EFFECTIVENESS OF SOURA SUBSIDY SCHEME- A STUDY AMONG DOMESTIC CONSUMERS IN ERNAKULAM DISTRICT

PROJECT SUBMITTED

TO

ST. TERESA'S COLLEGE (Autonomous), ERNAKULAM

Affiliated to

MAHATMA GANDHI UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENT

FOR THE AWARD OF THE DEGREE OF

BACHELORS OF ARTS IN ECONOMICS

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CERTIFICATE

This is to certify that the project titled "**EFFECTIVENESS OF SOURA SUBSIDY SCHEME- A STUDY AMONG DOMESTIC CONSUMERS IN ERNAKULAM DISTRICT**" submitted in partial fulfilment of the requirement of B.A Degree in Economics to St. Teresa's Collage (Autonomous), Ernakulam, affiliated to the Mahatma Gandhi University, Kottayam is bona fide record of work done by the project group under my supervision and guidance.

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DECLARATION

We hereby declare that the project titled" **EFFECTIVENESS OF SOURA SUBSIDY SCHEME- A STUDY AMONG DOMESTIC CONSUMERS IN ERNAKULAM DISTRICT"** submitted by us for our B.A Economics degree is our original work.

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ACKNOWLEDGEMENT

Primarily we thank God Almighty on the successful completion of this project.

We extend our gratitude to the Head of the Department of Economics, Dr. Mary Liya C A for her valuable suggestions and support. We express our utmost gratitude to our guide, Dr. Anupa Jacob for her valuable mentorship throughout the project. Her suggestions and directions have aided us through the thick and thin of the project.

We extend our gratitude to all the faculty members of the Department of Economics who supported us whole heartedly.

We would also like to thank the service providers of Soura including Alpha Zee, Green Energy Solutions, TATA, Renewable Energy Solutions who have helped us in gathering primary data.

Finally, we express our sincere gratitude to all the respondents for taking time to provide the primary data and help us in the successful completion of our project.

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CHAPTER 1

INTRODUCTION

INTRODUCTION

Solar energy- Today's resource for a brighter tomorrow

The use of solar energy has not been opened up because the oil industry does not own the sun

-Ralph Nader

To sustain life on earth, energy is inevitable. Energy is essential for carrying out almost all the activities of day-to-day life. Its impact on the environment is also equally important. It acts as a powerful engine for economic growth and social development, which in turn determines the quality of life and development of a nation. The per capita energy consumption is also an indicator for development progress of nations.

Energy sources have been classified according to their renewability and conventionality. The feature which distinguishes renewable energy from exhaustible energy is that it can be renewed or replenished unlike conventional energy sources which get depleted over time. There are various forms of renewable energy sources such as solar energy, wind energy, geothermal energy and many more. Renewable energy sources have attained significance in these ever-changing times.

In a world, where the need of the hour is to combat climate adversities and switch to sustainable energy sources, solar energy is becoming increasingly popular among all the other energy sources. Nations have come together to address these concerns and the energy sector is the level playing field where countries have entered into agreements for switching to renewable sources. In accordance with these agreements, India has also adopted various policies to achieve the target by 2030. To facilitate this process, the shift towards solar power is explicitly visible in India.

Solar power is defined as the energy from the sun that is converted into thermal or electrical energy. Solar technologies can harness this energy for a variety of uses and can convert sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation. This energy can be used to generate electricity or be stored in batteries or thermal storage (Foster, Ghassemi and Cota, 2009).

There has been a significant impact of solar energy in the Indian energy scenario during the last few years. Solar power in India is a fast-developing industry as part of the renewable energy in India. The country's solar installed capacity was 56.951 GW as of 1 June 2022. Solar energy has taken a central place in India's National Action Plan on Climate Change with National Solar Mission as one of the key Missions of the Government. To achieve the above target, Government of India have launched various schemes to encourage generation of solar power in the country like Solar Park Scheme, VGF Schemes, CPSU Scheme, Defence Scheme, Canal bank & Canal top Scheme, Bundling Scheme, Grid Connected Solar Rooftop Scheme etc. These policies and projects present an optimistic picture of the future of India's energy requirement.

Coming to the southern state Kerala, with its tropical and humid climate, have vast potential for development of solar energy, as it is the most feasible renewable energy source keeping in mind the climatic and geographical conditions. The state released its Solar Energy Policy in 2013 with a motive to increase the installed capacity of solar to 500 MW by 2017 and 2,500 MW by 2030. As of March 2019, the total installed capacity of solar in the state was 134 MW. The Kerala Government has also launched a program called "Soura", which aims to add 1,000 MW of solar projects to the existing capacity of Kerala State Electricity Board Limited (KSEBL) by 2022. Of the 1,000 MW, 500 MW will be from rooftop solar, 200 MW from ground-mounted solar, 100 MW from floating solar, 150 MW from the solar park, and 50 MW from canal top solar projects.

