modern women to a large extent. The use of such innovations helps them save time in domestic work and they can get plenty of hot water all the time free of cost. By using renewable energy resources the limited conventional energy resources could be stopped from human destruction to the maximum end. Moreover burning kerosene, wood and charcoal emits smoke that pollutes the environment. Once this innovation is adapted one will be free from pollution forever. Thus the efficient use of solar energy would reduce our dependence on non-renewable sources of energy and make our environment cleaner.

Okafor and Emeka (2008), in their study examined the provision of solar energy in rural area using solar panel. This work attempts to satisfy the desire to meet the energy demand in schools and most rural areas. Net Present Value (NPV) and Internal rate return (IRR) were employed in determining the economic viability of solar panel installation in a rural area for the purpose of providing alternative renewable energy to the rural dwellers. The study was done in Umuazu Village, Nise, Awka, South Anambra State, which had an estimated population of 1000 people and 50 buildings. The result obtained showed that the installation of solar panel in rural area was commercially viable.

Manas and Satyabrata (2013), examined the remote village electrification through renewable solar energy and studied the rural electrification scenario through Photo Voltaic cell systems of Sagar island which was isolated from main land mass of West Bengal state by river Hugli (width of river~3Km). Photovoltaic (PV) put in place by the West Bengal Renewable Energy Development Agency (WBREDA) have clearly brought benefits to many of the residents of Sagar Island. The highly-touted community management system governing the projects had been successful at instilling local pride and overcoming the traditionally thorny problem of no tariff collection. There are ten solar-powered stations which installed in between 1996 to 2006 at different remote sides of the Island. Kamalpur was the village where solar-powered station first installed in 1996 with power generation capacity of 26 (kW). After two years (1998) another solar-powered station was installed in the village of Mritunjoy Nagar with the same capacity as the previous project. In 1999 three solar-powered stations installed, namely Khasmahal, Gayenbazar, and Mahendraganj solar projects with capacity of 25 (kW) each. Natendrapur and Uttar Haradhanpur solar-power stations developed in 2000 having 28.5 and 32.5 (kW) power generation capacity. In 2001, only one solar-powered station was installed at Mandirtala, with power generate capacity of 28.5 (kW). Koylapara and Rudranagar Hospital solar-power stations were installed in 2006.Their power generate capacity was 120 and 20 kW respectively.

Bernard Matungwa (2014) analysed the contribution of Rural Photovoltaic solar energy electrification in the livelihood transformation process in the rural areas, based on Kisiju-Pwani village in Mkuranga District, Tanzania. Understanding the people’s perceptions, attitude and sense of ownership over the project installed in the village was another aim of this study, together with the reasons or bases of such attitude. It also wanted to take a closure look and understand the people’s electricity consumption behaviour in the rural areas. Results reveal that PV solar electricity was no longer doubtful in its effectiveness in the process of rural communities’ livelihood transformation. It is the best alternative for electrifying the rural areas as they struggle to participate in development process. Photovoltaic solar energy can no longer be ignored by the energy stakeholders as it provide an alternative source of energy which can benefit a number of people in the marginalized areas due to its availability, affordability, cleanliness and safety. Therefore, local enterprises as well as other stakeholders should be encouraged to further reach out to a wider part of the rural poor communities

Chelsea (2015) discussed the frameworks for understanding and promoting solar energy technology development. In this study, the contrasting theories of metabolic rift and ecological modernization theory (EMT) are applied to the same empirical phenomenon. Metabolic rift argues that the natural metabolic relationship between humans and nature has been fractured through modernization, industrialization and urbanization. EMT, in contrast, argues that societies in an advanced state of industrialization adopt ecologically benign production technologies and political policies, suggesting that modern societies could be on course to alleviate the ecological damage caused by capitalism. These two theories are fundamentally different in their assumptions about modern economies and technologies, yet both can be used as a theoretical lens to examine the phenomenon of solar energy technology adoption. Furthermore, both theories shed light on the increased adoption of solar energy technologies in both “developing” and “developed” regions and the potential social conditions for promoting renewable energy technology adoption.

Ramana (2016) discussing the significance of energy reiterated that every living organism on the planet earth needs input of energy. Energy is the basic requirement for economic development of any country. Energy is an important input to every sector of the nation for its development. Agriculture, industry, transport, commercial and domestic fields needs energy. Thus energy is the life line and driving force of civilization and at most care should be taken for its efficient production and utilization. Due to increased population, urbanization and transportation day to day consumption of fossil fuels increased drastically in the recent years and also causing environmental damage. Efficient use of energy could be achieved on the basis of a genuine energy strategy and the future of energy should be linked to the more efficient, less vulnerable and environmentally sustainable source of energy.

Ashok, et.al (2016), examining the solar-dc micro grid for Indian homes, suggested that, despite thousands of villages being electrified over the past decade under the government’s rural electrification program, over 85 percent of the households in five of the six states considered in the study had electricity for less than 8 h (maximum load of 50 W) or no electricity at all. A small home that in a day used two tube lights for 6 h, two fans for 12 h, two bulbs, a 24-in TV for 10 h, and a cell phone being charged for 4 h consumes a little over three units of power a day, costing about Rs. 500 a month. The study targeted to consider low- and mid-income homes with a solar panel to produces 4–4.5-kWh/kWp power per day; it also gives the number of appliances used in each home along with their operational hours. The study founded per day load requirement in the dc home was about 37 percent of that of an ac home due to lower consumption of DC appliances in comparison to AC appliances and per day cost of power to be around Rs. 12.6 for the solar DC home.

Malti Goel (2016) examined the solar rooftop policies and challenges in India. Solar photovoltaic rooftop had emerged as a potential green technology to address climate change issues by reducing reliance on conventional fossil fuel based energy. With a strong commitment to increase the renewable sources based energy capacity to 175 GW by 2022, India had a target to install 100 GW of solar energy capacity. Of this 40 GW was the share of grid connected solar PV rooftop. The study examines global growth in solar energy, world's major rooftop installed capacity countries' policies and solar rooftop policy instruments in India. The current Indian goals, issues and challenges achieved and trends in further development were discussed. The study proposed to make solar rooftop mandatory for properties with connected loads greater than 20 kW. Growth trends are continuing in 2016, total achievement in solar PV has crossed 5547 MW with RTPV share of approximately 10 percent in it.

Abhishek, et.al (2017), analysed the energy conservation through smart homes in a smart city (Singapore households), Energy saving was a hot topic due to the proliferation of climate changes and energy challenges globally. However, people's perception about using smart technology for energy saving was still in the conceptual stage. This means that people talk about environmental awareness readily, yet in reality, they accept to pay the given energy bill. Due to the availability of electricity and its integral role, modulating consumers’ attitudes towards energy savings can be a challenge. Notably, the gap in today's smart technology design in smart homes was the understanding of consumers’ behaviour and the integration of this understanding into the smart technology. As part of the Paris Climate change agreement (2015), it was paramount for Singapore to introduce smart technologies targeted to reduce energy consumption.

Priscila and Mario (2017) explained the conceptual framework of PV solar. The purpose of this study was to understand the state of art of photovoltaic solar energy through a systematic literature research, in which the following themes are approached: ways of obtaining the energy, its advantages and disadvantages, applications, current market, costs and technologies. For this research the authors had performed a qualitative and quantitative approach with a non-probabilistic sample size, obtaining 142 articles published since 1996–2016 with a slitting cut. Results of this research show that studies about photovoltaic energy are rising and may perform an important role in reaching a high energy demand around the world. To increase the participation of photovoltaic energy in the renewable energy market requires, first, increase awareness regarding its benefits, increase in research and development of new technologies and implement public policies and program that would encourage photovoltaic energy generation. The studies found on photovoltaic solar energy are all technical, thus creating the need for future research related to the economic viability, supply chain coordination, analysis of barriers and incentives to photovoltaic solar energy and deeper studies about the factors that influence the position of such technologies in the market.

II. ADOPTION OF SOLAR ENERGY AT THE HOUSEHOLD:

Dunkerehy, et.al (1990) and Jacob George (1988) have conducted an indepth study on energy consumption taking sample cases from certain sample cities. They have come out with the conclusion that the quantum and the composition of energy items consumed have a tendency to vary from city to city. They hold that the consumption of energy items in household is influenced by numerous factors. Among them mention could be made of household income, prices of fuel items, climatic conditions, household preference, food habits and regional cooking style.

Adam and Charles (2006) examined the consumer attitudes towards domestic solar power systems in UK. The success of the UK policy to reduce carbon emissions was partly dependent on the ability to persuade householders to become more energy efficient, and to encourage installation of domestic solar systems. Solar power is an innovation in the UK but the current policy of stimulating the market with grants was not resulting in widespread adoption. This study, using householders in Central England, investigates householder attitudes towards characteristics of solar systems and identifies some of the barriers to adoption. The study utilizes Diffusion of Innovations theory to identify attitudes towards system attributes, and isolates the characteristics that are preventing a pragmatic ‘early majority’ from adopting the technology. A group of ‘early adopters’, and a group of assumed ‘early majority’ adopters of solar power were surveyed and the results show that overall, although the ‘early majority’ demonstrate a positive perception of the environmental characteristics of solar power, its financial, economic and aesthetic characteristics are limiting adoption. However, if consumers cannot identify the relative advantage of solar power over their current sources of power, which is supplied readily and cheaply through a mains system; it was unlikely that adoption will follow. Recommendations concerning the marketing and development of solar products are also identified.

Njeri (2007) examined the solar home system electrification as a viable technology option for Africa's development. The study was based on a review of the effectiveness of solar home systems (SHS) in Africa in meeting user's expectations on a service based analytical approach. Various projects have deployed SHS on the promise that they are cost-effective, can meet end-user demands, have ability to alleviate poverty, can save time and reduce emissions. However, a close review of the actual cost of these systems given the services they provide indicates most of the promises remain unmet and hence questions the wisdom of using public funds to support the system at the expense of more appropriate technologies.

Morapakala (2011) examined the domestic solar hot water systems and its developments, evaluations and essentials for "viability" with a special reference to India. Following typical phases of any technology development, initially there have been research works focusing mainly on the solar hot water systems' (SHWS) technology development then followed by economic aspects. This had resulted in techno-economically feasible standardized solar hot water systems. Owing to these favourable features, SHWS in general and domestic SHWS (DSHWS) in particular attracted several promotional measures with a view to make them as the alternative for conventional water heating options in India. However, even after the implementation of these measures for more than two decades in India, the potentials-achievements difference remains to be extremely large, the reasons for which are attributed to the so-called "barriers for dissemination". The study presented a consolidated review of solar water heating related issues covering these technological developments, techno-economics, promotional measures, present dissemination status and barriers for dissemination, all with a special reference to the Indian context. Also presented in this study was the identified need for "viability" studies of DSHWS and "essentials for viability evaluations of DSHWS" in multi-dimensional environment that aid in developing decision making tools to improve dissemination of DSHWS.

Satoru, etal (2011), discussed the implications of the rapid expansion of Solar Home Systems (SHS) in rural Bangladesh for sustainable development. This study examined the multiple benefits of the adoption of Solar Home Systems (SHS) and discussed the dissemination potential for sustainable rural livelihoods in developing countries. Based on a household survey conducted in rural Bangladesh, the study identified the impact of SHS on the reduction in energy costs and purchasing costs. The study examines household lifestyle changes following the adoption of SHS. Finally, it considers several price reduction scenarios to examine the potential demand for SHS and to evaluate its future dissemination potential. The results of the analysis indicate that households with SHS successfully reduced their consumption of kerosene and dependency on rechargeable batteries, with the cost reductions accounting for some 20-30 percent of monthly expenditures on SHS. Moreover, most households with SHS can enjoy its benefits, including electric lighting, watching television, and the ease of mobile phone recharging at home. Further, the price reduction can make possible potential demand in more than 60 percent of households without SHS, while additional price reductions promote the purchase of even larger SHS packages. The study concluded that even though the scale of single SHS was small, the micro benefits for each household and the dissemination potential are substantial.

Kaja and Bradford (2011) attempted to analyse the knowledge and adoption of solar home systems in rural Nicaragua. Solar home systems (SHSs) are a promising electrification option for many households in the developing world. In most countries SHSs are at an early stage of dissemination, and thus face a hurdle common to many emerging alternative energy technologies: many people do not know enough about them to decide whether to adopt one or not. This study uses survey data collected in Nicaragua to investigate characteristics that predict the knowledge and adoption of SHSs among the rural population. First, a series of probit models was used to model the determinants of four measures of SHS knowledge. Next, a biprobit model with sample selection was employed to investigate the factors that predict SHS adoption, conditional on having sufficient knowledge to make an adoption decision. Comparison of the biprobit formulation to a standard probit model of adoption affirms its value. The study identifies multiple determinants of SHS knowledge and adoption, offers several practical recommendations to project planners, and provides an analytical framework for future work in this policy relevant area.

Ramchandra (2013) examined the financing of LED solar home systems in developing countries. The grid expansion was a vital objective of several developing countries and could be a long-term solution. However, the remoteness, isolation, low electricity demand of many rural communities and high investment cost of grid expansion make them very unlikely to be reached by the extension of the power grid. Consequently, the off-grid generation systems seem to be the most suited alternative to provide the electricity services to these isolated rural communities. Solar home systems (SHSs) with Light Emitting Diode (LED) lamps are considered to be cost effective and robust decentralized option for rural electrification. Two financing schemes, fee for service and micro-credit system (ownership), are primarily important for acquiring the SHSs by the rural population. Micro-Finance Institutions (MFIs) can be useful to address the gap between the high initial upfront cost of SHS and low paying capacity of rural households by providing flexible and affordable credit. The One-Stop-Shop model based on a single micro-energy provider who provides the services of finances, supply of standardized SHSs and after sale energy services was crucial. The success of the SHS program depends on the satisfactory technical performance, an adequate financing infrastructure, responsive after sales support, and the extent to which it can fulfil the needs of the end users of having grid quality energy.

Christopher and Christine (2013) examined the adoption of residential solar power under uncertainty and its implications for renewable energy incentive. Though, Solar panels are an attractive investment from a net present value perspective, the adoption rate was low, suggesting that households are either irrational or apply an abnormally high discount rate. The study used the option value framework to examine the decision by households to invest in solar PV and quantify the option value multiplier and adoption rate over time for solar PV investments. The study found that the option value multiplier was 1.8, which implied that the net present value of benefits from solar PV needs to be almost double the investment cost for investment to occur. Simulated adoption rates show that the adoption rate under the option value decision rule was significantly lower than that following a decision rule based on NPV, and was more consistent with the observed adoption rate of solar PV. The policies that support the solar PV market are crucial to households' adoption decision. The simulations showed that without tax credits and rebates, the median time to adoption increases by 110 percent compared to the baseline.

Santosh, et.al (2013) examined the adoption of solar home lighting systems in India (Karnataka). Karnataka had been among the most successful markets for solar lighting systems (SLS) among Indian states. In order to understand the dynamics of systems adoption and operation, that have fostered market based adoption of solar lighting, the study interviewed rural households from six districts that had purchased solar lighting systems using loans at market rates, the rural banks that provided loans and the solar firms that marketed the technology. The study found that a large proportion of households were connected to the grid but chose to install solar lighting because they considered the power supply from the grid to be unreliable. Households reported savings on electricity costs and reduced kerosene usage for lighting. In addition to providing credit, banks also play a key role in ensuring good service and maintenance. The viability of the SLS market was thus critically dependent on the role that the banks play as intermediaries between consumers and solar firms in rural areas. Government programs should be carefully designed to match the incentives of firms, banks and consumers if the successes of the ‘Karnataka model’ are to be repeated and amplified.

Tamas and Mita (2014) examined the energy usage in households with Solar PV installations. The National Energy Efficiency Data-Framework (NEED) produced and published by DECC, provide detailed information on annual electricity and gas usage, and energy efficiency in domestic and non-domestic buildings in Great Britain. The published consumption figures are broken down by property and household attributes, as well as geographic and socio-demographic characteristics. Analyses conducted on a representative sample of households allow DECC to investigate the impact of installing energy efficiency measures on gas consumption. The study aims to encourage the deployment of small-scale (up to 5MW) renewable micro generation installations, such as wind turbines and solar photovoltaic (PV) panels. The analysis of energy consumption habits allowed DECC to gain a better understanding of how the FIT scheme was performed against its objective of helping consumers become active participants in the transition to a low-carbon economy. The findings presented in this study are based on preliminary analysis which was developed further during 2015. As a result some of the preliminary results and associated messages may change.

Nnamdi (2014) examined the adoption of solar photovoltaic systems among industries and residential houses in Southern Nigeria. The objective of this study was identified the barriers and drivers of the adoption of solar PV system among home owners and organizations in Rivers State southern Nigeria and identified the challenges faced by the suppliers of this product for small and large scale suppliers. In order to achieve the objectives of this study, a qualitative research approach was used. A loosely-structured interview and a well-structured interview were used as the method. Findings from this study suggested that the need for a regular power supply was enough to motivate residential adopters to purchase and install solar PVC’s and sustainability was a sufficient driver to encourage adoption among the organizations interviewed in this study. Lack of implementation of policies for example double standard shown by custom officials at ports against the zero tax on importation of renewable energy products set by the government, low level of awareness among the public and lack of an organized co-operative group which provides advisory information to potential adopters were among the barriers identified within this study from interviews conducted with suppliers of solar PV systems.

Nadia Ahmed (2014) explains about the consumer choice towards renewable energy. The aim of this study was to find out what factors influence the consumer choice towards renewable energy. The study found that the main factors related to an adoption of renewable energy are energy cost reductions, energy supplier independency, increasing market price for energy, positive recommendations from people within the social network as well as financial support through grants. New factors found directing people towards a rejection are relating to the technological development and optic. The study concluded that renewable energy provides a lot of benefits, and should be adopted by many more people. Since many people still lack a lot of knowledge toward renewable energy, it was very important to increase the availability of information as well the knowledge towards renewable energy.

Griselda (2014) examined the household changes in electricity consumption behavior in post Solar PV-adoption. The study combined quantitative data on minute-resolved electricity-consumption profiles and survey data with qualitative interviews of PV adopters to create a holistic understanding of how PV adoption influences behavioural change of electricity use. The study explained that PV adoption does trigger increased awareness of electricity use. The study explained this seemed discrepancy by noting that these households were already energy conscious prior to PV adoption and had newer, more energy efficient homes, which could offset effects of increased awareness. Most of the respondents had a method of monitoring consumption, but their attentiveness to monitoring declines after installation-which could explain the awareness gap as well as the consumption increase. In addition, exogenous factors such as the purchase of an electric vehicle and changes in household size may explain increase in consumption. While the findings show a change in total consumption after adoption of solar PV at the individual household level, at the aggregate level the mean consumption for all households was just 1.0 percent and the change in means was insignificant.

Thalita, et.al (2014) examined a procedure for analyzing energy savings in multiple small solar water heaters installed in low income housing in Brazil, due to government subsidies. To improve measurement and verification in low income housing projects, the study presented a methodology for identified homogeneous subgroups based on their energy saving potential. This research strategy involved a cluster analysis designed to improve the understanding of energy savers and other influencing factors. A study in Londrina Brazil was undertaken with 200 low income families. Five clusters, created based on savings potential, were defined. The results showed that only two clusters demonstrated good electricity savings, representing 47 percent of the families. However, two clusters, or 37 percent, did not provide satisfactory savings, and the other 16 percent did not provide any consumption history due to previous use of illegal city electricity connection practices. Therefore, studies confirm the need for a detailed measurement of the representative subgroups to assess the influence of human behaviour on potential SWHS induced savings.

Venkatraman and Sheeba (2014) examined the customer's attitude towards solar energy devices. In India, solar energy devices are launched mainly with the objective to create environmental awareness of mass power consumption and the need to conserve power using solar energy devices. The major drawback of solar energy devices was high cost and high space requirement to set up a device. Apart from these drawbacks, the customers must consider the fact that solar energy devices are highly beneficial not only for the environment but also for human beings for its unique feature of infinite abundant energy. Though most people still prefer the usage of electrical devices, the attitude of the customers was steadily changing owing to the current environmental hazards caused by the former. Hence, the study examines about the customers attitude, preferences and their views and criticisms about the features and usage of solar energy devices and their evolution in the market trend. The study found that the respondents are 100 percent aware about the solar energy devices, but the satisfaction level of individual solar devices differs. The study suggested the need for reducing the cost of solar device for low income groups to buy.

Kumar Prasanna and Venketeswara Raju (2014) conducted a study to know the usage levels of solar panels in the present scenario, along with the people's opinion about the solar panels, the prospects of solar panels, and the ways to approach the various types of customers. This study mainly focuses on the people residing in Vijayawada, Guntur and Hyderabad and considers the factors related to availability, inhibitions, branding of solar panels. Results revealed that because of the higher cost of the solar panels and the more inhibitions about the working of solar panels people are not showing that much of interest on solar panels. In this situation solar panels are only the substitute for urban areas also. The success for the solar panels in the rural areas will be more. Because, now days the power cut timings are more than 12 hours a day, it may be increase in future. As the requirement is high, there is a bright future for the solar panels in coming days if they are made available at more subsidies and EMI's.

Christopher and Christine (2015) used the option value framework, which takes into account the benefit of delaying investment in response to uncertainty, to examine the decision by households to invest in solar PV. Using a simulation model, the study determines optimal adoption times, critical values of discounted benefits, and adoption rates over time for solar PV investments using data from Massachusetts. The study found that the option value multiplier was 1.6, which implied that the discounted value of benefits from solar PV needs to exceed installation cost by 60 percent for investment to occur. Without any policies, median adoption time was eight years longer under the option value decision rule compared to the net present value decision rule where households equate discounted benefits to installation cost. Rebates and other financial incentives decreased adoption time, but their effect was accentuated if households apply the option value decision rule to solar PV investments. Results suggested that policies that reduce the uncertainty in returns from solar PV investments were most effective at incentivizing adoption.

Johannes and Semee (2015), examined the solar home systems for rural India on awareness and willingness to pay in Uttar Pradesh, While solar home systems hold considerable promise for improving access to electricity in developing countries in tropical regions, scholars and practitioners argue that the lack of awareness, interest, and ability to pay for the technology undermines the growth of the market. The study described and explains patterns of awareness and interest in solar home systems (SHS) in a survey of 760 respondents in rural Uttar Pradesh, India and conducted the surveys in collaboration with a local solar enterprise and chose villages that are prime locations for the installation of solar home systems. The study found that high household income and education levels, as well as young age, predict awareness of SHS products. In addition to wealthy and educated households, willingness to pay was higher in households that have electricity. The findings can help policymakers identify and target households with low levels of awareness and solar entrepreneurs to identify suitable customers for their products.

Shamsun and Asif (2016), made an effort to assess the customer satisfaction of the Solar Home System service in Bangladesh by adopting the SERVQUAL model. A total of 70 users of the Solar Home System (of which 46 are household consumers and 24 are of retailers) in Dhaka

Division were selected to collect information. From the study it had been found that most of the consumers were just satisfied with the Solar Home System service and there was little gap between expectation and perception of the consumers of the Solar Home System service in Bangladesh. From a managerial point of view, the understanding of the customer satisfaction can suggest guidelines for better customer relationship management.

Stephan and Tukae (2016) examined the impact of livestock ownership on solar home system adoption in the Northern and Western Regions of Rural Tanzania. Livestock was hypothesized to be one of the major buffer stocks for consumption smoothing in rural areas of developing countries. It was therefore hard for poor farmers in the developing world to finance large investments. The author tested the latter by estimating a latent variable model of solar home systems. The study used off-grid household data from four districts of mainland rural Tanzania. Results indicate that solar adoption was higher for livestock owners than non-livestock owners and that these differences increases as household expenditure increases, but there was no statistical difference at lower-and some middle-expenditure levels. They argue that poor families tend to keep small livestock, which may not generate enough income for investment. They may also decide to accumulate livestock due to a lack of incentives to invest in solar. Furthermore, solar prevalence plays a role in the observed differences of solar adoption. Thus, solar investment financed through livestock will also depend on whether households have enough information on solar technology. In principle, if solar was to spread within a community, households will have to have information on the upfront costs and maintenance costs and the social and economic benefits of solar technology.

Mahesh (2016) in his study examined product adoption practices of solar water heater. The research was focused on consumer’s attitude towards Green Energy product i.e. Solar water Heater. The study had been conducted to explore the adoption practices for such non-conventional products. It dwells deeper through analyzed current policies and world as well as Indian solar market. The study was limited to Bhopal city and samples have been drawn exclusively from user category. The distributors of various manufacturing companies have been interviewed to get 360 degree insight into non-conventional energy market. The study finds saving on electricity through long term usage of solar water heater and also found respondents wishing to be identified as environment friendly class of buyers, and believe that installation of solar water heater increase value of their house.

Andrew and Gladys (2016) examined the determinants of adoption of domestic renewable energy in Kenya. In spite of the huge efforts and investments in the domestic renewable projects to alleviate many energy pressing problems in developing countries, such as rural energy shortages, low agricultural productivity, and poor public health, the implementation of such projects had not been successful as intended due to slow uptake of the technology. The general objective of this study was to establish the determinants of adoption of renewable energy in Kenya. The study adopted descriptive survey and sample of 100 household heads were considered. A simple random sampling technique method was used and data was collected through the questionnaires. On the other hand, secondary data was obtained from published documents. The study found that investment cost affected adoption of renewable energy as there was a high level of investment in solar system, the installation cost of the technology was high, there were accessible solar technology providers in the area and the transportation cost of the solar appliances for installation was high The was also correlation between investment cost and adoption of renewable energy.

Saumya and Anand (2016) examining the models for deployment of solar PV lighting applications in rural areas, found though solar PV lighting applications are better alternative in terms of quality of illumination, durability and versatility of use, there had been limited success with the deployment of this technology. This study had analysed various business models for deployment of solar PV lighting applications to identify the determinants of success and failure in rural India. The study was based on case studies, survey and interaction with various stakeholders. A variety of socio-economic, technical and market barriers have been identified. The study shows that the major factors affecting the deployment of solar PV applications in rural areas are: the local market for solar PV based products to create linkage between energy service providers and beneficiaries/end-user(s), availability of innovative financing mechanism to make product/ service affordable to the customers, awareness among people about solar PV or other renewable energy technology, the reputation of vendor (or NGO) in the respective region which drives the acceptance of the product/service, and willingness to pay for the product and its maintenance. Although an initial capital subsidy helps in acceptance of solar PV product/ service, the sustained use of product/service was observed only when the users contributed fully or substantially towards the same.

Pulak and Bhagirath (2016) examined the socio-economic and environmental implications of solar electrification and its experience in rural Odisha. Access to environmentally clean and renewable energy was critically linked with sustainable and inclusive development leading to improvement in overall standard of living of people in rural areas. The solar electrification has gained increased importance as a source of environmentally clean and economically efficient energy for people living in rural areas and the study was an attempt to understand its socio-economic and environmental implications. Analyzed from two villages of the Indian state of Odisha, the study found that households' adaptation to solar energy depends on a set of socio-economic, demographic and institutional factors including governments' approach towards rural electrification. Solar home system had facilitated socio-economic activities and improved standard of living of households, especially of women living in the area. The beneficiary households also perceive that solar electrification had improved environmental standard by reducing household pollution resulting from use of traditional sources of energy such as kerosene, though confirmation in this regard requires further investigation. However, households' adaptation to solar energy and realization of its potential benefits seems to be constrained by non-availability of maintenance and repairing facilities and access to conventional grid electricity under various programmes of the government. In addition to scaling up solar technology, an institutional framework with quality leadership and active participation of NGOs and other community level organization was necessary to link markets and policies effectively and enhance households' inclination towards greater use of this energy.

Gichuhi (2016) aimed to establish the level of solar energy technology adoption within Kiambu County in Kenya. The study adopted a stratified random sampling method and a sample size of 500 households was used. The study found that the people of Kiambu County have not adopted solar energy technology, a factor that can be attributed to the fact that there had not been any formal or informal training on solar energy technology use which resulted to the level of knowledge and awareness of solar energy and its use being relatively low. The level of knowledge and awareness from the individuals who had installed solar system in their household were high with respect to solar technology providers and had received informal training which influenced the adoption of the technology. The study concluded that the substitute sources of energy that may be perceived as cheaper and also the availability of hydro power in some of the households might have deterred the respondents from adoption of solar technology.

Jeff, etal (2017) attempted to examine the residential consumers' experiences in the adoption and use of solar PV. Public policy in many nations was seeking to transit energy generation towards renewable sources such as solar photovoltaic (PV). This study reported on an in depth qualitative analysis of 22 persons under different feed-in tariff (FiT) policy settings to explore consumer experiences in acquiring solar PV and their energy use behaviour. The responses of participants indicate there were different motivations and energy use behaviour that were based on the policy in which solar PV was acquired and these may provide insight into policy development or follow up studies.

III. PROBLEM IN ADOPTING AND USING SOLAR ENERGY:

Ram and Sheth (1989) stated that there are, three major barriers to adopt innovations including value, usage and risk. The value barrier means the innovation's inability to produce economic-or performance-based benefits, while use barrier means an innovation may not be compatible with existing workflows, practices and habits. The third barrier to adopt innovative products was the risk barrier, which includes physical, functional, economic and social risks (Nouri et al., 2011). Customers, aware of the risks, could postpone adopting an innovation until they could learn more about it or avoid the risks.

Hiranvarondon et al (1999) suggested that dissemination of solar PV systems required an implementation strategy that initially identifies the type of system needed. Governments could accelerate the dissemination by removing barriers to market expansion, by removing excessive duties and taxes, and by removing subsidies on products that compete with solar systems. They also listed the role of key players involved in the promotion and dissemination of solar systems in developing countries like national governments, donor agencies, educational and research institutions and private sectors or NGOs.

Cabraal, et al (2000) noted that successful solar PV market development for rural electrification requires the removal of financial and institutional barriers and the other major issues to be considered are the high initial costs, the establishment of a responsive and sustainable infrastructure and the guaranteeing of quality products and services. These findings were based on their studies in Indonesia, Sri Lanka, the Philippines and the Dominican Republic.

Adam Faiers and Charles Neame (2006) utilises Diffusion of Innovations theory to identify attitudes towards system attributes, and isolates the characteristics that are preventing a pragmatic 'early majority' from adopting the technology. A group of 'early adopters', and a group of assumed ‘early majority’ adopters of solar power were surveyed and the results show that overall, although the ‘early majority’ demonstrate a positive perception of the environmental characteristics of solar power, its financial, economic and aesthetic characteristics are limiting adoption. Differences exist between the two groups showing support for the concept of a ‘chasm’ between adopter categories (Moore, 1999). However, if consumers cannot identify the relative advantage of solar power over their current sources of power, which is supplied readily and cheaply through a mains system; it is unlikely that adoption will follow. Recommendations concerning the marketing and development of solar products are identified.

Cox et al. (2007) noted that consumers are cautious about accepting novel technologies because of the perceived risk and lack of benefits (Tehrani et al., 2009). They used a conjoint model to study consumers’ perceived risk, benefits, need, unnaturalness and safety of the technologies. Participants were segmented by the sum of their beliefs about the novel technologies.

Ahammed and Taufiq (2008) discussed that the factors contributing to the successful promotion of solar PV based rural electrification are suitable finance schemes to address the problem of high initial cost, adequate means of providing regular and proper maintenance and supplying spare parts and viable choice of available configurations to suit the consumers’ needs and affordability.

Aziz, et al (2009) found that the customers are largely satisfied with the availability and quality of the financing and sales services of the partner organizations. The study has measured the satisfaction level of the consumers in eight areas of the SHS service namely number of appliances supported, stability of electricity, quality of electricity, frequency of breakdowns, helpful information from the company, financing facilities of the company, troubleshooting services. The responses indicate that most of the consumers are either satisfied or highly satisfied with the SHS they use in their homes or rural small businesses. No respondent reported a high level of dissatisfaction regarding any of the parameters, and overall dissatisfaction is low.

Alireza and Kamran (2009) examined the optimal design of a forced circulation solar water heating system for a residential unit in cold climate using TRNSYS. An indirect forced circulation solar water heating systems using a flat-plate collector was modeled for domestic hot water requirements for a single-family residential unit in Montreal, Canada. All necessary design parameters were studied and the optimum values were determined using TRNSYS simulation program. The solar fraction of the entire system was used as the optimization parameter. Design parameters of both the system and the collector were optimized that include collector area, fluid type, collector mass flow rate, storage tank volume and height, heat exchanger effectiveness, size and length of connecting pipes, absorber plate material and thickness, number and size of the riser tubes, tube spacing, and the collector's aspect ratio. The results show that by utilizing solar energy, the designed system could provide 83-97 percent and 30-62 percent of the hot water demands in summer and winter, respectively. It is also determined that even a locally made non-selective-coated collector can supply about 54 percent of the annual water heating energy requirement by solar energy.

Hardie (2010) details the barriers to the natural growth of the SWH industry, as being the low market demand, which translates into a high investment risk for suppliers and due to this uncertainty industry participants only invest in the short-term. This does not lead to an increase in long-term benefits, such as competition, better choice, better quality and lower prices.

Shih and Chou (2011) focused on consumer concerns about uncertainty and willingness to pay for leasing solar power systems. Conjoint analysis method was used to find part worth utilities and estimate gaps of willingness to pay between attribute levels, including various leasing time lengths. The results show the part worth utilities and relative importance of four major attributes, including leasing time. Among concerns about uncertainties, government subsidy, electricity price, reliability, and rise of new generation solar power systems were found to be significantly related to the additional willingness-to-pay for a shorter leasing time. Cluster analysis was used to identify two groups standing for high and low concerns about uncertainty.. People with more concerns tend to pay more for a shorter lease time.

Siân Adams (2011) surveyed two consumer groups ("early adopters" and "early majority) adopters in South Africa, with the aim of investigating consumer attitudes towards characteristics of solar systems, utilizing the diffusion of Innovations theory to understand the attributes which affect the consumer decision-making process, and isolating the characteristics that are preventing a pragmatic "early majority" from adopting the technology. The results show that overall, while the "early majority" demonstrates a positive perception of the environmental characteristics of solar power, its financial, operational and aesthetic characteristics are limiting adoption. Differences existing between the two groups show support for the concept of the 'chasm' between adopter categories identified by Moore. The study concludes that if consumers cannot identify the relative advantage of solar power over their current source of power supplied readily and cheaply through the national grid, it was unlikely that wide-scale adoption will follow.

Shamsun Nahar Momotaz and Asif Mahbub Karim (2012) made an effort to assess the customer satisfaction of the Solar Home System service in Bangladesh by adopting the SERVQUAL model as the basis for conducting the research. A total of 70 users of the Solar Home System (of which 46 are household consumers and 24 are of retailers) in Dhaka Division were selected to collect information. From the study it has been found that most of the consumers are found just satisfied with the Solar Home System service and there is little gap exists between expectation and perception of the consumers of the Solar Home System service in Bangladesh. From a managerial point of view, the understanding of the customer satisfaction can suggest guidelines for customer relationship management.

Mashail (2013) examined the residential solar panels and their impact on the reduction of carbon emissions'. The objectives were to determine: the percentage of homes that have currently installed solar and the amount of carbon emissions this had reduced; the percentage of homes that should install solar for California to significantly mitigate carbon emissions when compared to baseline current emissions; and the groups of households that should be the main focus of government emissions mitigation policies. While currently 0.9 percent of California households have installed solar systems, the study found that at least 60 percent of homes would need to install solar to significantly reduce carbon emissions by 2020. The largest barrier to solar implementation was cost; thus, in order to get 60 percent of homes to install solar, the government must implement and enhance subsidy and feed-in tariff policies of emissions must also be considered.

Martina (2013) examined the perceptions of domestic consumer’s on solar systems and non-adopter views of a new technology to describe non-adopter perceptions of PV-systems. The study holds a qualitative approach using deep interviews for data collection. Theoretical framework used was Rogers (2003) diffusion of innovations, and the innovation characteristics of relative advantage, complexity, compatibility, observability and trailability. The main findings was that the relative advantage are perceived as negative in terms of finances, but that some of the respondents overestimates the payback times as well as stated payback times that are well within the price levels, when getting the questions of what levels that would make them seriously interested in getting a PV-system. Further, PV-systems are generally seen as an environmental friendly technology, which was positive for the relative advantage attribute, but with some of the respondents raising doubts about the actual environmental benefits by a life cycle approach. A finding in this study was also that PV-systems are seen as being very easy to use, which indicates a positive view of the characteristic of complexity.

Hakeem (2013), attempted to examine the challenges facing solar energy projects in Nigeria (Lagos State), The main goal of this study was to understudy the solar energy powered projects in Lagos state, Nigeria, analyzing the failed projects, understanding the reasons for the failure of the projects, improve the processes involved in manufacture, installations and the routine maintenance required to keeping every single solar energy powered projects working as expected findings revealed that in solar-powered projects, the capacity and performance of the batteries was a major challenge. This can be reduced by properly managing the batteries. Ensuring proper project management as a whole process was another key point for minimizing the failure in solar powered projects.

Sudhakara and Hippu (2013) examined the energy in the development strategy of Indian households-the missing half. There was a growing consensus that universalization of modern energy services was central to reduce major elements of poverty and hunger, to increase literacy and education, and to improve health care, employment opportunities, and lives of women and children. In India, as subsistence activities like firewood collection, carrying these head load for miles, and then burning these hard earned fuels inefficiently in traditional chullas adversely affect the health and standard of living for women and act as a barrier to gender development (here ‘gender’ means women). Although the links between gender inequity, poverty, and energy deprivation have been studied by many, not many practical solutions to the above problems have emerged. The study explores the nexus among gender–energy–poverty, highlights areas of gender concern, and suggests actions. The study analyzes how women from rural areas and low income households are at the receiving ends of energy poverty. The study then analyzes the roles women as an important stakeholder in universalizing modern energy services. It shows how women self-help groups can be a vital link in large-scale diffusion of energy-efficient and renewable technologies. The study concluded with policy pointers for sustainable development and gender empowerment through energy solutions.

Ted Trainer (2014) attempted to study the limits to solar thermal electricity. The potential and limits of solar thermal power systems depend primarily on their capacity to meet electricity demand in midwinter, and the associated cost, storage and other implications. Evidence on output and costs was also analysed. Problems of low radiation levels, embodied energy costs, variability and storage are discussed and are found to set significant difficulties for large scale solar thermal supply in less than ideal latitudes and seasons. The study concluded that for solar thermal systems to meet a large fraction of anticipated global electricity demand in winter would involve prohibitive capital costs.

Ameli and Brandt (2015), examined the determinants of households' investment in energy efficiency and renewable. This study provides novel evidence on the main factors behind consumer choices regarding investments in energy efficiency and renewable energy technologies using the OECD Survey on Household Environmental Behaviour and Attitudes. The empirical analysis was based on the estimation of binary logit regression models. Empirical results suggest that households' propensity to invest in clean energy technologies depends mainly on home ownership, income, social context and household energy conservation practices. Indeed, home owners and high-income households are more likely to invest than renters and low-income households. In addition, environmental attitudes and beliefs, as manifest in energy conservation practices or membership in an environmental non-governmental organisation, also play a relevant role in technology adoption.

Nicholas, Peter, et.al, (2015) examines household responses to sustainability issues and adoption of energy saving technologies. While SHW systems had the potential to provide the majority of household hot water and to lower carbon emissions, little research had been done to investigate how SHW systems are integrated into everyday life. The study draw on cultural understandings of the household to identify passive and active users of SHW systems and utilized a model that illustrated how technology use was dependent on interrelations between cultural norms, systems of provision, the material elements of homes and practice. A key finding was that households can be ill prepared to make the most of their SHW systems and lack post installation support to do so. Thus, an informed and efficient use of SHW systems was hit and misses. The policy was largely aimed at subsidizing purchase and installation on the assumption that this was sufficient for emission reduction goals. The analysis provides evidence to the contrary. Areas highlighted for policy and practice improvements are independent pre purchase advice, installation quality, and practical guidance on system operation and interaction with patterns of hot water use. The study recommends creating easy access to credit, establishing a robust complaint system, and developing strategic partnership to overcome the obstacles.

International Finance Corporation (2015) in its study explores the potential of another option: solar-powered lighting in Pakistan. Through a combination of market research and household surveys, it found that there is potentially a robust market for solar lighting solutions, which run the gamut from simple solar-powered desk lamps to large systems that can power multiple appliances. These systems are safer, more reliable, and, over the long run, cheaper than many of the technologies in widespread use today. Right now, only about 4 percent of Pakistani households tap into solar power and there are several barriers to its widespread adoption. They include a lack of consumer awareness, limited supply chains and a shortage of consumer finance, which was the key given the relatively high up-front cost of some solar products. However, these issues are surmountable. Below-the-line marketing can help raise awareness. Lenders, especially micro finance institutions, can be enlisted to help provide credit. And programs like IFC's Lighting Pakistan can help certify the quality of solar-powered lighting products, creating confidence among consumers. Most importantly, this study finds there was a tremendous opportunity for industry players that can deliver high-quality, cost-effective products to consumers. The market is both massive and largely untapped, presenting an excellent opportunity for first- movers.

Jain, et al (2016) focuses on the impediments associated with solar energy policies from the stakeholder's perspective. On studying one of the major initiatives of the National government, the "Remote Rural Village Electrification" in Chhattisgarh as a case, it was found that there was a gap between the policies and the actual scenario. The awareness level among the beneficiaries was found to be very low. Thus, there was an urgent need to create awareness among the stakeholders on Government initiatives, so that solar energy is widely accepted and used.

Sonal, etal (2016), conducted the Strength-Weakness-Opportunity-Challenges (SWOC) analysis of solar energy deployment in Indian context. Moreover, Analytical Hierarchy Process (AHP) technique was utilized to obtain priority of the SWOC variables in deployment of solar energy. The hybrid combination of AHP with SWOC analysis produces analytically determined priorities for the factors and makes them commensurable. Finally, sensitivity analysis had been used to investigate SWOC variables' rank stability. Among SWOC variables, opportunity factor emerged out to be the most dominant which concludes that deploying solar energy can provide several chances to grow for a nation sustainably. Moreover, weakness associated with solar energy reaches to bottom place which shows bright future of diffusion of solar energy. The study assists policy planners, and concerned authorities to understand the strengths, weaknesses, opportunities and challenges of solar energy in order to plan, manage and develop it effectively to attain sustainability.

IV. RELATED STUDY:

Using the data from the National Sample Survey (1983-2000), Reddy (2004) analyses the dynamics of energy end-use in household sector in India. The energy consumption was disaggregated according to social class (employment characteristics, access to resources) and income group for rural as well as urban households. It was observed that large variations in energy use exist across different sections of households urban/rural, low/high income groups, etc. The Indian household energy problem was not primarily a problem of the scarcity of energy per se, but inefficient energy conversion to obtain the desired services. The consequence of such utilization was the serious health hazards of inhaling the smoke from fuels used for cooking. Hence the strategy of climbing the “efficiency ladder" (wood stove efficient wood stove/Biogas stove to efficient kerosene stove, LPG stove and electric geyser/solar water heater) means addressing energy development, poverty, social justice, equity and gender issues as parts of the same political process of development. It involves bridging the gap between changing attitudes and environmental degradation and the patterns in the use and reuse of the earth's resources.

Khambalkar, et.al (2010) conducted a survey to assess attitudes of the public towards renewable energy. The information gathered was analysed for respondents attitudes towards issues such as, knowledge of renewable energy sources and power generation, encouragement by government as well as at a personal level, comparison of fossil fuels use and renewable power, opinions for encouragement, leads for encouraging renewable energy growth with financial incentives, global warming problem and renewable energy as an option and public financial contribution towards lowering global warming. It was observed that the public had considerable awareness of the sources of the energy. It confirms from the data that the public understands mostly that renewable energy was the non polluting source and going for utilization of renewable energy was a very good idea. It was also clear that people knew about wind and atomic energy generation systems. Among the renewable energy sources it was found that public opinion supported wind energy as the best option for generating energy. As for the comparison of the energy generation from the renewable energy with that from fossil fuel public opinion was that renewable energy was much better. Many slightly agreed that government encouragement was necessary for the promotion of renewable energy. It was observed that respondents individually had to take a lead for developing renewable energy use at the household level as well as business development. With a view that its application would probably lead to a reduction in global warming, people agree strongly with solar energy use. They would be willing to pay if the energy in their electricity bill comes from renewable energy. Most of the respondents in the area surveyed used solar equipment in some form.

Syed and Mokbul (2013), in their study aimed at understanding how increased energy access through SHS in rural Bangladesh contributes towards rural development. The findings are critically analyzed with respect to selected indicators of rural development. The study identified that increased access to energy through SHS in rural Bangladesh provides mostly recreational and leisure benefits with the so called ‘social status’, while income generation was negligible and support for education was average.

Sunil, et.al (2013), observed that in the context of coming energy crisis, due to the declining of oil era, water problems are expected to substantially worsen and vice versa, due to the close relationship between water and energy issues, Water problems are also expected to contribute to increase in energy problems. In addition to all this, environmental considerations such as global warming, will surely add significant pressure in all these matters. In this scenario renewable energies are rapidly increasing their contribution to the global mix, with solar energy being the one with higher potential. Therefore, if solar energy had the highest potential among all the renewable and there is also the coincidence, all over the world, that where water stress and/or scarcity exists, also there are good levels of solar radiation. Hence there was a need to develop suitable technologies which would permit to use solar energy to, simultaneously, help to solve the energy and water problems.