There has also been a growing demand for installation of rooftop solar panels in the residential areas of Ernakulam. Solar water heaters are a huge success in the state, and this has induced many people to go for rooftop solar panels. Another major milestone for the state is Kerala's fully solar powered airport, Cochin International Airport which has become the second largest producer of solar power after Kerala State Electricity Board (KSEB). Kerala is also the first state to get solar powered fishing boats, which also enhances the livelihood and income of the fishermen, by cutting down on the fuel for boating.

REVIEW OF LITERATURE

As solar energy is assuming great importance in the world today, various institutions, scholars, academicians, journals etc. have studied its growth as well as the economic and environmental aspects connected to it. Thus, the literature covers books, journals, reports, publications and newspaper articles relating to the growth, importance, challenges and environmental impacts of the Solar Energy sector. Some of these literatures have been reviewed here.

Solar energy, as a renewable energy source, is gaining much prominence in our present-day world as it promises a continuous supply of energy to meet the present and future needs. The main reasons behind this are that this energy source is an environmentally clean source of energy and is abundant. The focus given here is on solar thermal energy, along with solar photovoltaics (PV), which are the two typical ways in which solar energy is utilized (*Sukham, Nayak,* 2018).

At present, renewable energy constitutes nearly a quarter of the world's electricity production. Among these, wind energy and pumped hydroelectricity are the most successful. The rapid investment in solar PV has been bridging this gap in being the most successful energy source. It offers a comprehensive view on the present status of solar energy and its distribution globally. The growth and investment in photovoltaics (PV) and the technology and infrastructure developed for supporting these innovations will help in bringing solar energy production to its peak *(M Letcher, M Thankis*, 2018).

The scientific and technical aspects of solar energy conversion and its usage for modern industrial purposes expands our horizon on the topic and vividly depicts the breakthrough in solar energy through science and technology, especially in photovoltaics (PV). Some of these new innovations include solar seawater desalination, advancements in concentrating solar power plants etc. There are also new forecasting methods in solar radiation which is crucial in understanding the economics of large solar power plant systems (*Goswami,* 2022).

On a global scale, solar energy possesses various economics aspects. Countries around the globe are now increasingly adopting solar energy, with China and Japan leading the way. Large scale solar power plants help in building the solar capacities of nations. In addition, the current trend highlights the fact that rooftop solar plants, which are carried out on a smaller scale, are gaining immense popularity. This suggests the daily viability and sustainability of using solar power and the storage facilities makes rooftop solar power plants much more attractive. It forecasts the development and the growth trajectory in top solar producing nations (Economics of Solar Power Energy, 2015)

There are various obstacles on the way ahead for solar power such as increasing cost and relative inefficiency. However, innovations in technology and the structure and design of solar panels could bring about a decrease in the cost of the panels and increase their efficiency. The change in design, efficient conversion of sunlight into electricity, adding hardware's that allows the panels to capture more sunlight and decreasing the cost of resources, especially silicon, are some of the suggestions. The technology behind solar panels and their working is a main determinant of the efficiency of the panels. These challenges explain why there has not been a massive shift to solar energy, despite promising a better future *(Kurr, 2019*).

Looking at the various reports and statistics, the World Bank report evaluates the potential of solar photovoltaic power in different countries. It provides grounds for comparison between countries and intends to raise awareness and induce investments. The report concludes that countries exhibiting high potential tend to have low seasonality in solar photovoltaic output and aims to help low-income countries to harness solar energy. (*World Bank referred in March 2020).* International Renewable Energy Agency has done a comprehensive study on the role of solar energy in the transformation of the global energy systems with specific reference to solar PV systems, in accordance with the Paris Climate Agreement and the future of solar PV systems in these ever-changing times. This shows that the current PV systems could be improved by mitigating various barriers and considerable progress has already been achieved due to innovative models like net metering and fiscal policies in the rooftop solar system. It revolves around the environmental aspects of using solar PV. It forecasts solar PV industry as a fast-evolving industry due to innovations in this field and predicts rapid cost reductions in the future (Future of Solar Photovoltaic, *2019*).