Can and Vasilis (2014) explained about energy policy and financing options to achieve solar energy grid penetration targets. Accounting for external costs, the study presented a review and assessment of public-policy options for supporting large scale penetration of photovoltaic’s (PV) in the United States. The goal therein was to reduce the costs both of solar technology and of grid integration, so enabling solar deployment nationwide. In this context, the study analyzes the solar PV markets and the solar industry globally, and discussed the external benefits of PV that must be advertised, and perhaps marketed, to assure an increased social support for PV. The study discussed existing energy-policy mixes in those countries leading to the development of solar power, highlighting the lessons learnt, and outlining areas of improvement of the existing policy mix in the United States. The study highlight that there was a need for a holistic approach including social in addition to economic considerations, and discussed policy options for supporting the continuation of PV market growth when the current investment tax credits expire.

Mohammed, et.al (2014) attempted to assess solar lantern based lighting option for street vendors (often without access to grid electricity) in the city of Dehradun through a questionnaire based survey. Survey results indicate that the vendors are more likely to adopt a lighting device on rental mode that offers the benefit of low operation cost and high reliability. The study pointed that the city had potential for 10 Central Charging Stations of 1200 Wp capacity each. Each station would cater to the lighting needs of 100 vendors. Based on the vendors willingness to pay for lighting services, estimated minimum acceptable daily rental to an entrepreneur operating a station was Rs 3.97. This was about 45 percent of the average daily rental of Rs 8.90 that the vendors are willing to pay. For daily rental ranging between Rs 4.00 to Rs 9.00, the mark-up for the entrepreneur would range from 16 to 160 percent.

Xinhai and Vignarooban, etal (2016), examined the prospects and problems of concentrating solar power technologies for power generation in the desert regions. The study concentrated on solar power plants (CSPs) which are gaining momentum due to their potential of power generation throughout the day for base load applications in the desert regions with extremely high direct normal irradiance (DNI). Among various types of the CSPs, solar tower power technologies are becoming the front runners especially in the United States and around the world with the possibility to compete with traditional power generation technologies in terms of efficiency and levelized cost of electricity (LCOE). A bibliometric analysis of the publications on the CSP systems and components since 1990 shows a total of 6400+ publications and reveals an exponential growth due to reasons that CSP systems promises a lot of potential as the future large scale power source for varied applications. This review consolidates the benefits and challenges of the CSP technologies particularly in the desert regions. Thorough literature analysis as well as the meteorological data projects the trend that the CSP systems would become a reality in the Middle East and North Africa (MENA), Australia, Southwestern region of the

United States, Southwestern part of China and China/Mongolia border with high direct normal irradiance. However, enormous amount of support and capital investments are needed for making these CSP systems realistic as there was not much power grid network in existence. It is evident that there are multiple challenges specifically in water consumption, materials design and development for the optimum heat transfer fluid, thermal energy storage and receiver subsystems in addition to commercial viability and environmental impacts. Each of the challenges is discussed in detail and suggestions are made to address the challenges.

Hisashi Takeda (2017) examined the short-term ensemble forecast for purchased photovoltaic generation and proposed a novel short-term forecasting method for purchased photovoltaic (PV) generation. The proposed method was used to solve emerging problems, such as low accuracy of electricity load forecasting, which are associated with the rapid increase in PV generation. In this study, hourly PV power was first modeled in the form of state-space models (SSMs), which incorporate a local power model and PV system parameters. Hourly installed PV capacities are then estimated using data that are available on a monthly basis. Finally, using the hourly capacities and weather observations, data assimilation in the SSMs was performed by an ensemble Kalman filter. As a result, the hourly physics-based PV power models are enhanced by monthly PV purchase volumes and significantly outperform an existing operational model. Furthermore, it was possible to simultaneously estimate PV system parameters, such as the coefficient of PV conversion, in the data-assimilation process

Ka Lok, et.al. (2017), the study on an investigation into the effect of aspect ratio on the heat loss from a solar cavity receiver, the effect of aspect ratio and head-on wind speed on the force and natural (combined) convective heat loss and area-averaged convective heat flux from a cylindrical solar cavity receiver has been assessed using three dimensional computational fluid dynamics (CFD) simulations. The cavity assessment was performed with one end of the cavity open and the other end closed, assuming a uniform internal wall temperature (i.e. the cavity walls were heated). The numerical analysis shows that there are ranges of wind speeds for which the combined convective heat losses are lower than the natural convective heat loss from the cavity and that this range depends on the aspect ratio of the cavity. In addition, the effect of wind speed on the area-averaged flux of convective heat loss from a heated cavity is smaller for long aspect ratios than for short ones, which indicates that the overall efficiency of the solar cavity receiver increases with the aspect ratio for all conditions tested. It has been found that, for the scenario of uniform temperature of the cavity walls, a small increase in wind speed from zero reduces the combined convective heat loss below the value for the natural convection.

CONCLUSION

From the above empirical studies, the role of solar energy as an important aspect for social change and development in both developed and developing countries is evident. The above literature review shows a lot have been said and studied from different angles on the development of solar energy utilization. From the literature available; the role played by different stakeholders in the development of solar energy technology, advantages and challenges have been studied and put well. However, the literature doesn't show the community members' acceptance and sense of ownership of the solar energy systems nor do they explore the community members' views on the effectiveness of the solar energy devices in different areas. This study has addressed this gap focusing on addressing the community members' acceptability and sense of ownership of the solar energy system and the basis for the same. Moreover, the community members' perceptions on the effectiveness of the solar energy together with the energy consumption behaviour have been addressed.

CHAPTER III
METHODOLOGY

The methodology followed for the study is presented and discussed under the following heads:

I. Locale of the study
II. Selection of the sample
III. Data base of the study
IV. Period of the study
V. Techniques of analysis
VI. Limitations of the study

I. LOCALE OF THE STUDY

Coimbatore, the third largest city of Tamil Nadu, is also an important district of the state. It is the second largest city and urban agglomeration in the state. Coimbatore is one of the cities selected out of 98 smart cities under Smart City Mission. Due to the presence of several textile industries, it is sometimes referred to as the textile capital of South India or the 'Manchester of the South'. The district city is situated on the banks of the river Noyyal. The total area of the district is 7469 sq.kms which is divided into three revenue divisions, nine Taluks, 19 blocks and 482 revenue villages. The district lies in the southern part of the Indian peninsula. It lie between 10º10' to 11º36' northern latitude and 76º 46' to 77º 36' eastern longitude, on the extreme west of Tamil Nadu. It is surrounded by the Nilgiris in the western and south western side, Erode district in its northern and Dindigul district in its eastern side. It shares part of its boundaries with neighbouring state of Kerala.

Population of this district is 3472578 of which 1735362 are males and 1737216 are females (Census, 2011). The sex ratio as per 2011 census is 1001. The total rural population in the district is 839408 and urban population is 2820203. Scheduled castes and Scheduled tribe accounts for 13.8 per cent and 0.6 per cent of the total population. Over the years, the city has also experienced a decline in its population density which may be attributed to the repeated expansion of the city limits. The population density of the city was found to decrease from 6667 persons per sq km in 1981 to 6,294 persons per sq. km in 2011. The average sex ratio of the city is 999 females per 1000 males and is higher than the national average of 940 females per 1000 males. The average literacy rate of Coimbatore city is 91 percent of which male literacy is 95 percent and female literacy is 88 percent. Hence, it can be broadly concluded that status of women in the city is quite high.

The rich black soil of the region has contributed to Coimbatore's flourishing agriculture industry and, it is in fact the successful growth of cotton that served as a foundation for the establishment of its famous textile industry. The first textile mills came as far back as 1888 but there are now over a hundred mills. The result has been a strong economy and a reputation as one of the greatest industrial cities in South India.

There are more than 25,000 small, medium, large sale industries and textile mills. Coimbatore is also famous for the manufacture of motor pump sets and varied engineering goods, due to which it has earned the title “Detroit of the South". The Development of Hydro electricity from the Pykara Falls in the 1930s led to a cotton boom in Coimbatore. The result has been a strong economy and a reputation as one of the greatest industrial cities in South India. The major industries include textiles, textile machinery, automobile spares, motors, electronics, and steel and aluminium foundries. Agriculture however remains the major occupation. The rich fertile soil and tropical climate is excellent for the growth of millet, paddy, cotton, tea, oil seeds and tobacco.

The city is also known for its educational institutions. The district comprises of a number of universities and schools including eight universities, more than 1,400 primary schools, 420 middle schools and 165 higher secondary schools. Coimbatore is well connected with other cities and States through a vast road network across 360,400 kms of National Highways and 1168.725 kms of State Highways.

Coimbatore has also emerged as a tier-II destination for the IT sector. There are about six notified Special Economic Zones (SEZs) in the region, of which five are occupied by the IT/ITES (Information Technology Enabled Services) sector and one by hi-tech engineering. Factors such as a sound industrial base with adequate infrastructure, connectivity, top grade educational institutions and skilled workforce have made Coimbatore a favourable destination for IT companies.

Tamil Nadu has reasonably high solar insulation (5.6-6.0 kWh/sq. m) with around 300 clear sunny days in a year. Southern Tamil Nadu is considered to be one of the most suitable regions in the country for the development of solar power projects. With substantial solar insulation in the State, the strong commitment of the State Government and rapidly declining solar lower costs, there are remarkable opportunities in the solar energy domain. This will enhance energy security, making Tamil Nadu the global reference in the solar energy sector.

The State has an outlay of INR 55,000 crores (USD 9.16 Billion) for solar energy sector alone. This is more than 10 percent of the total allocation for power sector. Tamil Nadu is the state with the highest installed solar-power capacity in India on 21 September 2016, when the 648-MW Kamuthi Solar Power Project was dedicated. With this plant, the total installed capacity in Tamil Nadu is 1,692 MW as on 30 April 2017. This is 21 percent of the installed renewable energy in the state; the other 79 percent is wind power. Tamil Nadu is one of the national leaders in adding solar-power capacity. On 1 July 2017, solar power tariff in Tamil Nadu has hit an all-time low of Rs 3.47 per unit when bidding for 1500 MW capacity was held. In this context, a micro level study assumes immense significance to assess the adoption and utilisation of domestic solar energy device in selected households.

II. SELECTION OF THE SAMPLES

The location of the study was confined to Coimbatore city. Two-stage sampling technique was adopted in the selection of the sample. To give equal representation to all households, in the first stage the city was divided into four zones, namely, north, south, east and west and from these zones, two zones, namely, north and south were selected on the grounds of greater presence of solar users in these areas. From this universe, in the second stage 50 sample respondents were selected in each zone, of which 25 were solar adopters and 25 were non-adopters, by adopting purposive sampling technique as not all the respondents were willing to participate in the survey. The basic assumption behind purposive sampling is that with good judgement and appropriate strategy one can handpick the cases to be included in the sample and thus develop samples that are satisfactory in relation to ones needs (Guilford, 1978). A common strategy of purposive sampling is to pick cases that are judged to be typical of the population, in which one is interested, assuming errors of judgement in selection will tend to counter balance each other if sufficiently large sample is taken. Hence, the investigator approached only those people who were willing to cooperate and supply the needed information. Thus in the present study, 100 respondents were selected, of whom 50 were adopters and 50 non-adopters.

III. DATA BASE OF THE STUDY

The study was based on primary data. The primary data was collected with the help of an interview schedule to elicit information on the usage and non-usage of solar technology by the selected respondent. The schedule was first pre-tested with few selected sample units and based on their responses the questions were reformulated and the final interview schedule used in the study is given in Annexure I.

IV. PERIOD OF THE STUDY

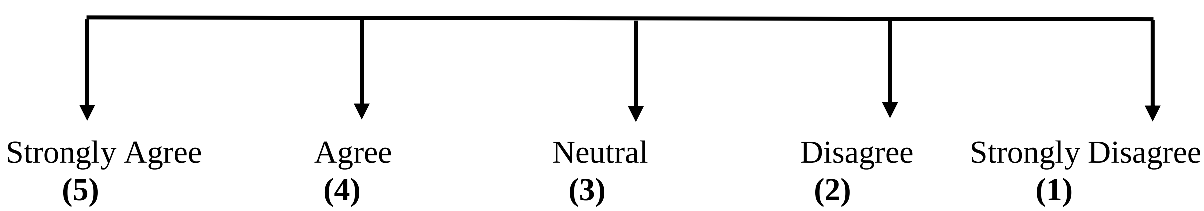
The field investigation and data collection for the study was carried out during the period January to April 2017.

V. TECHNIQUES OF ANALYSIS

Data collected were tabulated and analysed for giving precise and concise information. Besides, percentages and graphs, the following tools were used.

a) Likert's Summated Scale

The Likert's Summated Scale was used to scale the characteristics of various usages of solar devices at the household level, benefits and problems in using solar devices and the reasons for adoption and non-adoption of solar devices at the household level. In the Likert scale, the respondent was asked to respond to each of the statements in terms of five degrees of agreement or adjustment.



Each point on the scale carries a score. Response indicating the lowest favourable degree of statement is given the least score (say 1) and the most favourable one is given the highest score (say 5). This way the instrument yields a total score for the respondents which would then measure the respondents' favourableness or otherwise towards the given point of view.

b) Chi-Square Test

The chi-square (χ^2) test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. Do the individuals or objects that fall in each category differ significantly from the number you would expect? Is this difference between the expected and observed frequency due to sampling error, or is it a real difference? The χ^2 value is calculated from the formula:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

where 0 is observed frequency in each category and E is expected frequency in each category. The degrees of freedom are given by (c-1) (r-1) where ‘c’ denotes number of columns and ‘r’ number of rows. The obtained value was compared with the critical value at the given degrees of freedom to draw inference about the sample (Gupta, 2005). In the present study chi-square test was used to examine whether adoption behaviour of the respondents was independent of (i) socio-demographic factors and (ii) selected housing details.

c) Independent t Test

The independent t-test, also called the two sample t-test, independent-samples t-test or student's t-test, is an inferential statistical test that determines whether there is a statistically significant difference between the means in two unrelated groups. The formula is given as:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1}{n_1} - \frac{S_2}{n_2}}}$$

where, X_1 is the mean of group 1; S_1 is the standard deviation of group 1

X_2 mean of group 2; S_2 is the standard deviation of group 1

n_1 and n_2 is the sample size of group 1 and 2

The calculated value of t is compared with the table value of t at ($n_1 + n_2$ - 2) degrees of freedom to accept or reject the hypothesis. In the study t test was done to test whether there was any differences among the adopters and non-adopters with respect years of schooling, family income, expenditure level and the amount spend on electricity consumption.

d) Garrett’s Rating Scale

To find out the strength of each factor in motivating the selected sample respondents either to buy solar devices or the type of devices they intend buying, Garrett’s rating scale technique was used. From the ranks given for each factor, percent positions were calculated by using the formula.

Percent position=100*(R-0.5)/N

where R is the rank assigned and N is the number of items ranked. The percent position was then converted into scores using Garrett’s score table (Garrett H, 2005).

e) Cronbach's Alpha

Cronbach's alpha evaluates the unidimensionality of a set of scale items. It's a measure of the extent to which all the variables in a scale are positively related to each other. In fact, it is really just an adjustment to the average correlation between every variable and every other. The formula for alpha is

$$\alpha_{s\tan dardized} = \frac{K.\bar{r}}{(1+(K-1).\bar{r})}$$

where k is the number of variables and $\bar{r}$ is the average correlation among all pairs of variables. Cronbach's alpha values ranges from 0 to 1. The higher the score, the more reliable the generated scale is. Nunnally (1978) has indicated 0.7 to be an acceptable reliability coefficient but lower thresholds are sometimes used in the literature. In the study, the reliability testing was done for factors related to benefits and problems in using solar devices.

f) Factor Analysis

Factor analysis is a multivariate statistical analysis whose objective is to define the underlying structure in the data matrix. Broadly speaking, it addressed the problem of analysing the structure of interrelationship (correlation) among a large number of dimensions and the explanation of each variable are determined, so that the two primary uses for factor analysis, namely summarization and data reduction can be achieved. In summarizing the data, factor analysis derives underlying dimensions that, when interpreted and understood, describe the data in a much small number of concepts than the original individual variables.

Factor analysis was used in the present study to identify the underlying pattern of relationship between the various dimensions in the usage of solar devices, benefits of using solar devices and the problems in using solar devices.

g) Path analysis

Path analysis is a straightforward extension of multiple regressions. Its aim is to provide estimates of the magnitude and significance of hypothesized causal connections between sets of variables. This is best explained by considering a path diagram. Path analysis is used to describe the direct dependencies among a set of variables. In addition to being thought of as a form of multiple regression focusing on causality, path analysis can be viewed as a special case of structural equation modeling (SEM)-one in which only single indicators are employed for each of the variables in the causal model. That is, path analysis is SEM with a structural model, but no measurement model. Other terms used to refer to path analysis include causal modeling, analysis of covariance structures, and latent variable models. Its aim is to provide estimates of the magnitude and significance of hypothesised causal connections between sets of variables, which is best explained by a path diagram.

To construct a path diagram the names of the variables are written, arrow is drawn from one variable to other variable which it affects. One can distinguish between input and output path diagrams. An input path diagram is one that is drawn beforehand to help plan the analysis and represents the causal connections that are predicted by the hypothesis. An output path diagram represents the results of a statistical analysis, and shows what was actually found. The objective of path analysis is to understand the pattern of correlations among the variables and explain the variations within the model specified. The path of the model is shown by a square and an arrow, which shows the causation. Regression weight is predicted by the model. The goodness of fit statistic is calculated in order to see the fitting of the model. Path analysis was applied to evaluate the impact of relative advantage, compatibility, complexity and risk on the level of satisfaction. Path model was executed by using VPLS programme.

VI. LIMITATIONS OF THE STUDY

- The study seeks to provide a helicopter view of the field reality and hence inference drawn do not provide conclusive evidence to any social characteristics in particular, albeit they aid us in spotting an underlying trend.
- The findings are based entirely upon the research conducted in Coimbatore and hence may not be applicable directly to other metropolitan cities and towns of socio-cultural diversity and contextual factors.
- Due to constraints of time, certain topics have not been touched upon at all during the course of the study while some of them like the actual purchase pattern have been explored in a ‘limited’ manner. An in-depth analysis may be further taken up in each of sub-topics covered.
- Moreover the survey is not representative of the whole Coimbatore. The sample was collected only from two zones in Coimbatore city. Therefore, caution needs to be exercised when generalizing these research results to user groups in other geographical areas and environment.

These limitations in no way negate the findings of the study and offer scope for further research in future.

CHAPTER IV
RESULTS AND DISCUSSION

The findings of the study are presented under the following heads:

I. Socio-demographic Profile of the Respondents

II. Economic Environment

III. Living Environment

IV. Electricity Consumption at the Household Level

V. Perception of Households about Solar Energy

VI. Reliability and Green Life Style

VII. Benefits of using Solar Energy Devices

VIII. Problems in using Solar Energy Devices

IX. Path Model

I. SOCIO-DEMOGRAPHIC PROFILE OF THE RESPONDENTS

In order to develop a proper perspective analysis, all major components of social environment must be considered. The general notion of social environment is that it consists of religion, caste, type of family, marital status, size of family and age. A clear insight into the influence that these factors have on the life of the respondents would be of immense significance to understand better the usage of solar energy at the household level. In order to get a proper perspective on the adoption of solar energy at the household level, the respondents were classified into two groups namely, adopters who have been using solar devices and non-adopters who were not using solar devices but intend to use such devices in the future. An equal number of households in each category were selected to give equal representation to both the groups. An attempt was made in this section to see whether these households shared any common socio-demographic characteristics. An analysis of the socio-demographic factors is presented in table 4.1.1.

Religion

Data pertaining to the religion of the adopters and non-adopters unravel that 62 percent of the adopters and 76 percent of the non-adopters owned allegiance to Hindu religion, followed by 38 percent and 14 percent respectively were Christians. About 4 percent and 6 percent in the non-adopters were Muslims and Jains respectively. Thus, Hindus predominates in both categories of the households, followed by Christians.

TABLE 4.1.1
DISTRIBUTION OF RESPONDENTS BASED ON SOCIO-DEMOGRAPHIC FACTORS
(in numbers)

S.No.	Particulars	Adopters	Non-Adopters	All
1.	**Religion**			
	Hindus	31(62.0)	38 (76.0)	6 (69.0)
	Muslims	0 (0.0)	2 (4.0)	2 (2.0)
	Christians	19 (38.0)	7 (14.0)	26 (26.0)
	Jains	0 (0.0)	3 (6.0)	3 (3.0)
	Total	50 (100)	50 (100)	100 (100)
2.	**Caste**			
	BC	34 (68.0)	30 (60.0)	64 (64.0)
	OBC	8 (16.0)	5 (10.0)	13 (13.0)
	Other Community	8 (16.0)	15 (30.0)	23 (23.0)
	Total	50 (100)	50 (100)	100 (100)
3.	**Type of Family**			
	Nuclear	38 (76.0)	41 (82.0)	79 (79.0)
	Joint family	0 (0.0)	0 (0.0)	0 (0.0)
	Extended family	12 (24.0)	9 (18.0)	21 (21.0)
	Total	50 (100)	50 (100)	100 (100)
4.	**Age**			
	Below 30	7 (14.0)	18 (36.0)	25 (25.0)
	30-40	8 (16.0)	12 (24.0)	20 (20.0)
	40-50	16 (32.0)	10 (20.0)	26 (26.0)
	Above 50	19 (38.0)	10 (20.0)	29 (29.0)
	Total	50 (100)	50 (100)	100 (100)
5.	**Marital Status**			
	Married	42 (84.0)	25 (50.0)	67 (67.0)
	Unmarried	8 (16.0)	24(48.0)	32 (32.0)
	Widow	0 (0.0)	1 (2.0)	1 (1.0)
	Total	50 (100)	50 (100)	100 (100)
6.	**Size of Family**			
	2-3 Members	13 (26.0)	12 (24.0)	25 (25.0)
	4-5 Members	33(66.0)	35 (70.0)	68 (68.0)
	Above 6 Members	4(8.0)	3 (6.0)	7 (7.0)
	Total	50 (100)	50 (100)	100 (100)

Source: Based on field survey, 2017.
Figures within parentheses indicate column percentage.