India receives over 5,000 trillion kWh per year energy with most areas receiving 4-7 kWh per sq. m per day. National Institute of Solar Energy has assessed the Country's solar potential of about 748 GW on the assumption that three per cent of the waste land area to be covered by Solar PV modules. Solar energy has occupied the key attention in India's National Action Plan on Climate Change with National Solar Mission as one of the key Missions. The Mission's objective is to establish India as a global leader in solar energy through policy initiatives. To achieve this, the government have launched various schemes like Solar Park Scheme, Defence Scheme, Grid Connected Solar Rooftop Scheme etc. Various policy measures undertaken included Standards for deployment of Solar Photovoltaic systems and devices, Provision of roof top solar, Raising tax free solar bonds etc. It shows the importance given by the government in meeting the sustainable development agenda and ensuring energy security. Solar power capacity has increased by more than 11 times in the last five years. Presently, solar tariff in India is very competitive and has achieved grid parity (Solar Energy, 2022).

India's renewable energy sector is the fourth largest and the solar power sector the fifth largest in the world. The report by IBEF shows the statistics on the share of solar energy sector in the total renewable share in India and the role of solar energy in achieving the required target. Installed renewable power generation capacity has posted a CAGR of 15.92 per cent between FY16-22. As of April 2022, India's installed renewable energy capacity (including hydro) stood at 158.12 GW, representing 39.43 per cent of the overall installed power capacity. The country is targeting about 450 Gigawatt (GW) of installed renewable energy capacity by 2030 and about 280 GW (over 60%) is expected from solar. This highlights the important role that solar energy plays towards attaining the country's goals. According to the analytics firm British Business Energy, India is ranked 3rd globally in terms of its investment in renewable energy in 2020. The renewable energy hubs in India are the northern states of Rajasthan, Gujarat, Andhra Pradesh, Karnataka, Tamil Nadu and Telangana (Renewable Energy Industry in India, 2022*).*

However, the evolution of solar energy in India has always been coupled with various hindrances. These hindrances could slow down the effectiveness and implementation of government projects in this direction. The evolution of solar in India began in the 1950s and

the government need to take tackle these issues to realize its desired objectives (*Kapoor and Pandey*, 2014).

The current state of solar technologies in Kerala has been optimistic, even though there is a long way ahead to meet its targets. One of the major problems that Kerala faces regarding Solar PV is space constraint and some of the viable alternatives include space intensive solar technology. Others include floating, dam top, smaller rooftop solar system and canal top installations, all of which help in utilizing the available space. Another scheme introduced by the central government and ongoing under the state government is Phase II of the Centre's Grid Connected Rooftop Solar System program, which comes under KSEB and ANERT. The implementation of this project also gives us a glimpse of the future of solar power in the state of Kerala. (India's 40 GW solar rooftop target for 2022- A Kerala case study, 2020).

The Navalta Solar & Electric Boats have built the world's first ever solar ferry 'Aditya' in Kerala, which operates between Thavan Kadavu and Vaiko. This ferry is the first of its kind in the world as a commercially viable form of transport. Aditya has also been the recipient of the prestigious Gustave Trove Award for the World's Best Electric Ferry in 2020. It has redefined India's waterway systems and is a testament to responsible green transport projects, leaving no carbon footprint and saving thousands of liters of diesel every year, thereby reducing environmental damage. (Introduction to India's first solar ferry, 2022).

RESEARCH PROBLEM

Solar power is the most eco-friendly generation source. Solar power systems derive clean, pure energy from the sun. Solar power plants are space-efficient; generally, they are installed on rooftops. It is a cost-effective solution; it does not require high wiring costs and has low maintenance. Installing solar panels in our homes help to combat greenhouse gas emissions and reduces our collective dependence on fossil fuel. Kerala is a state which receives abundance of sunlight throughout the year except for a few days. Hence it has infinite potential for using solar power compared to the northern states. (Hydropower or solar power, 2017).

However, Kerala's electricity generation is largely hydroelectric. This has a detrimental effect on the environment as vast areas of forest gets submerged under water and are cleared for such projects, thus disturbing the local habitat. Even setting up of new thermal power stations could generate harmful emissions. As an alternative, photovoltaics is a clean, renewable, carbon dioxide free power source with the least environmental impacts. Many institutions have chosen this path like the Cochin International Airport which was the first to receive the acclaim. The trend is also visible on a domestic scale as there has been a steep rise in the installation of rooftop solar power plants among the households, especially in the metro city of Kochi. To make this project more affordable and accessible, the government has brought out the Soura Project which subsidizes the initial cost of installing rooftop Solar PV in households. However, the project comes with its challenges as the cost outweighs the benefits received by the consumers. The area of study has been taken to understand more on the expenditure and income prospects for the households and the hindrances faced in implementing this scheme. Recently as the electricity bills increased vastly so the government has taken new initiatives like subsides to install solar panels at homes, such as any customers can install solar panels by any solar distributors. (Samuel and Prasad, 2021*)*

OBJECTIVES OF THE STUDY

1. To understand the challenges faced by households switching to solar energy, with special reference to Soura Subsidy Scheme.

2. To analyse the expenditure and benefits of the beneficiaries of Solar Subsidy scheme.

THEORETICAL FRAMEWORK

- Corporate social responsibility as a specific theory affirms that corporations are entities with economic, legal, ethical, and philanthropic obligations. Corporations responsible for a triple bottom line seek sustainability in the economic, social, and environmental realms.
- Green growth theory focus on a growth model based on renewable energy, whereby the main purpose is to create wealth without causing environmental destruction (Ditlev and Simonson, 2021).

- Real Options Theory- The real options theory focusses on assessing the value of flexibility of a project under uncertain conditions. The scope of theory is also extended to the practical applications of flexibility. The theory can be applied to manage the uncertainty associated with the Photovoltaics (PV) in domestic power sector (among households). The Real Options can be used to defer investments in PV in the expectation that more efficient and less expensive PV modules can be developed (Martinez and Cesena, 2012).

METHODOLOGY

The study is based on primary data. The method used for this research is survey through questionnaire and data analysis. The area chosen for the study is the residential areas in Ernakulam district. The main basis for selecting this area is the presence of a large number of Soura consumers, compared to other districts.

The mode for obtaining primary data involves collecting information about the registered users of Soura Scheme by approaching distributer companies of solar power registered under Soura Thejas scheme. Some of the empaneled service providers such as Alpha Zee, Green Energy Solutions are being approached to get information on the consumers who are availing the scheme through their firm. The data regarding Soura consumers in Ernakulam are also obtained from the Kerala State Electricity Board office, Mulanthuruthy. Out of 18,000 households, the required data is collected from a sample of 40 consumers due to lack of availability of data. The sampling method followed here is simple random sampling method, where every sample had an equal chance of being selected. The random sampling method selected is lottery method, which comes under simple random sampling. The required information is collected with the help of a questionnaire.

The study also focuses on assessing the expenditure and benefits involved for domestic consumers, whose source of electricity is from rooftop grid connected to solar panels.

Official websites of Soura and various research publications have been referred to obtain secondary data. A few sources are:

- ❖ The data from the official website of Kerala State Electricity Board (KSEB), Ministry of New and Renewable energy, various publications and studies conducted.

- ❖ Various publications and journals such as “The Economics of Renewable Energy” (Timmon and Haris, 2016), “Hydro Electric Power Dams in Kerala and Environmental Consequences from Socio-Economic Perspectives” (Samuel and A K 2014).

SCHEME OF STUDY

Chapterization of the study is organized under four chapters in the following manner:

- ➢ Chapter 1- Introduction- It includes introduction, Review of literature, problem identification, objectives of the study, significance, Methodology, Theoretical framework and Limitations.
- ➢ Chapter 2- Overview of Soura Scheme - It consists of an overview of the Soura Thejas scheme and status of solar energy in the world, in India and Kerala.
- ➢ Chapter 3- Analysis of the impact of the Soura Subsidy Scheme among domestic household in Ernakulam.
- ➢ Chapter 4- Findings, Recommendations and Conclusion.

LIMITATIONS OF STUDY

- Unwillingness of some respondents to provide information.
- Time consumption
- Difficult to establish trust with consumers.

GLOSSARY

- **Solar energy**: Solar energy is the radiation from the sun that is converted into thermal or electrical energy. It is the cleanest and most abundant renewable energy source available.
- **Conventional energy sources**: These are energy sources that are available in limited quantity, also known as non-renewable sources of energy. It includes sources like coal, petroleum, natural gas, etc.
- **Photovoltaic**: A PV system is composed of one or more solar panels, which are either ground mounted or installed on rooftop. Combined with an inverter and other electrical and mechanical hardware, these PV systems use energy from the Sun to generate electricity.
- **Photovoltaic panels**: It converts light into electricity using semiconducting materials that are also known as solar cells. They are then connected to form larger power-generating units known as modules or panels.
- **MW**: Megawatts. It is a unit of power equal to one million watts, especially as a measure of the output of a power plant.
- **Soura Subsidy Scheme**: In Soura project by KSEB, solar panels will be installed through subsidy on rooftops of houses to utilize sunlight to generate solar power. There are two models for the project- the Kerala model and the central government model. In Kerala model, the cost of installation of the plant is shared between the consumer and KSEB. A share of the solar power generated will be given to the consumer in proportion to his/her share in the installation expense. In central government model, the installation cost subtracting subsidy should be spent by the consumer. The whole of generated power can be utilized by them.
- **MNRE**: The Ministry of New and Renewable Energy is a ministry of the Government of India that is mainly responsible for research and development, intellectual property protection, and international cooperation, promotion, and coordination in renewable energy sources such as wind power, small hydro plants, biogas and solar power.