Community

A peculiar type of social grouping which is found in India is the caste grouping. Caste differences even determine modes of domestic and social life and cultural patterns of the people. Community-wise analysis revealed that a majority of the households irrespective of their adoption belong to backward caste, (64 percent) followed by general category (23 percent) and most backward caste (13 percent). Adoption-wise also, backward caste was predominant in the both groups, 68 percent among adopters and 60 percent among non-adopters. It is interesting to note here that the proportion of the backward caste and other backward caste to total sample size was more among adopters while the proportion of other community was higher among non-adopters.

Type of Family

Type of family is an important indicator of the status of the family. Modernisation and disintegration of joint family system has paved the way for the emergence of nuclear family system in India. Out of the 100 samples, 79 percent of the respondents belong to nuclear family and remaining 21 percent belong to extended family. Adoption-wise, 76 percent of the adopters and 82 percent of non-adopters belong to nuclear family. Thus the predominance of nuclear family was seen among both groups of households.

Age of the head of the household

Age of the head of the household is one of the crucial factors in determining adoption of new technology. General credence is that younger generation easily adapt to new innovation when compared to the older generation. However in the case of using solar energy devices it is usually the older generation who favours the use of such technologies when compared to the younger generation. In the present notable age differences was seen among the two groups. The adopters had 37 percent of the respondents in the age category of above 50 years, while only 20 percent were in this category among non-adopters. In contrast, 36 percent non-adopters were below 20 years and this percentage for adopters was 14 percent. In short, the need for using energy saving devices was more popular among the middle age population with 70 percent of the respondents in the age group above of 40 years favouring adoption and use of such devices.

Marital Status

The married population is subjected to more liabilities which encourage them to find ways and means of cutting down on their expenditure especially on their electricity consumption. About 84 percent of the adopters were married and the remaining 16 percent were unmarried. Among the non-adopters 50 percent were married, 48 percent were unmarried and the remaining two percent were widows. Thus nearly $4/5^{th}$ of the adopters were married, while among the non-adopters there were equal representation of married and unmarried respondents.

Size of Family

The family size of less than 5 is considered as a small family and equal to and greater than 5 is considered as a large family. About 92-94 percent of the respondents in both categories practised small family norms with household size not exceeding five members. Thus, both groups shared common features with respect to family size.

Chi-Square Test

To find out the association between the selected socio-demographic factors and the adoption behaviour of the respondents, chi-square test was applied. The null hypothesis tested was:

H_o: The adoption behaviour of the respondents was independent of the selected socio- demographic factors.

H_a: The adoption behaviour of the respondents was not independent of the selected socio- demographic factors.

The calculated chi-square values along with table values are given in table 4.1.2.

TABLE 4.1.2
ASSOCIATION BETWEEN ADOPTION BEHAVIOUR AND SOCIO-DEMOGRAPHIC FACTORS (CHI-SQUARE VALUES)

S.No	Variable	Calculated $\chi 2$ Values	Degrees of Freedom	P value	Inference
1	Religion	11.249	3	0.010	**Reject H_o**
2	Community	3.073	2	0.215	**Accept H_o**
3	Type of Family	0.542	1	0.461	**Accept H_o**
4	Age of Head of the Household	9.818	3	0.020	**Reject H_o**
5	Marital status	13.313	2	0.001	**Reject H_o**
6	Family size	1.772	1	0.183	**Accept H_o**

Source: Estimation based on Field survey, 2017.

From the above table, it can be inferred that the adopters differed from the non-adopters with respect to religion, age of the head of the household and marital status, while with respect to community, type of family and size of family there was no significant difference between two categories of respondents. Thus, the adopters belonged to Hindu religion, above 40 years of age and were married.

II. ECONOMIC ENVIRONMENT

The status of an individual in the society is to a large extent determined by the literacy level and financial conditions of the family. Therefore an analysis on the economic environment is essential. The economic status depends on the literacy level, occupation, income and expenditure of the family. The distributions of respondents based on economic factors are presented in table 4.2.1.

TABLE 4.2.1

DISTRIBUTION OF RESPONDENTS BASED ON ECONOMIC FACTORS

(in numbers)

S.No.	Particulars	Adopters	Non-adopters	All
1.	**Education of Head of the Household**			
	Secondary Level	2 (4.0)	3 (6.0)	5 (5.0)
	Higher Secondary	3 (6.0)	4 (8.0)	7 (7.0)
	Diploma	3 (6.0)	2 (4.0)	5 (5.0)
	Undergraduate	16 (32.0)	16 (32.0)	32 (32.0)
	Post- graduate and Higher level	18 (36.0)	24 (48.0)	42 (42.0)
	Professional Course	8 (16.0)	1 (2.0)	9 (9.0)
	Total	50 (100)	50 (100)	100 (100)
2.	**Occupation of the Head of the Household**			
	Government Employee	19 (38.0)	17 (34.0)	36 (36.0)
	Private Employee	19 (38.0)	21(42.0)	40 (40.0)
	Self-employed	12(24.0)	12 (24.0)	24(24.0)
	Total	50 (100)	50 (100)	100 (100)
3.	**Family Income per month (in Rs.)**			
	Below 20,000	4 (8.0)	13 (26.0)	17 (17.0)
	20,000 to 30,000	15 (30.0)	17 (34.0)	32 (32.0)
	30,000 to 40,000	10 (20.0)	7 (14.0)	17 (17.0)
	40,000 to 50,000	11 (22.0)	6 (12.0)	17 (17.0)
	50,000 and above	10 (20.0)	7 (14.0)	17 (17.0)
	Total	50 (100)	50 (100)	100 (100)
4.	**Total Expenditure per month (in Rs.)**			
	Below 10,000	1 (2.0)	5 (10.0)	6 (6.0)
	10,000-20,000	24 (48.0)	27 (54.0)	51 (51.0)
	20,000-30,000	14 (28.0)	10 (20.0)	24 (24.0)
	30,000 – 40,000	5 (10.0)	7 (14.0)	12 (12.0)
	Above 40,000	6 (12.0)	1(2.0)	7 (7.0)
	Total	50 (100)	50 (100)	100 (100)

Source: Based on field survey, 2017.

Figures within parentheses indicate column percentage.

Education

Education not only creates knowledge and understanding but also generates attitude and behaviour patterns and thereby plays an important role in all kinds of decisions. Information concerning the highest level of education of the adopters unravels that 32 percent of the sample respondents had completed under-graduation level, 36 percent had completed post-graduation and higher studies, 16 percent had completed professional courses, 6 percent higher secondary and 2 percent secondary level. This percentage for non-adopters was 32 percent, 48 percent, 2 percent, 8 percent and 6 percent respectively. Both groups had a high level of education as is evident from the fact that nearly 50 percent of them had completed post-graduation or professional courses. The figure 4.2 shows education status of head of the household.

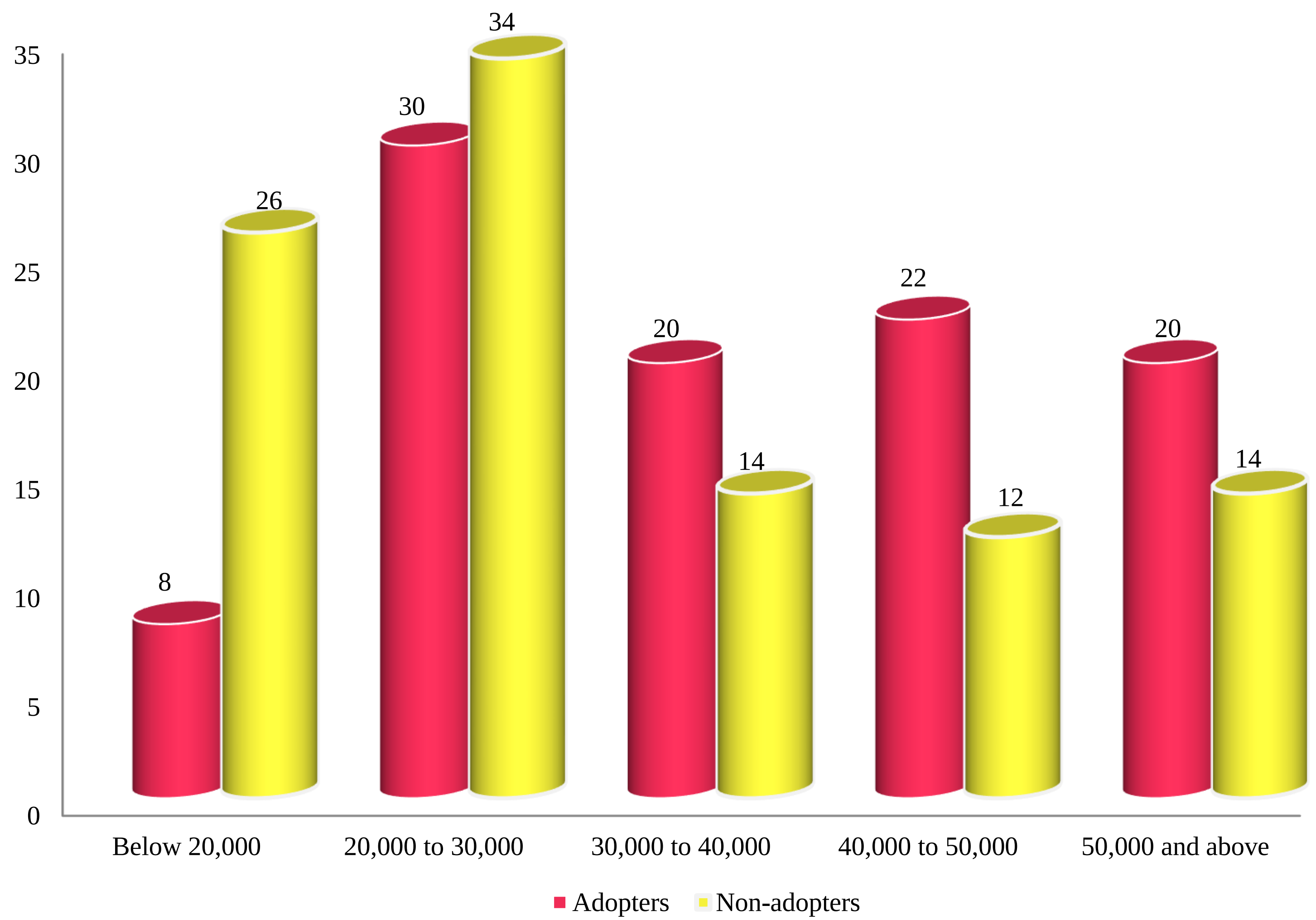
Occupation

The occupation of the head of the household is a factor affecting the decision-making behaviour of the households. Among the adopters there was equal distribution of government and private employees (38 percent each), followed by 24 percent who were self-employed. In contrast, among the non-adopters, majority (42 percent) were employed in private sector, followed by 34 percent in government and the remaining 24 percent were self-employed. Thus, employment pattern did not show any significant differences among the adopters and non-adopters.

Family Income

The income of the family determines the status of the family in the society. Nearly 62 percent of the adopters were in the income brackets of above Rs. 30,000 per month while this proportion among the non-adopters was only 40 percent. The proportion of the respondents earning less than Rs. 30,000 per month was 38 percent for adopters and sixty percent for non-adopters indicating that majority of the adopters were high income earners. Low income may have deterred the non-adopters from investing in solar energy devices.

FIGURE 4.1
FAMILY INCOME (PER MONTH)



Expenditure

The total expenditure per month was marginally higher for the adopters with 50 percent of them spending more than Rs. 20,000 per month, 48 percent spending Rs. 10,000 to 20,000 and 2 percent less than Rs. 10,000 per month. This percentage for non-adopters was 36 percent, 54 percent and 10 percent respectively. Low income may be the cause for the low level of expenditure among non-adopters.

t-Test

To find out whether there are any significant differences among the adopters and non-adopters in terms of years of schooling, family income and expenditure level, t test was applied. The null hypothesis tested was:

Ho: There were no differences in the years of schooling, family income and expenditure level between adopters and non-adopters.

Ha: There were significant differences in the years of schooling, family income and expenditure level between adopters and non-adopters.

The calculated t values and the level of significance are given in the table 4.2.2

TABLE 4.2.2
t-VALUES AND LEVEL OF SIGNIFICANCE

Variable	Group	Mean	Standard Deviation	t Value	Level of Significance
Years of Schooling	Adopters	15.6	2.458	- 0.948	0.345
	Non-adopters	16.1	3.37		
Family income	Adopters	38820.0	17043.69	1.606	0.162
	Non-adopters	32610.0	21388.60		
Expenditure	Adopters	23421.40	11444.98	1.621	0.108
	Non-adopters	20010.80	9501.52		

Source: Estimation based on field survey, 2017.

No adoption differences were seen among the respondents in terms of their years of education, family income and total expenditure as the level of significance was more than 0.05. Thus the adopters did not differ from the non-adopters in terms of education, income and level of expenditure.

III. LIVING ENVIRONMENT

The availability and usage of solar energy depend on the living environment of the households, namely location of the house, ownership of the house and type of house lived in.

Availability of and close proximity to service providers generally increases the demand for the product, while the non-availability tends to lessen the demand for such services. Similarly self-owned and independent houses also increase the demand for solar energy devices. Table 4.3.1 presents the details on the location as well as the housing details of the selected respondents.

TABLE 4.3.1
DISTRIBUTION OF RESPONDENTS BASED ON ECONOMIC FACTORS

(in numbers)

S.No.	Particulars	Adopters	Non-Adopters	All
1.	**Location**			
	City	37 (74.0)	37 (74)	74(74)
	Urban	13 (26)	8 (16)	21 (21)
	Suburban	0 (0.0)	3 (6)	3 (3)
	Rural	0 (0.0)	2 (4.0)	2 (2.0)
	Total	50 (100)	50 (100)	100 (100)
2.	**Ownership**			
	Own house	43 (86)	31 (62)	74 (74)
	Rented House	7 (14)	19 (38)	26 (26)
	Total	50 (100)	50 (100)	100 (100)
3.	**Type of House**			
	Bungalow	9 (18)	4 (8)	13 (13)
	Apartment/ Flat	1 (2)	22 (44)	23 (23)
	Town House	40 (80)	24 (48)	64 (64)
	Total	50 (100)	50 (100)	100 (100)

Source: Based on field survey, 2017.
Figures within parentheses indicate column percentage.

Location

Data pertaining to the location of the house of the respondents unravel that the majority (74 percent) of the sample respondents irrespective of the adoption level were living within city limits. About 26 percent of the adopters and 16 percent of the non-adopters were living in urban areas slightly away from city limits. Around three percent and two percent of the non-adopters' houses were located in semi-urban and rural areas respectively. Thus three-fourth of the households enjoyed close proximity to solar energy service providers.

Ownership of House

While 86 percent of the adopters lived in self-owned houses and the remaining 14 percent in rented houses, this percentage for non-adopters were 62 percent and 38 percent respectively. Thus, ownership of the house may have facilitated the adopters to opt for solar energy system. But the fact that 14 percent of the adopters living in rented accommodation have opted for solar energy devices clearly indicates that ownership of the house was not a constraint in opting for solar energy devices.

Type of House

Majority of the adopters (98 percent) were living in independent houses which include Town and Bungalow type and 2 percent were living in Apartment, while 56 percent of the non-adopters were living in independent houses and 44 percent in Apartment. As solar energy system can be adapted to all types of houses, type of house may not be a significant factor for the non-adopters to switch to solar energy system.

Chi-Square Test

An attempt was to find out if there was any association between housing details and the adoption behaviour of the respondents by using chi-square test. The null hypothesis tested was:

H_o: The adoption behaviour of the respondents was independent of location, ownership and type of house.

H_a: The adoption behaviour of the respondents was not independent of location, ownership and type of house.

The calculated chi-square values along with table values are given in table 4.3.2.

TABLE 4.3.2
ASSOCIATION BETWEEN ADOPTION BEHAVIOUR AND SOCIO-DEMOGRAPHIC FACTORS (CHI-SQUARE VALUES)

S.No	Variable	Calculated $\chi 2$ Values	Degrees of Freedom	P value	Inference
1.	Location of the house	4.895	2	0.086	**Accept H_o**
2.	Ownership of the house	7.484	1	0.006	**Reject H_o**
3.	Type of house	25.097	2	0.000	**Reject H_o**

Source: Estimation based on Field survey, 2017.

From the above table, it can be inferred that the adopters differed from the non-adopters with respect to ownership and type of house (p value < 0.05), while with respect to location there was no significant difference between two categories of respondents. Thus, the adopters can be characterised as those living in self-owned, independent houses.

IV. ELECTRICITY CONSUMPTION AT THE HOUSEHOLD LEVEL

One of the biggest problems that our nation is facing in today's world is supply of electricity to the public. The main cause for this problem is increase in the usage of electrical equipments, decrease in the availability of natural resources like coal, water and gas. Coal and water are the major resources for the generation of electricity in India. Lack of these resources have worsened the problem to the extent that public often face power cuts. These power cuts have not deterred the households from using electrical equipments, but often one finds the use of such products is on the rise and along with it the consumption of electricity. In this section an attempt was made to identify the electrical gadgets used by the households and amounts spend by the household on electricity consumption per month.

Type of Electrical Gadgets Used

Table 4.4.1 presents the details on various types of gadgets used by the adopters and non-adopters.

TABLE 4.4.1
PERCENTAGE OF HOUSEHOLDS USING ELECTRICAL GADGETS

S.No.	Type of Gadget	Adopters	Non-Adopters	All
1.	Light	100	100	100
2.	Fan	100	100	100
3.	Mixie	100	100	100
4.	Washing Machine	90	78	84
5.	Iron Box	96	100	98
6.	Fridge	98	80	89
7.	Induction stove	52	38	45
8.	Home Theatre	26	20	23
9.	TV	98	98	98
10.	Microwave Oven	40	14	27
11.	Music System	38	28	33

Source: Based on field survey, 2017.

All households irrespective of their adoption pattern were using gadgets like light, fan and Mixie which are considered basic necessity for a household. Similarly television was used by 98 percent of the adopters and non-adopters. However, in the usage of other gadgets significant differences was seen in the two categories of the households. Usage of washing machine, fridge, induction stove, home theatre, microwave oven and music system was seen more among the adopters, while iron box usage was 100 percent among non-adopters and 96 percent among adopters. The increase use of gadgets among adopters can be attributed to their adoption of solar energy system.

Amount spend on Electricity Consumption

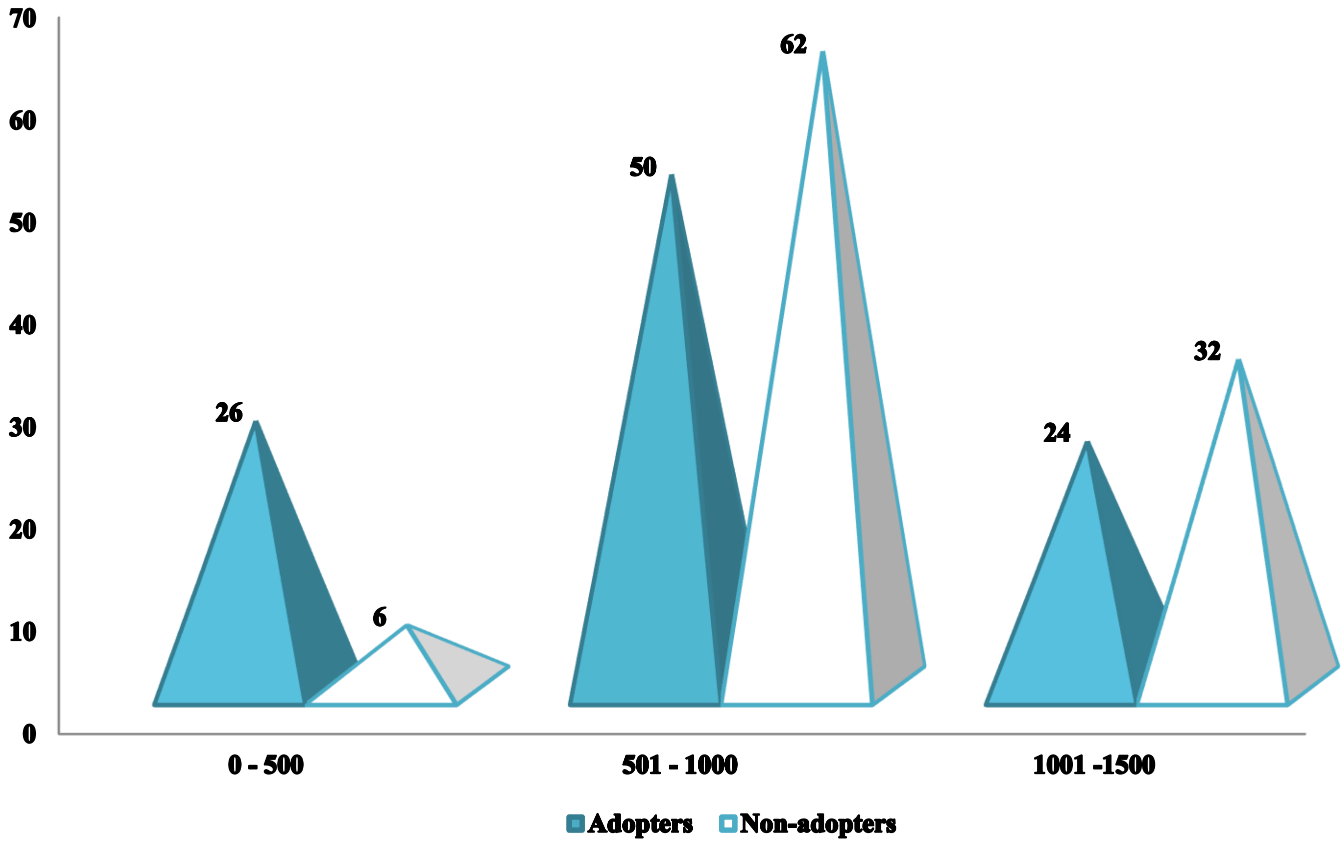
Table 4.4.2 gives details on the amount spend on electricity per month by the selected households.

TABLE 4.4.2
AMOUNT SPEND ON ELECTRICITY CONSUMPTION PER MONTH

Amount Spend(in Rs. Per month)	Adopters	Non-adopters	All
0 – 500	13 (26.0)	3 (6.0)	16 (16.0)
501 – 1000	25 (50.0)	31 (62.0)	56 (56.0)
1001 -1500	12 (24.0)	16 (32.0)	28 (28.0)
Total	50 (100)	50 (100)	100 (100)

Source: Based on field survey, 2017.
Figures within parentheses indicate column percentage.

FIGURE 4.2
AMOUNT SPEND ON ELECTRICITY CONSUMPTION (PER MONTH)



From the table it is evident that expenditure on electricity varied among adopters and non-adopters. While 50 percent of the adopters spend between Rs.501 to 1000 on electricity per month, this percentage among non-adopters was 62 percent. Similarly while 26 percent of the adopters spend less than Rs. 500 or Rs.500 per month, this proportion among non-adopters was only 6 percent. In contrast, while 32 percent of the non-adopters spend more than Rs. 1000 per month, the percentage of adopters was only 24 percent. Thus, the low spending on electricity per month for the adopters may be attributed to the alternate source of energy available to them.

t Test

To find out whether there are any significant differences among the adopters and non-adopters on the amount spend on electricity consumption, t test was applied. The null hypothesis tested was:

Ho: There were no differences in the amount spend on electricity consumption between adopters and non-adopters.

Ha: There were significant differences in the amount spend on electricity consumption between adopters and non-adopters.

The calculated t values and the level of significance are given in the table 4.4.3

TABLE 4.4.3
t-VALUES AND LEVEL OF SIGNIFICANCE

Variable	Group	Mean	Standard Deviation	t Value	Level of Significance
Amount spend on electricity consumption	Adopters	878.40	253.43	-2.370	0.020
	Non-Adopters	1012.06	307.65		

Source: Estimation based on Field survey, 2017.

The analysis of the average amount spend on electricity consumption reveals that the non-adopters spend a higher amount of Rs. 1012.06 per month than the adopters whose average spending was only Rs. 878.40 per month showing a mean difference of Rs. 133.58 per month. The t value also indicates there was significant differences in the amount spend on electricity by two groups of households at five percent level. Thus lack of alternative source of energy may be the reason for increasing spending on electricity by non-adopters.

V. PERCEPTION OF HOUSEHOLDS ABOUT SOLAR ENERGY

This research study focused on the adoption of solar power technologies by the households, most particularly the attitudes of householders to solar power technologies as opposed to the supply or distribution of solar systems. The research aimed to understand the issues that seem to promote or prevent the adoption of solar power technologies by householders. To get a more realistic picture on the issues pertaining to solar energy utilisation, an attempt was made to discuss separately the attitude of the adopters and non-adopters.

A. ADOPTERS' VIEWPOINT

Awareness about Solar energy

The advent of renewable energy is very timely as more and more individuals are becoming curious and engaging in the increasing role of renewable energy in the country. What general masses know, think and talk about renewable is viewed as absolutely essential in determining the level of acceptability of renewable energy among Indian citizens. Research has shown that interest and support for renewable energy can be increased by informed dialogue and information sharing. The respondents were asked about the source of information about solar energy product, purpose of using solar energy and their views on whether it is possible to replace the conventional energy with solar energy. The details are presented in table 4.5.1

TABLE 4.5.1
AWARENESS ABOUT SOLAR ENERGY AMONG ADOPTERS

S.No.	Particulars	Number of household	Percentage
1.	**Source of Information**		
	Advertisement	13	26
	Television	13	26
	Exhibition	8	16
	Neighbours	16	32
	Total	50	100
2.	**Shift to Solar Energy to meet Power Demand**		
	Fully	7	14
	Partially	37	74
	Not at all	6	12
	Total	50	100
3.	**Purpose of Using Solar Energy**		
	Heating	32	64
	Light	9	18
	Solar Home Lighting	9	18
	Total	50	100

Source: Based on field survey, 2017.
Figures within parentheses indicate column percentage.

The major information about solar technologies for 32 percent of the adopters was neighbours, followed by Advertisement (26 percent), Television (26 percent) and Exhibitions (16 percent). Thus neighbours and media played a significant role in promoting and creating awareness about solar technologies. Venketraman and Sheeba (2014) also opined that majority (54.68 percent) of the respondents were aware about the solar energy devices through advertisements.

The survey questions to assess the awareness among the adopters about the potential of solar energy to meet electricity demand at the household level show near positive response with 74 percent stating partially, 14 percent fully and 12 percent not at all. This leads to the conclusion that the adopters have a positive outlook about the role that solar energy can play in the near future and its potential to gradually replace dependence on electricity.

About 64 percent of the adopters had knowledge about the use of solar energy for heating and an equal percentage (18 percent) was aware about its use for lighting and solar home lights. However the adopters had no knowledge regarding its use for cooking and generating power for running home gadgets. Thus, the adopters had limited knowledge regarding the applications of solar energy. This highlights the need for promoting greater awareness among the respondents on the utility of solar energy.

Type of Solar Energy Devices and Level of Satisfaction

Adopters were asked to state the type of solar devices they used and the level of satisfaction in its performance. The details are presented in table 4.5.2

TABLE 4.5.2
TYPE OF SOLAR ENERGY DEVICES USED AND LEVEL OF SATISFACTION

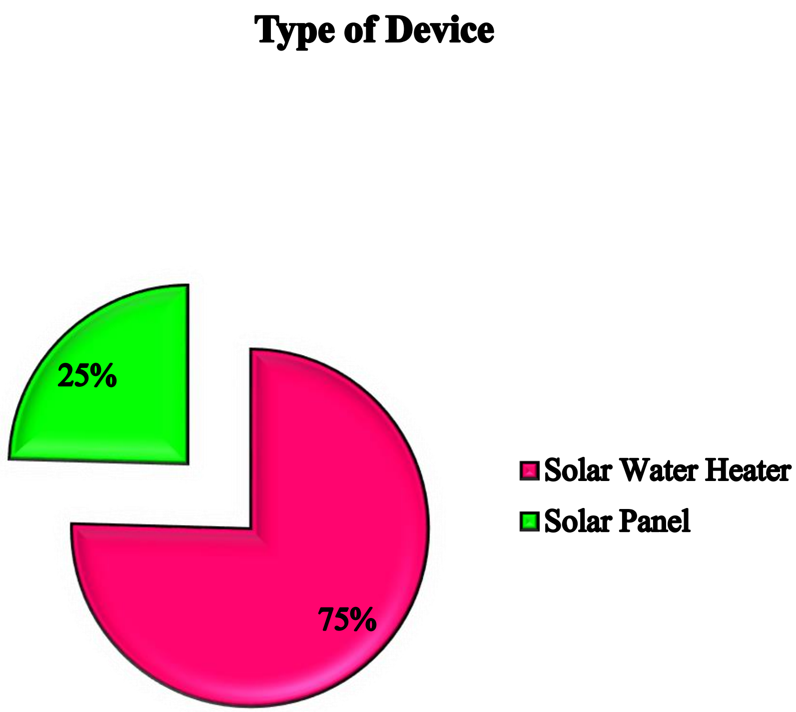
S. No.	Type of Device	Percentage of Adopters	Level of Satisfaction (in Percentage)		
			Satisfied	Neutral	Dissatisfied
1.	Solar Water Heater	86	60	6	20
2.	Solar Panel	28	22	6	0

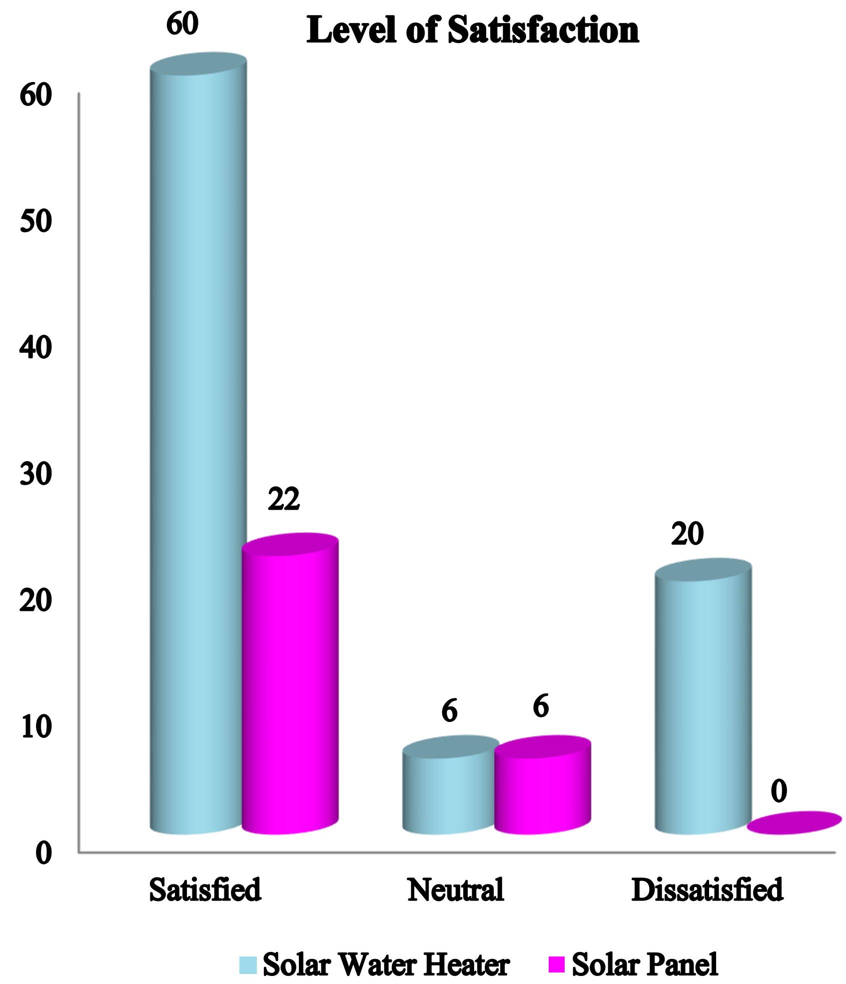
Source: Based on field survey, 2017.

The two solar devices popularly used by the adopters were solar water heater and solar panel. The proportion of respondents using these devices was 86 percent and 28 percent respectively. Thus solar water heater enjoyed greater popularity among the adopters when compared to solar panel. The WWH Report (2015) also points out that solar water heater was the most popular choice of Renewable energy technology among individuals. Other popular applications included solar lantern and solar PV for electricity. The level of satisfaction in the use of these products also varied with 60 percent being satisfied with performance of solar water heater, 6 percent neutral and 20 percent expressing dissatisfaction in its performance. In contrast, while none had expressed dissatisfaction in the use of solar panel, 22 percent were satisfied and 6 percent were neutral. Thus, the service providers should offer a good quality system at a reasonable price with adequate capacity and longevity to meet the requirements of the customers. This will contribute to the strengthening of customers' loyalty towards solar devices.

FIGURE 4.3

TYPE OF SOLAR ENERGY DEVICES USED AND LEVEL OF SATISFACTION





Reasons for Buying Solar Devices

Solar technology is becoming more popular, day by day world over as an attractive alternative to conventional electricity such as no monthly bills, no fuel cost, very little repair and maintenance costs, easy to install any where etc. It also creates employment opportunities and contributes to national income. By using these systems people can improve their social condition through education, running TV, CD, DVD players, lighting, telecommunication through Solar Home System powered mobile phones etc. In the present study, the respondents were asked to rank the reasons for buying solar devices and ranks were converted into percent position by using the formula:

$$\text{Percent position} = \frac{100(R_j - 0.5)}{N}$$

Where R_j is the rank of the j^{th} item and N refers to the number of items ranked. The percent position was converted into score by using Garrets' Rating scale and the average score obtained for differential reasons are tabulated and presented in table 4.5.3.

TABLE 4.5.3
REASONS FOR BUYING SOLAR DEVICES

S.No.	Reasons	Average Score	Rank
1.	Lower power bill	59.52	3
2.	Generate own electricity	70.16	1
3.	Improve the environment	68.24	2
4.	A long term investment for power	46.74	5
5.	Increasing the value of home	42.46	7
6.	Sell home quickly	33.2	10
7.	Save time	43.1	6
8.	Access energy anywhere	42.18	8
9.	Promote green energy	53.32	4
10.	Access tax credit and government incentives	35.58	9

Source: Estimation based on Field survey, 2017.

The ranking of the average score revealed that the prime reason for installing solar devices was to 'generate own electricity' (1^{st} rank). This would free the household from power outages which are on the increase in Coimbatore city. The next important reason was to

'Improve the environment' (2nd rank), followed by 'lower power bill' (3rd rank), 'promote green energy' (4th rank) and 'a long term investment for power' (5th rank). Thus people did understand the long term benefits of solar energy. The reasons which were of least priority were 'Access tax credit and government incentives' (9th rank) and 'sell home quickly' (10th rank). This once again reiterates that respondents gave more priority to long term potentialities of solar technology rather than the monetary benefits they would receive by adopting the schemes. Thus the adopters had positive outlook towards usage of solar energy devices.

Cost of Installation

The major barrier to the wide use of solar energy devices world over was the capital and installation cost. The high cost often dissuades the consumers from using energy saving devices. Table 4.5.4 presents the details on the cost expended in installing solar devices.

TABLE 4.5.4
COST OF INSTALLING SOLAR ENERGY DEVICES

Cost of Installation (in Rs.)	Number of households	Percentage
Up to 50,000	9	18
50,001 -1,00,00	36	72
Above 1,00,000	5	10
Total	50	100

Source: Based on field survey, 2017.

From the table it is evident that majority (72 percent) had to spend Rs. 50,000 to Rs. 1 lakh in installing solar devices, followed by 18 percent less than Rs. 50,000 and 10 percent above Rs. 1 lakh. Information provided by the informants also reveals that they had used their own resources as capital rather depending on borrowed capital. Thus, the high cost may have acted as a deterrent in increasing the demand for such energy saving devices. A survey conducted by WWF (2015) among the manufacturers/ retailers of Renewable energy product reveal that the biggest challenge they face was cost and this was stated by 75 percent of the manufacturers.

Adopters Awareness on Government Subsidies

Research has highlighted that many Indians have not heard about government subsidies on renewal energy applications. Further studies on renewal energy application have emphasized that large public subsidies, both implicit and explicit, in varying amounts can distort investment cost decisions. The selected respondents in the current study were asked whether they were aware about government scheme and if so whether they had availed the benefits of such scheme. The findings are presented in table 4.5.5.

TABLE 4.5.5

AWARENESS AND AVAILING OF GOVERMENT SUS|BSIDY

S.No.	Particulars	Number of household	Percentage
1.	**Awareness of Government Subsidy**		
	Yes	42	84
	No	8	16
	Total	50	100
2.	**Availing Government Subsidy**		
	Yes	20	40
	No	30	60
	Total	50	100

Source: Based on field survey, 2017.

About 84 percent of the respondents were aware about the existence of Government subsidy and only 16 percent have expressed their ignorance about the existence of such schemes. Despite knowing about the scheme, only 40 percent had approached the authorities for subsidy. As claiming subsidy was quite complex and time consuming, it may have deterred the customers from availing such benefits. WWF Report on Renewable Energy (2015) also points out that about 65 percent of RE manufacturers say that their consumers are aware of subsidies but are clueless on how to avail them. Besides, 43 percent of the respondents also said that they have no information at all on existing subsidies on renewable. Thus, information on subsidies was perceived to be quite complicated and very difficult for consumers to decode and understand. Lack of awareness coupled with complexities involved in claiming subsidy may be the reason why the respondents do not avail the benefits of such scheme.

Years of Using and Problems in Purchasing the Device

Table 4.5.6 presents details on how long the respondents have been using the device and whether they faced any difficulty in purchasing the device.

TABLE 4.5.6
YEARS OF USING AND PROBLEMS IN PURCHASING THE DEVICE

S.No.	Particulars	Number of household	Percentage
1.	**Years of Using the Device**		
	Up to 2 years	12	24
	3 -4 years	26	52
	5 years and above	12	24
	Total	50	100
2.	**Problems in Purchasing the Device**		
	Yes	4	8
	No	46	92
	Total	50	100

Source: Based on field survey, 2017.

Majority (52 percent) have been using the device for the 3 to 4 years, 24 percent for the past 5 years and more and equal proportion (24 percent) for less than 5 years. Thus the years of usage clearly indicates that nearly three-fourth of the respondents are not 'late adopters' but 'early adopters', who have been using the solar device for more than 3 years.

About 92 percent of the adopters stated that they did not face any problems in purchasing the device and only a negligible proportion (8 percent) has claimed difficulties in acquiring the device.

Savings on Electricity Charges

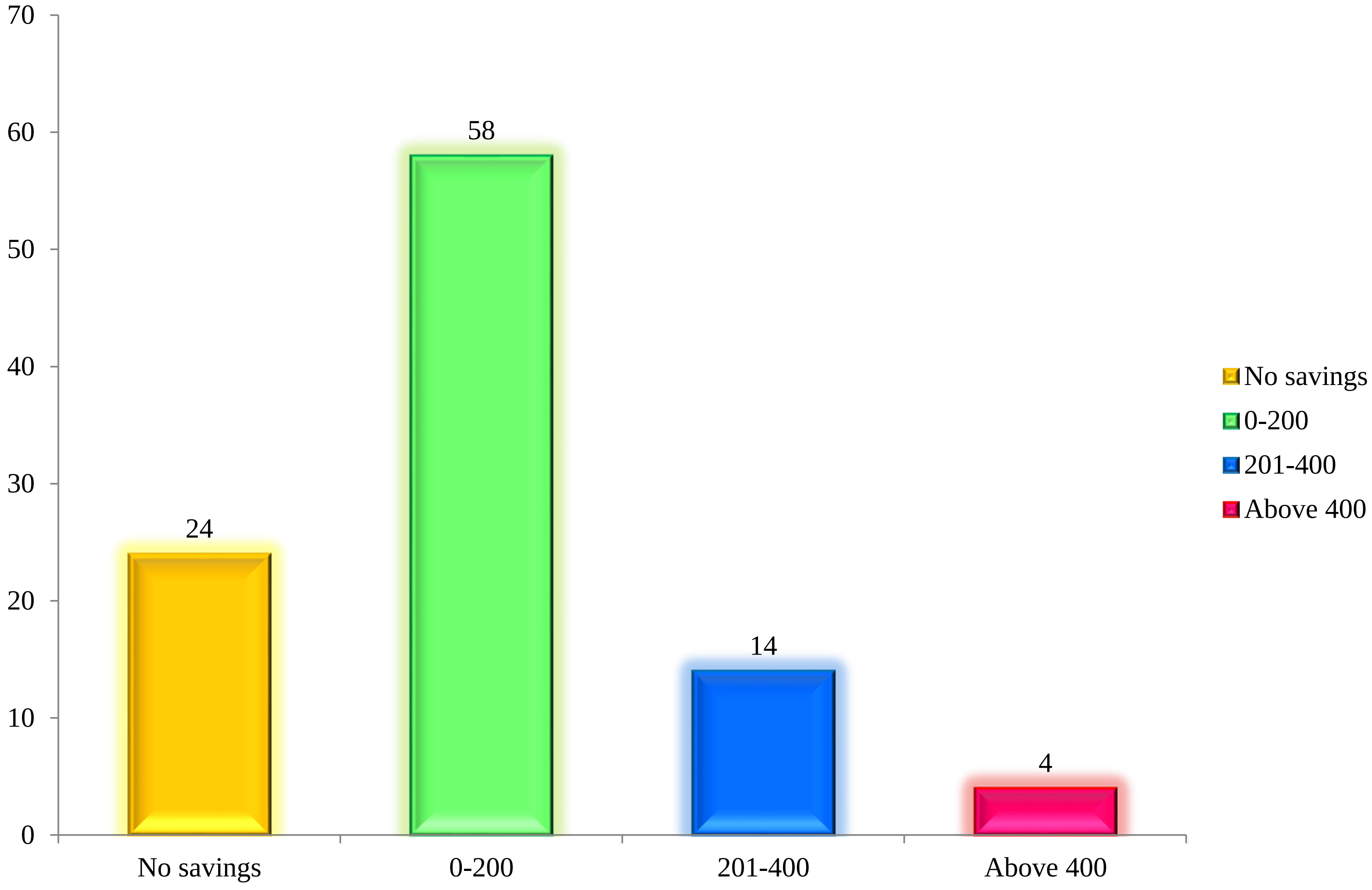
In India, solar energy devices are launched mainly with the objective to create environmental awareness of mass power consumption and the need to conserve power using solar energy devices. Customers also opt for such devices with the objective of reducing their power bill and also to save themselves from power outages. Hence the customers were asked whether they were able to find any differences in their power bill and if so the actual amount of savings. The details are shown in table 4.5.7.

TABLE 4.5.7
SAVINGS ON ELECTRICITY CHARGES

S.No.	Particulars	Number of household	Percentage
1.	**Did Difference Exist?**		
	Yes	38	76
	No	12	24
	Total	50	100
2.	**Amount of Savings (in Rs.)**		
	No savings	12	24
	0 - 200	29	58
	201 -400	7	14
	Above 400	2	4
	Total	50	100

Source: Based on field survey, 2017.

FIGURE 4.4
SAVINGS ON ELECTRICITY CHARGES



Installing solar devices did make a difference to their power bill for 76 percent of the respondents and 24 percent claim that it did not make any differences. The savings in their power bill also varied across the adopters with majority (58 percent) stating savings of less than Rs.200 per month, 14 percent above Rs.200 but less than Rs.400 and for 4 percent above Rs. 400. Only 24 percent stated there was no savings. Thus, nearly three-fourth of the adopters experienced some savings in their power bill by installing solar devices.

Overall Satisfaction in using solar devices

In order to determine the acceptability of solar energy applications among the respondents, it is important to know the overall satisfaction of the respondents in using the devices. The adopters were asked to rate themselves on a five point scale starting from extremely dissatisfied to extremely satisfied and the results are presented in table 4.5.8.

TABLE 4.5.8
LEVEL OF SATISFACTION

Level of Satisfaction	Number of household	Percentage
Extremely Dissatisfied	0	0.0
Slightly Dissatisfied	0	0.0
Neutral	11	22.0
Slightly Satisfied	27	54.0
Extremely Satisfied	12	24.0
Total	50	100

Source: Based on field survey, 2017.

Analysis showed that 54 percent were slightly satisfied, 24 percent extremely satisfied and the remaining 22 percent were neutral. It is noteworthy that none of the respondents have expressed their dissatisfaction in using the device. Thus 78 percent of the respondents have expressed their satisfaction in using solar devices. These are people who can definitely influence the prospective buyers to shift to a greener life style. This augurs well for a city like Coimbatore and a country like India where power outages are a common feature of every day existence.

B. NON-ADOPTERS VIEWPOINT

Continued use of conventional energy sources is set to face multiple challenges in the current scenario given the depletion of reserves, global warming and other environmental challenges and the significant fuel price rise. Renewable energy is the solution to the growing energy challenges as they are abundant, inexhaustible and environmentally friendly. Thus the Government has taken significant steps in promoting renewable energy in the country. Research studies have indicated that the major impediments in the adoption of renewable energy had been lack of awareness among the public. In the present study the attitude of the public was assessed along with their awareness and knowledge about solar energy in terms of its contribution to greener environment and identifies some of the barriers to adoption.

Awareness and Source of Information

Table 4.5.9 summarizes the information about the awareness among the non-adopters about solar energy devices and the source of information.

TABLE 4.5.9
AWARENESS ABOUT SOLAR DEVICES AND SOURCE OF INFORMATION

S.No.	Particulars	Number of household	Percentage
1.	**Awareness about Solar Energy**		
	Yes	36	72
	No	14	28
	Total	50	100
2.	**Source of Information**		
	Newspapers	9	18
	Magazine	8	16
	Advertisement	19	38
	Don't Know	14	28
	Total	50	100

Source: Based on field survey, 2017.

The assessment of the awareness of the public about solar devices revealed that 72 percent had knowledge about the devices, while 28 percent had little knowledge about it. Khambalkar, et.al (2010) in his study found that 53 percent had knowledge about renewable energy while 48 percent lacked awareness. This means that there was need for wide publicity of available technologies among the public so as to motivate them to adopt energy saving devices.

The major source of information for 38 percent of the respondents was advertisement, followed by Newspapers (18 percent) and magazine (16 percent). Thus, media played a significant role in creating awareness about solar devices.

Plan to adopt Solar Devices in Future

Solar devices are power generators capable of meeting the energy demands of the users and providing security of energy supply. Based on this concept, opinion was sought from the non-adopters whether they plan to use solar device in future. The findings are summarised in table 4.5.10.

TABLE 4.5.10
OPINION OF NON-ADOPTERS IN USING SOLAR DEVICES IN FUTURE

Particulars	Number of household	Percentage
Plan to Use Solar Devices in Future		
Yes	25	50
No	25	50
Total	50	100

Source: Based on field survey, 2017.

The respondents were evenly divided when asked about their plans to use solar devices in future. While 50 percent replied in affirmative, an equal number negatived the idea. This implies that the non-adopters need to be more educated about the advantages of using such energy sources and the Government need to encourage the non-users by providing necessary incentives and subsidies which will encourage the public to switch to renewable energy sources.

Reasons for Adoption

An attempt was also made to determine the reasons for personal encouragement of solar devices and the results are summarised in table 4.5.11

TABLE 4.5.11
REASONS FOR ADOPTION

(in percentage)

S.No	Details	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
1.	Cut down on electricity charge	30	10	10	0	0
2.	Low maintenance cost	24	16	10	0	0
3.	Generate electricity without pollution	26	22	2	0	0
4.	Increase house resale value	12	26	12	0	0
5.	Most reliable and renewable energy	16	26	8	0	0
6.	Reduce global warming	30	16	4	0	0
7.	Energy independent	32	14	4	0	0
8.	Free from power cut	24	22	4	0	0
9.	Save time	28	14	8	0	0

Source: Based on field survey, 2017.

The assessment of the reasons for the adoption of solar devices by non-adopters showed that 32 percent strongly believed that it would make them ‘energy independent’, while 14 percent agreed and 4 percent were neutral. The next most important reasons for switching to solar energy was it would ‘reduce global warming’ (30 percent strongly agreed, 16 percent agreed and 4 percent were neutral) and ‘cut down on electricity charge’ (30 percent strongly agreed, 10 percent agreed and 10 percent were neutral). Other reasons stated by the respondents were ‘save time’, ‘generating electricity without pollution’ and ‘freedom from power cuts’. The proportion of respondents who strongly believed in these statements varied from 28 to 24 percent. About 26 percent agreed that it would ‘increase the resale of their house’ and equal percentage agreed that it was ‘most reliable and renewable energy’. Thus many of the respondents were positive about the characteristics of solar devices as an energy saver, non-polluting device and as a means to reduce global warming.

Reasons for Non-Adoption

The non-adopters, who not willing to adopt solar devices in future, were asked to state the reasons for non-adoption and the information is summarised in table 4.5.12.

TABLE 4.5.12
REASONS FOR NON-ADOPTION

(in percentage)

S.No	Details	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
1.	No proper knowledge about incentives provided by the government	28	14	8	0	0
2.	Infrastructural constraints	12	22	14	2	0
3.	No easy availability of the technology in the market	6	6	36	2	0
4.	Individuals are not convinced enough to adopt the technology	6	22	20	2	0
5.	Restricted accessibility to such products	8	24	18	0	0
6.	High maintenance cost	12	28	10	0	0
7.	Rental habitant	16	10	24	0	0
8.	Financial constraint	14	24	12	0	0
9.	Do not suit my external decoration	6	12	30	2	0
10.	Its unsuitable for climatic conditions in my area	6	22	20	2	0
11.	initial cost a barrier to invest	18	16	14	2	0

Source: Based on field survey, 2017.

The results of the analysis show that the respondents are unlikely to adopt solar devices if they perceive ‘lack of knowledge about Government subsidy’ (28 percent strongly agreed), ‘high maintenance cost’ (28 percent agreed), ‘financial constraint’ (24 percent agreed), ‘restricted accessibility to such product’ (24 percent agreed), ‘not convinced about the technology’ (22 percent agreed), ‘infrastructural constraint’ (22 percent agreed) and ‘unsuitable climatic conditions’ (22 percent agreed). Similarly, the respondents will not adopt solar devices if they live in 'rental accommodation' (16 percent strongly agreed) and if they feel 'it does not suit external decoration' (12 percent agreed). Thus the adoption of solar device was closely linked to cost or financial aspects of the system and the knowledge about the technology and if these are improved, adoption should follow as more reasons for people to adopt become apparent.

Knowledge about Service Providers

Awareness about the service providers is essential for the success of any project and more so in the case of solar devices as not many are proficient in the technology and use of such devices. Hence the non-adopters were asked if they were aware of the vendors from whom the products can be purchased. The results are presented in table 4.5.13.

TABLE 4.5.13
ACCESS TO INFORMATION ON VENDORS

Access to Information	Number of household	Percentage
Yes	9	18
No	41	82
Total	50	100

Source: Based on field survey, 2017.

Of 50 non-adopters surveyed, a high percentage of people, i.e., 82 percent did not know of vendors from whom they could purchase solar equipments, which shows that a huge number of people still do not have knowledge of and access to technology providers. Only 18 percent of the respondents knew of avenues to purchase such products. WWF Report (2015) on Renewable Energy in India also found that 66.37 percent did not know of outlets from where they could purchase RE equipment. Thus lack of information about service was a major obstacle in the adoption of solar technology.

Financial Sustainability of Solar Devices

Acceptability of solar technology depends to a large extent on the financial sustainability of solar energy in the long run since the high cost often deter the consumers from adopting the technology. If the consumers perceive that they will gain in long run by installing the technology despite the huge initial investment they will definitely opt for solar technology. Hence the respondents were asked to rate whether investing in solar energy devices was financially viable in the long run on a five point scale ranging from strongly agree to strongly disagree. The results are presented in table 4.5.14.

TABLE 4.5.14
OPINION ON FINANCIAL SUSTAINABILITY OF SOLAR DEVICES

Degree of Agreement	Number of household	Percentage
Strongly Agree	5	10
Agree	33	66
Neutral	12	24
Disagree	0	0
Strongly Disagree	0	0
Total	50	100

Source: Based on field survey, 2017.

Analysis showed that 66 percent agreed that solar devices were financially sustainable in the long run, followed by 24 percent neutral and 10 percent strongly agreed with the statement. Thus except for 12 respondents, majority replied in affirmative that solar devices are financially sustainable in the long run. WWF Report (2015) also point out that 87 percent of the respondents think that investing in renewable energy was financially viable. This means that there is tremendous scope for expansion of solar energy devices in the country. Individuals are keen and eager to adopt new technology. Rampant scaling up and rapid awareness creation is the need of the hour.

Type of Application Respondents Plan to Use

Since two-thirds of the respondents perceived that investing in solar devices was financially viable, they were asked to state which application they will install initially. The respondents were asked to rank the applications in the order of priority and ranks were converted into percent position by using the formula:

$$\text{Percent Position} = \frac{100(R_j - 0.5)}{N}$$

where R_j is the rank of the i^{th} item and N refers to the number of items ranked. The percent position was converted into score by using Garrets' Rating scale and the average score obtained for differential reasons are tabulated and presented in table 4.5.15.

TABLE 4.5.15
RANK ANALYSIS OF TYPE OF SOLAR DEVICES TO BE INSTALLED

S.No.	Type of Devices	Average Score	Rank
1.	Heating	56.9	2
2.	Lighting	58.94	1
3.	Cooking	41.9	5
4.	Power to Home Appliances	52.76	3
5.	Solar Home Lighting	49	4
6.	Solar Flashlights	39.62	6

Source: Estimation based on field survey, 2017.

The analysis of ranks reveal that applications they intend installing in the order of priority was lighting (1^{st} rank), followed by heating (2^{nd} rank), power to home appliances (3^{rd} rank) and solar home lighting (4th rank). The respondents gave least priority to cooking (5th rank) and using solar flashlights (6th rank). The increased importance given to lighting and heating may be attributed to constant power outages faced in the city and the need to slash power bills.

VI. RELIABILITY AND GREEN LIFE STYLE

Given the present trends of increasing energy use and requirements to minimize environmental impact, green energy adoption has become a key element of strategies to ensure long-term economic growth (Harmon and Cowan, 2009). Considering the facts, on the one hand there is indeed a rising concern for the environment from people and government, resulting in that the importance of renewable forms of energy is on the rise but at the same time there are many people who still resist this new alternative energy source, the following research question was asked to the selected sample to what extent they perceived the solar devices to be reliable and promoting green lifestyle. The findings are presented in table 4.6.1.

TABLE 4.6.1

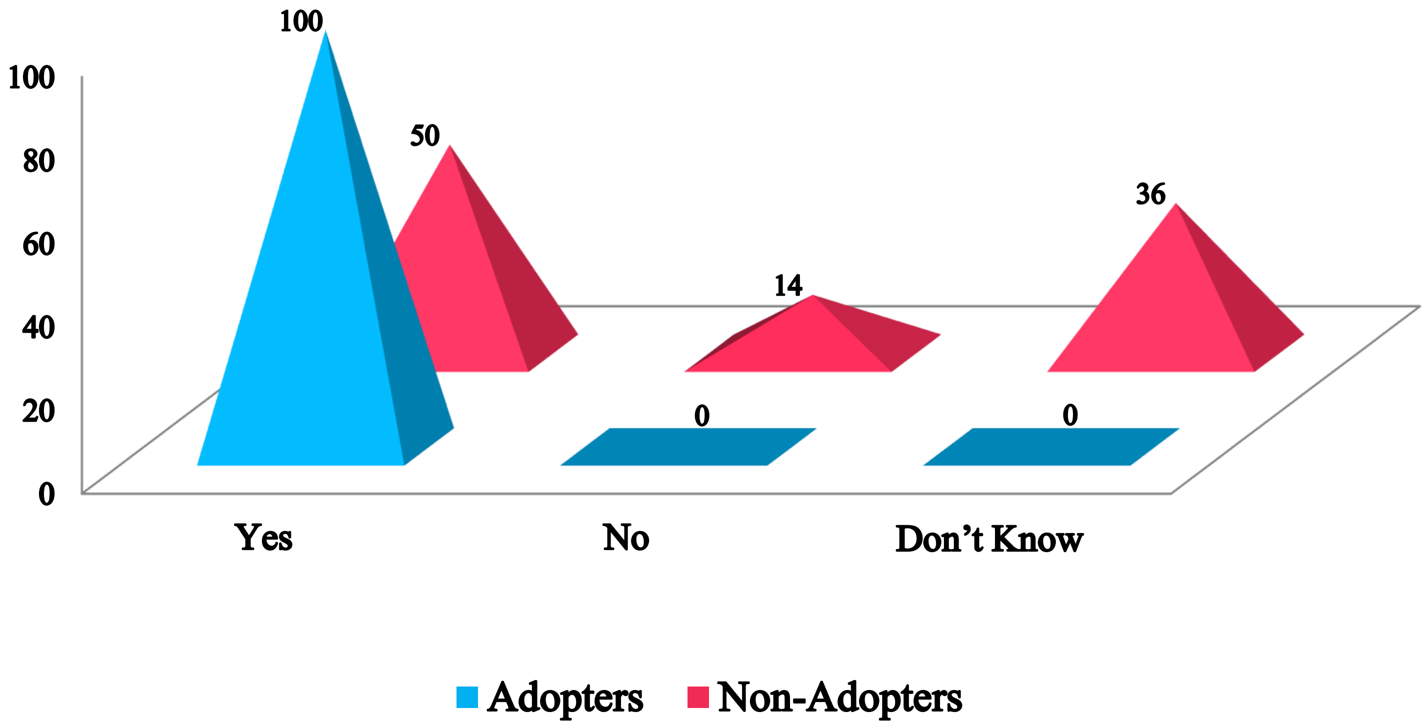
OPINION ON RELIABILITY AND GREEN LIFESTYLE OF SOLAR DEVICES

Particulars	Adopters	Non-Adopters	All
Yes	50 (100)	25 (50.0)	75 (75.0)
No	0 (0.0)	7 (14.0)	7 (7.0)
Don’t Know	0 (0.0)	18 (36.0)	18 (18.0)
Total	50 (100)	50 (100)	100 (100)

Source: Based on field survey, 2017.

All the adopters opined that solar devices were not only reliable, but also promote green lifestyle by minimizing environmental impact. In contrast, the opinion of the non-adopters was divided with 50 percent believing it was reliable and promotes green lifestyle, 36 percent stating their ignorance and 14 percent saying no. The 50 percent who have replied negatively or expressed their ignorance are those who do not have experience in using the device or lacked sufficient knowledge on solar devices. Since majority (75 percent) of the respondents are positively inclined to solar applications and that it can promote green lifestyle, there is tremendous scope to scale up its applications in the city and country as a whole.

FIGURE 4.5
OPINION ON RELIABILITY AND GREEN LIFESTYLE OF SOLAR DEVICES



VII. BENEFITS OF USING SOLAR ENERGY DEVICES

Past research shows that domestic solar system are a proven and effective technology which offers the opportunity for individuals in terms of savings on power bill, reduce pollution (Luque,2001), technically reliable(Knudsen, 2001) and in terms of compatibility with other technologies. Timilsina et al. (2000) suggest solar power is attractive at a national policy level because it can reduce national carbon emissions and contribute to the GDP through jobs and income in the manufacturing and engineering sectors and provide an export product. Hence an attempt was made to identify the perceived benefits of using solar devices from point of view of adopters, non-adopters and all respondents taken together. Five point Likert scale was used to ask the respondents how strongly they agree or disagree with a statement, with most preferred statement getting a score of five and the least preferred statement a score of one. Factor analysis was used to identify the underlying dimensions in the benefits of using solar devices. To determine the reliability of applying factor analysis the Cronbach's alpha test was applied and presented in table 4.7.1.

TABLE 4.7.1

CRONBACH'S RELIABILITY TEST

S.No	Groups	Cronbach's Alpha
1.	Adopters	0.713
2.	Non-adopters	0.808
3.	All	0.763

Source: Estimation based on Field survey, 2017.

The Cronbach's alpha value for adopters, non-adopters and all respondents were, 0.713, 0.808 and 0.763 respectively, which was greater than .7 and indicates the internal consistency of the various constructs used in identifying the benefits of using solar devices.

To determine the appropriateness of applying factor analysis the KMO and Bartlett's test measures were computed and the results are presented in table 4.7.2.

TABLE 4.7.2

KMO AND BARTLETT'S TEST MEASURES

Measure \ Group	Adopters	Non-Adopters	ALL
Kaiser-Meyer-Olkin Measure	0.511	0.625	0.677
Bartlett's Test of Sphericity (i) Approx. Chi-Square	229.564	195.788	316.243
(ii) Degrees of freedom	36	36	36
(iii) Significance	0.000	0.000	.000

Source: Estimation based on Field survey, 2017.

The KMO statistics for adopters, non-adopters and all respondents were 0.511, 0.625 and 0.677 signifying higher than acceptable adequacy of sampling. The Bartlett's test of sphericity was also found to be significant at one percent level providing evidence of the presence of relationship between the variables to apply factor analysis.

The table 4.7.3 enlists the Eigen values, their relative explanatory powers and the factor loadings for 9 components identified within the data set. The Eigen values greater than one alone was considered for inclusion in the analysis. Results indicates first three factors alone was greater than one for adopters, non-adopters and all respondents, indicating that these factors alone were appropriate for inclusion in the analysis. The percentage of variations accounted by the three factors was 70 percent for adopters, 71.78 percent for non-adopters and 68.86 percent for all respondents.

For adopters, factor 1 had significant loadings on two dimensions, namely, 'low maintenance cost' and 'cut down on electricity charges', together constituting monetary gains. Factor 1 was more powerful explaining nearly 33 percent of the variance. Factor 2 had significant loadings on two dimensions, namely, 'reduce global warming' and 'energy independent', together constituting reliability and accounted for 25 percent of the variance. Factor 3 had significant loadings on one dimension, namely, 'increase house resale value', constituting monetary gains and explains nearly 13 percent of the variance.

For non-adopters, factor 1 had significant loadings on five dimensions, namely, 'cut down on electricity charge', 'low maintenance cost', 'increase in house resale value' (together constituting monetary gains), 'free from power cuts' and 'save time' (constituting relative advantage). Factor was quite powerful explaining nearly 42 percent of the variance. Factor 2 had significant loadings on three dimensions namely, 'reduces global warming', 'energy independent' and 'most reliable and renewable energy, together constituting reliability and explains 18 percent of the variance. Factor 3 had significant loadings on one dimension namely 'generate electricity without pollution', constituting green lifestyle and explains 12 percent of the variance.

TABLE 4.7.3

FACTOR LOADINGS FOR THE BENEFITS OF USING SOLAR DEVICES

S.No	Benefits	Adopters			Non-Adopters			All		
		F1	F2	F3	F1	F2	F3	F1	F2	F3
1.	Cut down on electricity charge	0.815			0.852			0.844		
2.	Low maintenance cost	0.924			0.750			0.856		
3.	Generate electricity without pollution						0.962			0.854
4.	Increase house resale value			0.694	0.764					
5.	Most reliable and renewable energy					0.641				
6.	Reduce global warming		0.943			0.854			0.866	
7.	Energy independent		0.933			0.841			0.873	
8.	Free from power cut				0.841			0.719		
9.	Save time				0.796					
Eigen Value		**2.959**	**2.213**	**1.130**	**3.734**	**1.637**	**1.089**	**3.229**	**1.903**	**1.065**
Percentage of Variance		**32.87**	**24.59**	**12.55**	**41.49**	**18.192**	**12.095**	**35.877**	**21.147**	**11.835**
Cumulative Percentage of Variance		**32.87**	**57.46**	**70.01**	**41.49**	**59.683**	**71.777**	**35.877**	**57.024**	**68.859**

Source: Estimation based on field survey, 2017.

Taking all respondents together, factor 1 had significant loadings on three dimensions namely, ‘cut down on electricity charge’, ‘low maintenance cost’ (together constituting monetary gains) and ‘free from power cuts’ (constituting relative advantage). Factor 1 was very powerful explaining nearly 36 percent of the variance. Factor 2 had significant loadings on two dimensions namely, ‘reduces global warming’ and ‘energy independent’, constituting reliability and explains 21 percent of the variance. Factor 3 had significant loadings on one dimension namely ‘generate electricity without pollution’, constituting green lifestyle and explains 12 percent of the variance.

The overall inferences drawn from the above analysis are

- ✓ For adopters, the major benefits of using solar devices were monetary gains and reliability.
- ✓ For non-adopters the major benefits were monetary gains, relative advantage, reliability and green lifestyle.
- ✓ For all respondents it was monetary gains, relative advantage, reliability and green lifestyle.

VIII. PROBLEMS IN USING SOLAR ENERGY DEVICES

Despite the positive characteristics of solar devices there are issues which create hurdles for adopters and make it unattractive for non-adopters as a home improvement (Timilsina 2000) and incompatible with personal priorities (Berger 2001). Issues such as high capital costs and a lack of confidence in the long-term performance of the systems are limiting widespread adoption (ETSU 2001; Timilsina 2000). Knudsen (2001) reports that oversized systems are often installed which adds to expenses. Cabraal (1998) proposes that quality service, products and support should help to overcome the high initial costs. Oliver and Jackson (1999) state that installed costs are being reduced. However, in later research Luque (2001) concludes that there was very little potential for reducing costs in the future.

An attempt was to identify the problems in using solar devices as perceived by adopters, non-adopters and all the respondents taken together. Five point Likert scale was used to ask the respondents how strongly they agree or disagree with a statement, with most preferred statement getting a score of five and the least preferred statement a score of one. Factor analysis was used to identify the underlying dimensions of the problems in using solar devices. To determine the reliability of applying factor analysis the Cronbach's alpha test was applied and presented in table 4.8.1.

TABLE 4.8.1
CRONBACH'S RELIABILITY TEST

S.No	Groups	Cronbach's Alpha
1.	Adopters	0.876
2.	Non-Adopters	0.903
3.	All	0.892

Source: Estimation based on Field survey, 2017.

The Cronbach's alpha value for adopters, non-adopters and all respondents were, 0.876, 0.903 and 0.892 respectively, which was greater than .7 and indicates the internal consistency of the various constructs used in identifying the problems in using solar devices.

To determine the appropriateness of applying factor analysis the KMO and Bartlett's test measures were computed and the results are presented in table 4.7.2.

TABLE 4.8.2
KMO AND BARTLETT'S TEST MEASURES

Measure \ Group	Adopters	Non-adopters	ALL
Kaiser-Meyer-Olkin Measure	0.684	0.518	0.784
Bartlett's Test of Sphericity (i) Approx. Chi-Square	549.183	703.979	968.476
(ii) Degrees of freedom	91	91	91
(iii) Significance	0.000	0.000	.000

Source: Estimation based on Field survey, 2017.

The KMO statistics for adopters, non-adopters and all respondents were 0.684, 0.518 and 0.784 signifying higher than acceptable adequacy of sampling. The Bartlett's test of sphericity was also found to be significant at one percent level providing evidence of the presence of relationship between the variables to apply factor analysis. The table 4.7.3 enlists the Eigen values, their relative explanatory powers and the factor loadings for 14 components identified within the data set.

The Eigen values greater than one alone was considered for inclusion in the analysis. Results indicates first four factors alone was greater than one for adopters, non-adopters and all respondents, indicating that these factors alone were appropriate for inclusion in the analysis.

The percentage of variations accounted by the four factors was 78 percent for adopters, 84 percent for non-adopters and 78 percent for all respondents.

For adopters, factor 1 had significant loadings on four dimensions, namely, ‘replacing solar energy panel is difficult’ (technical issues), ‘poor services’ (poor after sales service), ‘high maintenance cost’ (high investment cost) and ‘rented accommodation’ (infrastructural issues). Factor 1 was more powerful explaining nearly 42 percent of the variance. Factor 2 had significant loadings on three dimensions, namely, ‘reduction of power generation during cloudy days and night’, ‘low inefficiency for high voltage’, and ‘installation problem’, together constituting technical issues and explains nearly 19 percent of the variance. Factor 3 had significant loadings on two issues namely, ‘lack of skilled professional for after sales service’ and ‘suppliers do not respond to post-sale grievances’, together constituting poor after sales service and explains 9 percent of the variance. Factor 4 had significant loadings on two dimensions namely, ‘non-availability of spare parts’, and ‘very few places where the equipment can be repaired’, together constituting poor after sales service and explains nearly 8 percent of the variance.

For non-adopters, factor 1 had significant loadings on four dimensions, namely, ‘high cost of installation’, ‘high maintenance cost’ (together constituting high investment cost), ‘rented accommodation’ (infrastructural issues) and ‘wires and tubes of solar equipment are eaten up by rodents’ (maintenance issue). Factor 1 was most powerful explaining nearly 46 percent of the variance. Factor 2 had significant loadings on four dimensions, namely, ‘non-availability of spare parts’, ‘very few places where the equipment can be repaired’, ‘lack of skilled professional for after sales service’ and ‘suppliers do not respond to post-sale grievances’, together constituting poor after sales service and explains 18 percent of the variance. Factor 3 had significant loadings on three dimensions, namely, ‘reduction of power generation during cloudy days and night’, ‘low inefficiency for high voltage’, and ‘installation problem’, together constituting technical issues and explains nearly 11 percent of the variance. Factor 4 had significant loadings on two dimensions, namely, ‘large storage space for batteries’ (infrastructural issues) and ‘replacing solar energy panel is difficult’ (technical issues) and explains nearly 9 percent of the variance.

TABLE 4.8.3

FACTOR LOADINGS FOR THE PROBLEMS IN USING SOLAR ENERGY DEVICES

S.No	Benefits	Adopters				Non-Adopters				All			
		F1	F2	F3	F4	F1	F2	F3	F4	F1	F2	F3	F4
1.	Reduction of power generation during cloudy days and night		0.902					0.825				0.896	
2.	Low inefficiency for high voltage		0.903					0.893				0.896	
3.	Installation problem		0.862					0.863				0.861	
4.	Large storage space for battery								0.758				0.814
5.	Replacing solar energy panel is difficult	0.731							0.763				
6.	High cost of installation					0.880				0.812			
7.	Poor services	0.721											
8.	High maintenance cost	0.775				0.877				0.879			
9.	Rented accommodations.	0.779				0.822				0.806			
10.	Non-availability of spare parts/batteries				0.848		0.786				0.786		
11.	Wires and tubes of solar equipment are eaten up by rodents					0.806				0.705			
12.	Very few places where the equipment can get repaired				0.883		0.859				0.862		
13.	Lack of skilled professional for after sale servicing			0.930			0.796				0.786		
14.	Suppliers do not respond to post-sale grievances			0.902			0.909				0.797		
Eigen Value		**5.982**	**2.634**	**1.275**	**1.070**	**6.405**	**2.567**	**1.589**	**1.200**	**5.932**	**1.998**	**1.945**	**1.047**
Percentage of Variance		**42.728**	**18.512**	**9.110**	**7.643**	**45.752**	**18.333**	**11.354**	**8.573**	**42.369**	**14.270**	**13.895**	**7.481**
Cumulative Percentage of Variance		**42.728**	**61.540**	**70.650**	**78.292**	**45.752**	**64.085**	**75.439**	**64.012**	**42.369**	**56.64**	**70.535**	**78.016**

Source: Estimation based on field survey, 2017.

Taking all the respondents together, factor 1 had significant loadings on four dimensions, namely, ‘high cost of installation’, ‘high maintenance cost’ (together constituting high investment cost), ‘rented accommodation’ (infrastructural issues) and ‘wires and tubes of solar equipment are eaten up by rodents’ (maintenance issue). Factor 1 was most powerful explaining 42 percent of the variance. Factor 2 had significant loadings on four dimensions, namely, ‘non-availability of spare parts’, ‘very few places where the equipment can be repaired’, ‘lack of skilled professional for after sales service’ and ‘suppliers do not respond to post-sale grievances’, together constituting poor after sales service and explains 14 percent of the variance. Factor 3 had significant loadings on three dimensions, namely, ‘reduction of power generation during cloudy days and night’, ‘low inefficiency for high voltage’, and ‘installation problem’, together constituting technical issues and explains nearly 11 percent of the variance. Factor 4 had significant loadings on one dimension, namely, ’large storage space for batteries’ (infrastructural issues) and explains nearly 9 percent of the variance.

From the above it can be inferred that the major issues facing the respondents irrespective whether they are using the device or not are poor quality of after sales service, high investment cost, technical issues relating to its performance and infrastructural issues in the form of lack of space and rented accommodation.

IX. PATH MODEL

The literature concerning the adoption of domestic solar power systems is limited and paints a pessimistic picture for a higher take-up in future. It is a mature technology that is being pushed by policy but, so far has failed to be adopted as it is expensive (Energy Research Centre, 2010). Investigations in the past, into the adoption of energy efficiency and renewable energy technologies, confirmed that the barriers to adoption of renewable technologies are mostly financial, as well as some practical issues regarding installation and general levels of knowledge (Caird et al, 2008; Faiers, 2006; Labay and Kinnear, 1981). Rogers (1995) also found that if an innovation has been developed in order to prevent something occurring (reduced energy consumption), its rate of adoption will be slow because the advantages take a long time to be realised. Given this background, there is a need to gain a better understanding about what affect the adoption process, specifically in relation to solar technology innovations.

Rogers (1995) indicates that individual perceptions of product attributes affect the rate of adoption of an innovation. The attributes most commonly considered include:

- Relative advantage: the degree to which an innovation is perceived as being superior to the idea or product its replaces

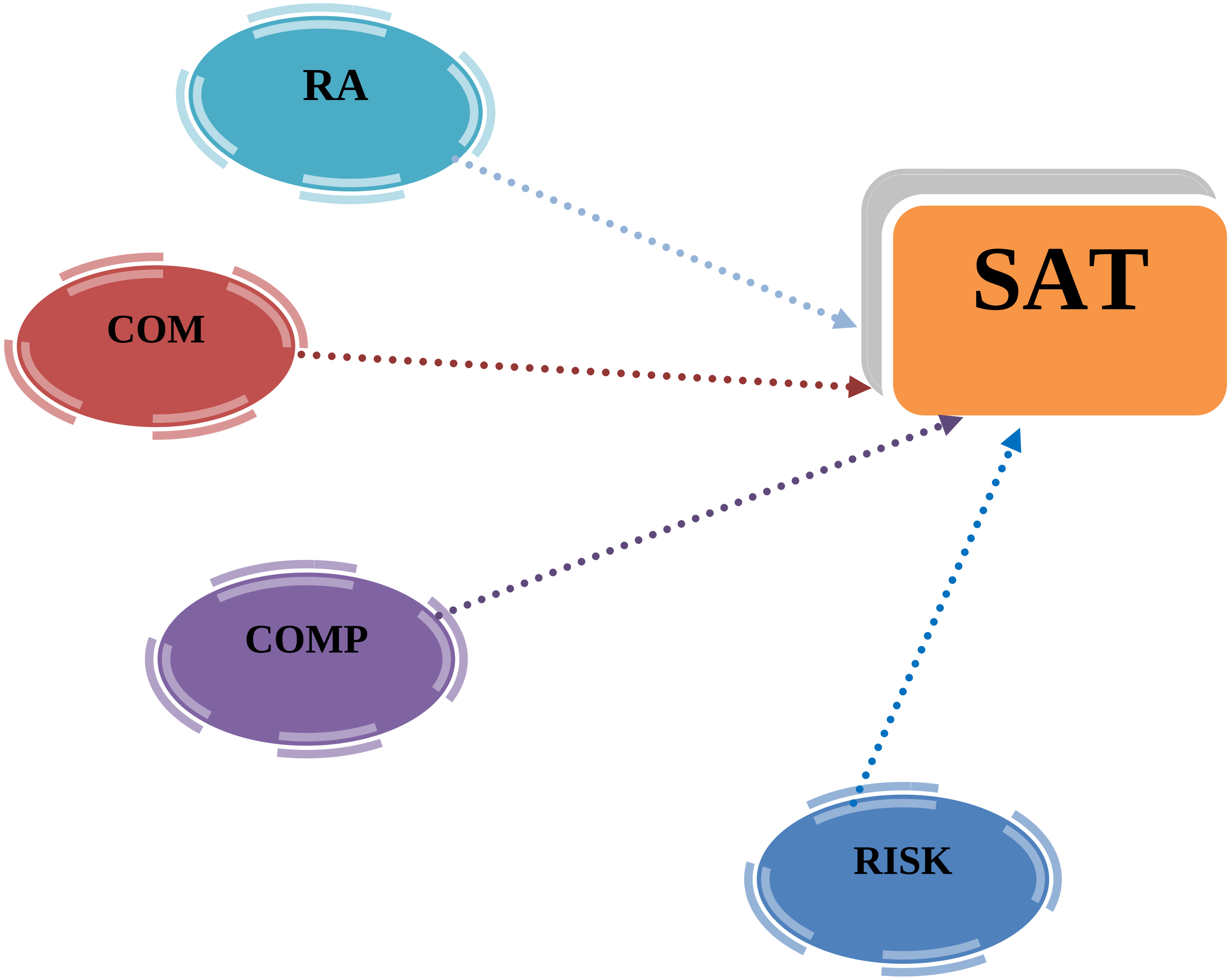
- Perceived risk: the expected probability of economic or social loss resulting from the innovation
- Complexity: the extent to which the innovation appears difficult to use and understand
- Compatibility: the degree to which the innovation is seen as consistent with the innovator's existing values, past experience and needs
- Trialability: the extent to which one can experiment on a limited basis with the innovations, and
- Observability: the degree to which the results of innovating are visible to others.

Relative advantage is considered to be the most influential of the five attribute categories (Rogers, 1995) and together with compatibility and complexity has been shown to hold the most influence over the decision of whether or not to adopt. However trialability is difficult to measure in the case of solar devices, as it is not possible to trial a system for a limited period before purchase, the final choice has to be made without the opportunity to test the system. This lack of trialability of solar systems as a barrier to adoption is also confirmed by Labay and Kinnear (1981). Risk is a critical determinant of innovation adoption and can be based on either physical or operational aspects of the innovation, for example, performance and hence was incorporated into the system in the place of trialability. Similarly, observability was also not included as a variable for want of data.

The dependant variable in this research is the perceived level of satisfaction by adopting the technology. The level of satisfaction depends on four attributes of the product. These attributes include relative advantage (RA), compatibility (COM), complexity (COMP) and risk (RISK). The model proposed for analysing the interrelationship among the variables was that the perceptions of the consumer on the relative advantage and compatibility of the product will positively influence the level of satisfaction and thereby make him more inclined to adopt the innovation, while complexity and risk may act negatively impact the level of satisfaction and make him less inclined to adopt the innovation. To test these hypothesised predictions, the following model was specified as shown in figure 4.6.

Five point Likert scale was used to ask the respondents how strongly they agree or disagree with a statement. Rating or Scale questions were used to collect opinion data from the respondents regarding the relative advantage (RA), compatibility (COM), complexity (COMP), risk (RISK) and the level of satisfaction(SAT).

FIGURE 4.6
PROPOSE PATH MODEL



Composite Reliability and Convergent Validity

The reliability of the constructs refers to the accuracy with which the constructs repeatedly measure the same phenomenon within permissible variation. The composite reliability for internal consistency of the constructs should be above 0.7. The convergent validity of each construct was checked by examining the Average Variance Extracted' (AVE) values. Constructs which have AVE values greater than 0.5 are said to have convergent validity or unidimensionality. In some cases, values up to 0.4 are also considered if they are central to the model (Chin, 1998; Chin and Newsted, 1999; Chin et al, 2003). The composite reliability and the AVE values of the five constructs used in the study were carried out using VPLS software which is presented in table 4.9.1 below.

TABLE 4.9.1
RELIABILITY AND AVE VALUES

Constructs	Composite Reliability	AVE	Cronbach's Alpha
Relative Advantage	0.821607	0.609066	0.722314
Compatibility	0.938819	0.884700	0.870044
Complexity	0.846743	0.648331	0.740001
Risk	0.821312	0.489260	0.817149
Satisfaction	1.000000	1.000000	0.000000

Source: Estimation based on field survey, 2017.

The reliability of the constructs refers to the accuracy with which the constructs repeatedly measure the same phenomenon within permissible variation. The composite reliability for internal consistency of the constructs was tested and was above 0.7. The convergent validity of each construct was checked by examining the Average Variance Extracted' (AVE) values. The AVE scores for all the constructs are greater than 0.5 indicating sufficient convergent validity.

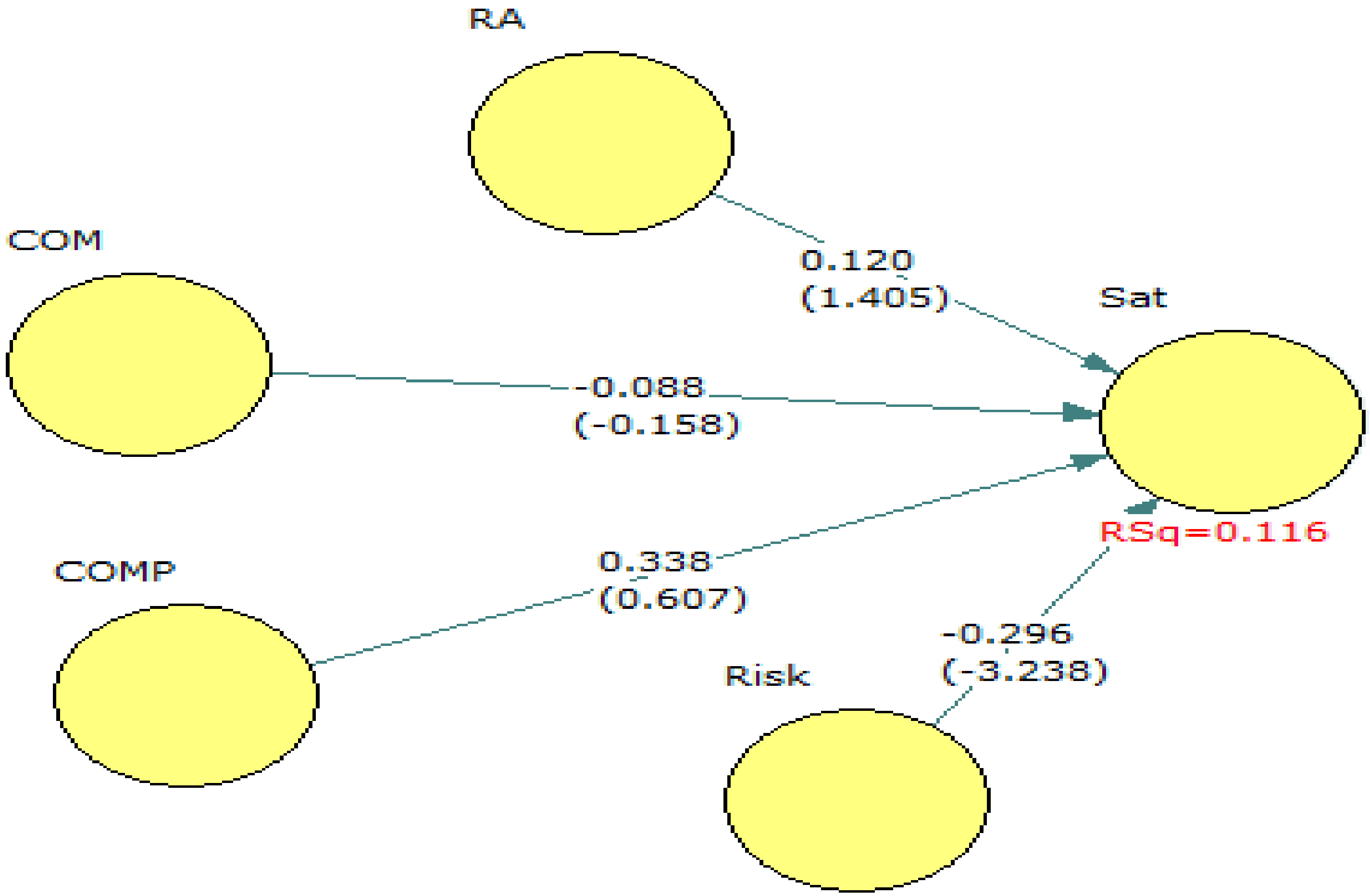
The study aims at examining the impact of relative advantage, compatibility, complexity and risk on the level of satisfaction. The hypothesis formulated was:

H_1: Relative advantage and compatibility has positive effect on the level of satisfaction.

H_2: Complexity and risk has negative impact on the level of satisfaction.

The estimated path model is shown in figure 4.9.2.

FIGURE 4.7
PATH MODEL



A path to be significant, its t value needs to be greater than 1.96. The analysis of the above diagram reveals that the path between perceived risk and the level of satisfaction was found to be negative and significant at one percent level. The path coefficient was -0.296 and t value was -3.238 which was greater than 1.96 (ignoring the sign). Thus, perceived risk tends to diminish the level of satisfaction of the respondents making them less receptive to the adoption of solar technology and devices. The above findings are also confirmed by Caird et al, (2008); Faiers, (2006) and Labay and Kinnear (1981) when they observed that the barriers to adoption of renewable technologies are mostly financial, as well as some practical issues regarding installation and general levels of knowledge. The remaining paths were found to be insignificant. When an innovation tends to be pushed by policy, its adoption tends to be slow since it takes a long time for its advantages to be realised. In the case of solar devices its relative advantages are not immediate and people often perceive the advantage to be far too meagre when compared to the initial investment.

CHAPTER V
SUMMARY AND CONCLUSIONS

Energy has been recognized as one of the most pertinent contributors of economic growth and human development universally. There is a strong two-way relationship between economic development and energy consumption. On one hand, the growth of an economy hinges on the availability of cost-effective and environmentally benign energy sources, and on the other hand, the level of economic development relies on the energy demand. Today, India can well be identified as an energy guzzler. The demand for energy is growing exponentially in India because of increasing population growth. India is heavily dependent on fossil fuels for most of its demand. It is evident by the fact that coal accounts for almost 55 percent of the country's total energy supplies and about 75 percent of the coal in the country is consumed in the power sector. Coal is followed by crude oil and natural gas in terms of usage in the power sector. Continued use of fossil fuels is set to face multiple challenges: depletion of fossil fuel reserves, global warming and other environmental concerns, geopolitical and military conflicts and of late, continued and a significant increase in fuel price. Renewable energy is the solution to the growing energy challenges as they are abundant, inexhaustible and environmentally friendly (Asif and Muneer, 2006). Investing in renewable energy would enable India to develop globally competitive industries and technologies that can provide new opportunities for growth and leadership (Sargsyan et al., 2010). If one looks at all the renewable energy sources, it is seen that India is among the top five destinations for solar energy development in the world as per Ernst and Young's renewable energy attractiveness index (MNRE, 2011). From less than 12 MW in 2009, solar-power generation in the country grew to 190 MW in 2011. By March 2013, it is expected to grow fivefold to 1,000 MW, but the country has a long way to go to reach its goal of increasing solar-power generation to 20 gigawatts by 2020.

Despite growing acceptance of solar energy as an alternate to other energy sources, a variety of barriers exist in regards to adoption of solar technology in India. Challenges at the micro (consumer) level to adoption of solar products include lack of awareness, lack of affordability, lack of confidence in its use and high cost. Despite these barriers, there remains immense opportunity in the solar market. Companies that offer solar products need to understand these challenges, and more, understand their BoP (Base of Pyramid) target consumers including their needs, wants, and preferences in regard to these products. In Tamil Nadu specifically, as the kerosene subsidy has been largely removed in towns that are ‘100 percent electrified’, there can be greater market opportunity. This study seeks to make a contribution to the technology adoption literature by exploring the determinants of such investments, which can include households’ socio-economic characteristics, attitudes towards solar devices, households’ knowledge about their energy consumption, performance of the technology and the determinants of satisfaction in using the technology.

RESEARCH GAP

Previous studies suggest that households’ socioeconomic characteristics play a relevant role in technology adoption. Generally a positive correlation between income and the probability of investing in energy technologies was observed (Long1993; Millsand Schleich 2010; Sardianou and Genoudi 2013). A number of studies underline the importance of dwelling characteristics behind consumer choices (Davis, 2010). Indeed, several studies found that people with strong environmental preferences are more likely to invest in energy conservation technologies (Olli et al 2001, Kollmuss and Agyeman 2002, Di Maria et al 2010). Households’ energy use and energy conservation actions can also be shaped by habits, routines and social practices (Shove 2012). To date, as the literature review highlights energy research has not sought to understand the attitudes of householders to the new solar power technologies either with regard to their attitudes to the technology or their decision making processes when adopting the technology.

The present study differs from the earlier studies in that

- Not many studies have done to ascertain the consumer’s perspective on the use of solar energy devices in Indian context.
- No attempt has been made to compare the perspectives of the adopters with that of non-adopters.
- The present study focuses on both adopters and non-adopters of solar energy to ascertain their level of awareness, utilization, benefits and problems in solar energy usage.

OBJECTIVES

The specific objectives of the study are:

- To explore the profile characteristics of the adopters and non-adopters of solar energy devices.
- To examine the awareness about solar energy device among adopters and non-adopters.

- To explore the extent of utilization of solar energy devices and the resulting financial savings for the users.
- To assess facilitating and inhibiting factors in the use of solar energy devices at the household level.
- To suggest policy measures for enhancing the use of solar energy at the household level.

HYPOTHESES

- The adoption behaviour of the respondents was independent of the selected socio-demographic, economic and locational factors.
- There were no differences in the amount spend on electricity consumption between adopters and non-adopters.
- Adoption of solar device was closely linked to cost or financial aspects of the system and the knowledge about the technology.
- Monetary gains, relative advantage, reliability and green life style were the major benefits of using solar devices as perceived by the respondents.
- The major issues facing the respondents irrespective of adoption are poor quality of after sales service, high investment cost, technical and infrastructural issues
- Relative advantage, compatibility, complexity and risk are the key factors affecting the level of satisfaction in using solar technology.

METHODOLOGY

The location of the study was confined to Coimbatore city. Two- stage sampling technique was adopted in the selection of the sample. To give equal representation to all households, in the first stage the city was divided into four zones, namely, north, south, east and west and from these zones, two zones, namely, north and south were selected on the grounds of greater presence of solar users in these areas. From this universe, in the second stage 50 sample respondents were selected in each zone, of which 25 were solar adopters and 25 were non-adopters by adopting purposive sampling technique as not all the respondents were willing to participate in the survey. Hence, the investigator approached only those people who were willing to cooperate and supply the needed information. Thus in the present study, 100 respondents were selected, of whom 50 were adopters and 50 non-adopters.

Data was collected by administering a pretested interview schedule to the selected respondents. The field investigation and data collection for the study was carried out during the period January to April 2017. Data collected was analysed by using techniques like, chi-square test, independent t test, Garrett's rating scale, Likert's summated scale, Cronbach's Alpha, factor analysis and Partial Least Square regression method

EMPIRICAL FINDINGS

Socio-Demographic Characteristics of Households and the Respondents

- ➔ About 62 percent of the adopters and 76 percent of the non-adopters belonged to Hindu religion, and 38 percent and 14 percent respectively were Christians. Thus, Hindus predominates in both categories of the households, followed by Christians.
- ➔ Majority of the households belonged to backward caste, (64 percent) followed by general category (23 percent) and most backward caste (13 percent). Adoption-wise also, backward caste was predominant in the both groups, 68 percent among adopters and 60 percent among non-adopters.
- ➔ Out of the 100 samples, 79 percent of the respondent belonged to nuclear family and remaining 21 percent to extended family. Adoption-wise, 76 percent of the adopters and 82 percent of non-adopters belonged to extended family. Thus nuclear family predominates in both groups of households.
- ➔ The adopters had 37 percent of the respondents in the age category of above 50 years, while only 20 percent were in this category among non-adopters. In contrast, 36 percent non-adopters were below 20 years and this percentage for adopters was 14 percent. In short, the need for using energy saving devices was more popular among the middle age population with 70 percent of the respondents in the age group of above 40 years favouring adoption and use of such devices.
- ➔ Nearly $4/5^{th}$ of the adopters were married, while among the non-adopters there were equal representation of married and unmarried respondents.
- ➔ About 92-94 percent of the respondents in both categories practised small family norms with household size not exceeding five members. Thus, both groups shared common features with respect to family size.
- ➔ The chi-square test done to test the association between the selected socio-demographic factors and the adoption behaviour of the respondents revealed that the adopters differed

from the non-adopters with respect to religion, age of the head of the household and marital status. Thus, the adopters belonged to Hindu religion, above 40 years of age and were married.

Economic and Living Environment

- ➔ The highest level of education of the adopters unravels that 32 percent of the sample respondents had completed under-graduation level, 36 percent had completed Post-graduation and higher studies, 16 percent had completed professional courses, 6 percent higher secondary and 2 percent secondary level. This percentage for non-adopters was 32 percent, 48 percent, 2 percent, 8 percent and 6 percent respectively. Both groups had a high level of education as is evident from the fact that nearly 50 percent of them had completed post-graduation or professional courses.
- ➔ Among the adopters there was equal distribution of government and private employees (38 percent each), followed by 24 percent who were self-employed. In contrast, among the non-adopters, majorities (42 percent) were employed in private sector, followed by 34 percent in government and the remaining 24 percent were self-employed.
- ➔ Nearly 62 percent of the adopters were in the income brackets of above Rs. 30,000 per month while this proportion among the non-adopters was only 40 percent. The proportion of the respondents earning less than Rs. 30,000 per month was 38 percent for adopters and 60 percent for non-adopters indicating that majority of the adopters were high income earners.
- ➔ The total expenditure per month was marginally higher for the adopters with 50 percent of them spending more than Rs. 20,000 per month, 48 percent spending Rs. 10,000 to 20,000 and 2 percent less than Rs. 10,000 per month. This percentage for non-adopters was 36 percent, 54 percent and 10 percent respectively.
- ➔ To find out whether there are any significant differences among the adopters and non-adopters in terms of years of schooling, family income and expenditure level, t test was applied. No adoption differences were seen among the respondents in terms of their years of education, family income and total expenditure as the level of significance was more than 0.05. Thus the adopters did not differ from the non-adopters in terms of education, income and level of expenditure.

Living Environment

- ➔ Majority (74 percent) of the sample respondents irrespective of the adoption level were living within City limits. About 26 percent of the adopters and 16 percent of the non-adopters were living in urban areas slightly away from city limits. Around 3 percent and 2 percent of the non-adopters' houses were located in semi-urban and rural areas respectively.
- ➔ While 86 percent of the adopters lived in self-owned houses and the remaining 14 percent in rented houses, this percentage for non-adopters were 62 percent and 38 percent respectively. It is interesting to note that 14 percent of the adopters living in rented accommodation have opted for solar energy devices. This clearly indicates that ownership of the house was not a constraint in opting for solar energy devices.
- ➔ Majority of the adopters (98 percent) were living in independent houses which include Town and Bungalow type and 2 percent were living in Apartment, while 56 percent of the non-adopters were living in independent houses and 44 percent in Apartment. As solar energy system can be adapted to all types of houses, type of house may not be a significant factor for the non-adopters to switch to solar energy system.
- ➔ The chi-square test to examine the association between housing details and adoption behaviour reveal that the adopters differed from the non-adopters with respect to ownership and type of house (p value < 0.05), while with respect to location there was no significant difference between two categories of respondents. Thus, the adopters can be characterized as those living in self-owned, independent houses.

Electricity Consumption at the Household Level

- ➔ All households irrespective of their adoption pattern were using gadgets like light, fan, television and Mixie which are considered basic necessity for a household. However, usage of washing machine, fridge, induction stove, home theatre, microwave oven and music system was seen more among the adopters. The increase use of gadgets among adopters can be attributed to their adoption of solar energy system.
- ➔ While 50 percent of the adopters spend between Rs.501 to 1000 on electricity per month, this percentage among non-adopters was 62 percent. Similarly while 26 percent of the adopters spend less than Rs. 500 or Rs.500 per month, this proportion among non-adopters was only 6 percent. In contrast, while 32 percent of the non-adopters spend more

than Rs. 1000 per month, the percentage of adopters was only 24 percent. The low spending on electricity per month for the adopters may be attributed to the alternate source of energy available to them.

- ➔ The t test applied to find out whether there are any significant differences among the adopters and non-adopters on the amount spend on electricity consumption indicates there was significant differences in the amount spend on electricity by two groups of households at five percent level. The average amount spend on electricity consumption was 1012.06 for non-adopters, while for adopters it was Rs. 878.40 per month showing a mean difference of Rs. 133.58 per month. Thus lack of alternative source of energy may be the reason for increased spending on electricity by non-adopters.

Perception of Households about Solar Energy

a) Adopters Viewpoint

- ➔ The major information about solar technologies for 32 percent of the adopters was neighbours, followed by advertisement (26 percent), television (26 percent) and exhibitions (16 percent). Thus neighbours and media played a significant role in promoting and creating awareness about solar technologies. Venketraman and Sheeba (2014) also opined that majority (54.68 percent) of the respondents were aware about the solar energy devices through advertisements.
- ➔ About 88 percent of the adopters have a positive outlook about the role that solar energy can play in the near future and its potential to gradually replace dependence on electricity.
- ➔ About 64 percent of the adopters had knowledge about the use of solar energy for heating and an equal percentage (18 percent) was aware about its use for lighting and solar home lights. Thus, the adopters had limited knowledge regarding the applications of solar energy. This highlights the need for promoting greater awareness among the respondents on the utility of solar energy.
- ➔ The two solar devices popularly used by the adopters were solar water heater and solar panel. The proportion of respondents using these devices was 86 percent and 28 percent respectively. The WWH Report (2015) also points out that solar water heater was the most popular choice of Renewable energy technology among individuals.

- ➔ The ranking of the average score revealed that the prime reason for installing solar devices was to 'generate own electricity' (1st rank), 'improve the environment' (2nd rank), followed by 'lower power bill' (3rd rank), 'promote green energy' (4th rank) and 'a long term investment for power' (5th rank). The reasons which were of least priority were 'access tax credit and government incentives' (9th rank) and 'sell home quickly' (10th rank).
- ➔ Majority (72 percent) of the adopters had to spend Rs. 50,000 to Rs. 1 lakh in installing solar devices, followed by 18 percent less than Rs. 50,000 and 10 percent above Rs. 1 lakh. Information provided by the informants also reveals that they had used their own resources as capital rather than depending on borrowed capital. A survey conducted by WWF (2015) among the manufacturers/ retailers of Renewable energy product reveal that the biggest challenge they face was cost and this was stated by 75 percent of the manufacturers.
- ➔ About 84 percent of the adopters were aware about government subsidies and only 16 percent have expressed their ignorance about the existence of such schemes. Lack of awareness coupled with complexities involved in claiming subsidy may be the reason why the respondents do not avail the benefits of such scheme.
- ➔ Majority (52 percent) of the adopters were using the device for the 3 to 4 years, 24 percent for the past 5 years and more and equal proportion (24 percent) for less than 5 years. Thus the years of usage clearly indicates that nearly three-fourth of the respondents are not 'late adopters' but 'early adopters', who have been using the solar device for more than 3 years.
- ➔ About 92 percent of the adopters stated that they did not face any problems in purchasing the device and only a negligible proportion (8 percent) has claimed difficulties in acquiring the device.
- ➔ Installing solar devices did make a difference to their power bill for 76 percent of the respondents. The savings in their power bill also varied across the adopters with majority (58 percent) stating a savings of less than Rs.200 per month, 14 percent above Rs.200 but less than Rs.400 and for 4 percent above Rs. 400. Only 24 percent stated there was no savings. Thus, nearly three-fourth of the adopters experienced some savings in their power bill by installing solar devices.

- Analysis of the level of satisfaction of the adopters showed that 54 percent were slightly satisfied, 24 percent extremely satisfied and the remaining 22 percent were neutral. It is noteworthy that none of the respondents have expressed their dissatisfaction in using the device. This augurs well for a city like Coimbatore and a country like India where power outages are a common feature of every day existence.

b) Non-adapters Viewpoint

- The awareness of the non-adopters about solar devices revealed that 72 percent had knowledge about the devices, while 28 percent had little knowledge about it. The major source of information for 38 percent of the respondents was advertisement, followed by Newspapers (18 percent) and magazine (16 percent). Thus, media played a significant role in creating awareness about solar devices.
- While 50 percent replied in affirmative, an equal number negatived the idea to use solar devices in future. The most important reasons for switching to solar energy was it would ‘reduce global warming’ (30 percent strongly agreed, 16 percent agreed and 4 percent were neutral) and ‘cut down on electricity charges’ (30 percent strongly agreed, 10 percent agreed and 10 percent were neutral). About 26 percent agreed that it would ‘increase the resale of their house’ and equal percentage agreed that it was ‘most reliable and renewable energy’.
- The respondents were unlikely to adopt solar devices as they perceive ‘lack of knowledge about Government subsidy’ (28 percent strongly agreed), ‘high maintenance cost’ (28 percent agreed), ‘financial constraint’ (24 percent agreed), ‘restricted accessibility to such product’ (24 percent agreed), ‘not convinced about the technology’, ‘infrastructural constraint’ and ‘unsuitable climatic conditions’ (22 percent agreed). Thus the adoption of solar device was closely linked to cost or financial aspects of the system and the knowledge about the technology and if these are improved, adoption should follow as more reasons for people to adopt become apparent.
- Of 50 non-adopters surveyed, a high percentage of people, i.e., 82 percent did not know of vendors. Only 18 percent of the respondents knew of avenues to purchase such products.
- About 66 percent agreed that solar devices were financially sustainable in the long run, followed by 24 percent neutral and 10 percent strongly agreed with the statement. WWF

Report (2015) also point out that 87 percent of the respondents think that investing in renewable energy was financially viable. This means that there is tremendous scope for expansion of solar energy devices in the country.

- ➔ Rank analysis of type of solar devices to be installed reveal that applications they intend installing in the order of priority was lighting (1st rank), followed by heating (2nd rank) , power to home appliances (3rd rank) and solar home lighting (4th rank).

Reliability and Green Life Style

- ➔ The opinion of the non-adopters was divided with 50 percent believing it was reliable and promotes green lifestyle, 36 percent stating their ignorance and 14 percent saying no. The 50 percent who have replied negatively or expressed their ignorance are those who do not have experience in using the device or lacked sufficient knowledge on solar devices.
- ➔ Majorities (75 percent) of the respondents are positively inclined to solar applications and that it can promote green lifestyle. Thus, there is tremendous scope to scale up its applications in the city and country as a whole.

Benefits and Problems in using solar energy devices

- ➔ For adopters, the major benefits of using solar devices were monetary gains and reliability. For non-adopters the major benefits were monetary gains, relative advantage, reliability and green lifestyle. For all respondents it was monetary gains, relative advantage, reliability and green lifestyle. The major issues facing the respondents irrespective whether they are using the device or not are poor quality of after sales service, high investment cost, technical issues relating to its performance and infrastructural issues in the form of lack of space and rented accommodation.

Path Model

- ➔ Path analysis was applied to evaluate the impact of relative advantage, compatibility, complexity and risk on the level of satisfaction. The analysis reveals that the path between perceived risk and the level of satisfaction was found to be negative and significant at one percent level. The path coefficient was -0.296 and t value was -3.238 which was greater than 1.96 (ignoring the sign). Thus, perceived risk tends to diminish the level of satisfaction of the respondents making them less receptive to the adoption of solar technology and devices. The remaining paths were found to be insignificant. When an innovation tends to be pushed by policy, its adoption tends to be slow since it takes a long time for its advantages to be realised.

CONCLUSION

The success of the Government policy to reduce carbon emissions is partly dependent on the ability to persuade householders to become more energy efficient, and to encourage installation of domestic solar systems. Solar power is an innovation in India but the current policy of stimulating the market with subsidies is not resulting in widespread adoption. This case study, using householders in Coimbatore city, investigates householder attitudes towards characteristics of solar systems and identifies some of the barriers to adoption. Findings reveal that the adoption of solar device was closely linked to risk associated with the use of technology, cost or financial aspects of the system and the knowledge about the technology and if these are improved, adoption should follow as more reasons for people to adopt become apparent.

RECOMMENDATIONS

Based on the above findings, the following recommendations are made:

- ➔ Awareness is a major area that requires immediate attention. Training programs need to be developed in local languages to spread information on the benefits of solar energy and proper use of the technology.
- ➔ Since women are the main end-users of energy in the households as they spend most of their time indoors doing most of the household chores. Empowering them would result in the empowerment of the entire society. Thus, specialized training programs need to be created for women and delivered from time to time.
- ➔ Most of the respondents are found dissatisfied with service quality variables like convenient use of the system, maintenance cost of the system, warranty support of the device, credibility of the providers, behavior of the personnel, the leaflet, catalog etc. provided with the system and availability of the parts of the system in the local market. The service providers therefore should offer a good quality system at a reasonable price with adequate capacity and longevity to meet up the requirements of the customers. Moreover they should maintain a better after sale service at reasonable cost for the customers for convenient use of the systems and also arrange training on technical and better service delivery to their personnel.

- People must be made aware of the subsidies provided by the government on buying a solar energy device and also the Government should take more steps in promoting solar energy devices in other ways such as reducing tax etc.
- In order to meet the customer`s needs the business sectors should come with innovative yet cost-benefit and new techniques in the solar market as it not only attracts more number of customers and keeps the business intact, but also increases the consumers responsibility towards the environment and eco-friendliness for securing mother earth.
- Targeted policies are required to address specific barriers for different groups of consumers. For instance, credit constraints are more relevant for low-income households and lifting these constraints would likely promote investment for this group. Direct subsidies, tax credits or rebates can also be relevant policy instruments to lower the upfront cost of energy investments.

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ADOPTION AND UTILISATION OF DOMESTIC SOLAR ENERGY DEVICE IN SELECTED HOUSEHOLDS IN COIMBATORE CITY

INTERVIEW SCHEDULE

SOLAR USERS

PERSONAL DETAILS

1. Name :
2. Age :
3. Marital status :

   Married ☐ Single ☐ Divorced ☐ Separated ☐ Widow ☐ Widower ☐
4. Educational Qualification:
5. Religion :
6. Community :
7. Where is your house located? City ☐ Urban ☐ Sub urban ☐ Rural ☐
8. Family background

Name	Age	Educational Qualification	Sex	Relationship	Occupation	Income

9. Expenditure pattern

Categories	**Expenditure in Rs**
Food	
Clothing	
Rent	
Education	

Categories	**Expenditure in Rs**
Transport	
Electricity	
Entertainment	
Misc .,	

10. Ownership of house --------- Own House ☐ Rented House ☐
11. Type of House? Bungalow ☐ Apartment/Flat ☐ Penthouse ☐ Town House ☐
12. The average unit of consumption of electricity *(per month)……………………
13. Amount spend for consuming electricity *(per month) …………..
14. What are all the gadgets you are using at home(**Multiple Options**)

S.No	**Household Items**	
1	Light	
2	Fan	
3	Mixie	
4	Washing Machine	
5	Iron Box	
6	Fridge	
7	Induction stove	
8	Home theater	
9	TV	
10	Microwave Oven	
11	Music System	

15. Do you think it is possible for you to shift to solar energy at the household level to meet the electricity demand?

Fully □ Partial □ Not at all □

16. Where did you get the information about solar energy?

Advertisements □ Television □ Radio □ Exhibition □ Govt schemes □

Neighbours □ Friends □ Others □

17. Are you using solar energy technology?

Yes ☐ No ☐

18. If YES, What purpose

Heating	Yes☐	No☐
Lighting	Yes☐	No☐
Cooking	Yes☐	No☐
Power to Home appliances	Yes☐	No☐
Solar home lightning	Yes☐	No☐
Solar flashlights	Yes☐	No☐

19. Which of the following times you are using and level of satisfaction

Devices		**Dissatisfied**	**Satisfied**	**Neutral**
Solar water heater	Yes ☐ No ☐			
Solar Inverter	Yes ☐ No ☐			
Solar Air Conditioner	Yes ☐ No ☐			
Solar LED/CFL Light	Yes ☐ No ☐			
Solar Panel	Yes ☐ No ☐			

Any other, specify__________________

20. Reasons for buying solar devices? (Give Ranks)

S.No	**Details**	**Rank**
1	Lower power bill	
2	Generate own electricity	
3	Improve the environment	
4	A long term investment for power	
5	Increasing the value of home	
6	Sell home quickly	
7	Save time	
8	Access energy anywhere	
9	Promote green energy	
10	Access tax credit and government incentives	

21. The amount spending for installation (Rs.) ………………………

Own ☐__________________

Borrowed ☐ _________________

Total ☐ _________________

22. What brand of the solar technology have you implanted? ....
23. Do you find any difference in the electricity expenses, due to the usage of solar energy?

Yes □ No □

24. If YES, how much amount have you saved (in rupees)………………………………..
25. Since how long are you using solar energy appliances………………………..

26. Do you face problems of purchasing a solar energy product?

S.No	Details	Strongly Agree	Agree	undecided	Dis agree	Strongly disagree
1	Cut down on electricity charge					
2	Low maintenance cost					
3	Generate electricity without pollution					
4	Increase house resale value					
5	Most reliable and renewable value					
6	Reduce global warming					
7	Energy independent					
8	Free from power cut					
9	Save time					

Yes ☐ No ☐

26.1. If YES, state the problem______________________________

27. Are you aware of government subsidy to purchase solar energy?

Yes ☐ No ☐

28. Have you approached for the benefit of government scheme?

Yes ☐ No ☐

29. What are the benefits in using Solar Energy appliances?
30. Is there any problem in using solar energy appliances?

S. No	Details	Strongly Agree	Agree	Undecided	Dis agree	Strongly disagree
1	Reduction of power generation during cloudy days and night					
2	Low inefficiency for high voltage					
3	Installation problem					
4	Large storage space for battery					
5	Replacing solar energy panel is difficult					
6	High cost of installation					
7	Poor services					
8	High maintenance cost					
9	Rented accommodations.					
10	Non-availability of spare parts/batteries					
11	Wires and tubes of solar equipment are eaten up by animals					
12	Very few places where the equipment can get repaired					
13	Lack of skilled professional for after sale servicing					
14	Suppliers do not respond to post-sale grievances					

31. Do you think solar is reliable and green lifestyle?

Yes ☐ No ☐

32. Satisfaction level of solar technology using in home

Extremely dissatisfied	Slightly dissatisfied	Neutral	Slightly satisfied	Extremely satisfied

NON SOLAR USER

1. Do you know about solar devices?

   Yes ☐ No ☐

2. If YES, sources of information

   Newspapers ☐ Magazines ☐ Radio ☐ TV ☐ Ads ☐

3. Do you plan to use solar in your house?

   Yes ☐ No ☐

3.1 If YES, what reason?

S.No	Details	Strongly Agree	Agree	undecided	Disagree	Strongly disagree
1	Cut down on electricity charge					
2	Low maintenance cost					
3	Generate electricity without pollution					
4	Increase house resale value					
5	Most reliable and renewable value					
6	Reduce global warming					
7	Energy independent					
8	Free from power cut					
9	Save time					

3.2. If NO, what reason?

S. No	Details	Strongly Agree	Agree	undecided	Disagree	Strongly disagree
1	No proper knowledge about incentives provided by the government					
2	Infrastructure constraints					
3	No easy availability of the technology at the market					
4	Individuals are not convinced enough to adopt the technology					
5	Restricted accessibility to such products					
6	High maintenance cost					
7	Rental habitant					
8	Financial constraint					
9	Do not suit my external decoration					
10	Its unsuitable for climatic conditions in my area					
11	initial cost a barrier to invest					

4. Do you know the list of vendor who makes available such devices?

   Yes □ No □

5. Do you think investing in solar energy is financially sustainable in the Long run?

Strongly Agree	Agree	Undecided	Disagree	Strongly disagree

6. Which appliance do you choose for installing solar at your home (ranking order)

Heating	
Lighting	
Cooking	
Power to Home appliances	
Solar home lightning	
Solar flashlights	

7. Do you think solar is reliable and green lifestyle?

   Yes □ No □ do not know □

8. What are the benefits you perceive in using Solar Energy appliances?

S. No	Details	Strongly Agree	Agree	Undecided	Disagree	Strongly disagree
1	Cut down on electricity charge					
2	Low maintenance cost					
3	Generate electricity without pollution					
4	Increase house resale value					
5	Most reliable and renewable value					
6	Reduce global warming					
7	Energy independent					
8	Free from power cut					
9	Save time					

9. Is there any problem in using solar energy appliances?

S. No	Details	Strongly Agree	Agree	Undecided	Dis agree	Strongly disagree
1	Reduction of power generation during cloudy days and night					
2	Low inefficiency for high voltage					
3	Installation problem					
4	Large storage space for battery					
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7	Poor services					
8	High maintenance cost					
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12	Very few places where the equipment can get repaired					
13	Lack of skilled professional for after sale servicing					
14	Suppliers do not respond to post-sale grievances					