- **LCOE**: The levelized cost of energy (LCOE), also referred to as the levelized cost of electricity or levelized energy cost, is a measurement used to assess and compare alternative methods of energy production. The LCOE of an energy generating asset can be thought of as the average total cost of building and operating the asset per unit of total electricity generated over an assumed lifetime.
- **CAGR**: Compound Annual Growth Rate. It is the measure of an investment's annual growth rate over time, with the effect of compounding taken into account. It is often used to measure and compare the past performance of investments or to project their expected future returns.

CHAPTER 2

SOURA SUBSIDY SCHEME

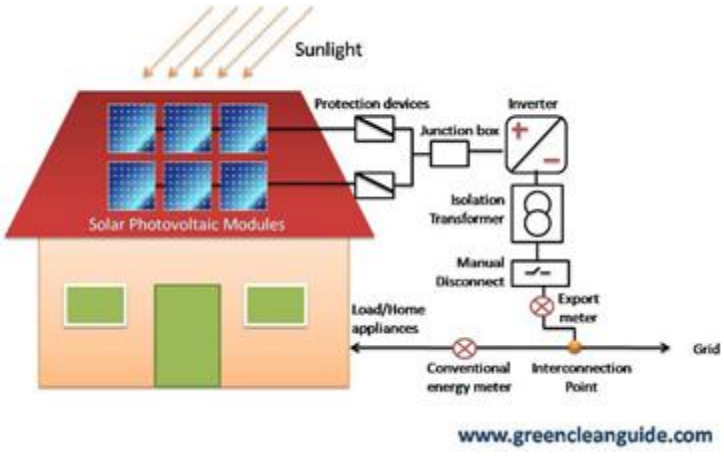
OVERVIEW

Solar panels are devices which converts sunlight into electricity, which can be used for various personal, domestic and commercial purposes. The light from the sun consists of particles known as photons, which is the essential element for converting into electricity. The panels are composed of a set of solar cells which are composed of materials such as phosphorous, silicon and boron. The entire process of generation of electricity by solar panels from direct sunlight is known as Photovoltaic effect (What is solar panel, 2023)

Technology and Mechanism behind Rooftop Solar PV

There are mainly 3 components in the Grid Interactive Rooftop Solar Photo Voltaic PV. These include solar PV modules, the inverter and mounting structure to hold PV modules. Solar PV modules form an array and it requires a mounting structure to hold PV modules at the certain angle for generating maximum amount of electricity. Solar energy is converted to electricity by the solar panels in Direct Current (DC) form. The inverter converts the direct electrical energy converted to Alternate Current (AC) power. The metering panel connected to the AC power measures the output (How grid interactive rooftop solar PV systems work, 2013).

Figure 2.1: Conversion of sunlight into electricity



Source: Secondary Data

The three primary technologies by which solar energy is harnessed are photovoltaic (PV), concentrating solar power (CSP) and solar heating and cooling (SHC) systems. Among the

three technologies, photovoltaic converts sunlight into electricity directly, CSP uses thermal energy such as in the operation of electric turbines; and SHC systems collect the heat from the sun to provide hot water, conditioning or air heating. (SEIA as on 13th August 2022).

Solar PV is the most widely accepted and commonly used medium. The term Photovoltaic is derived from Photovoltaic Effect, which is the process by which light is converted into electricity. At present, the electricity generated from solar cells has become much cheaper globally and this has led to the massive deployment of photovoltaic systems. Businesses and industry have switched to solar technologies to expand their energy resources and become cost efficient. Solar PV is used by energy developers these days and they aim to produce electricity on a large scale for industrial and commercial purposes (Solar Photovoltaic technology basics, 2022).

People are now opting to set up solar panels in their home premises due to increasing popularity. The energy generated can be used to power most of the home appliances like fans, computers and heavy machinery. Decrease in water footprint associated with solar energy system is another factor which has led to a hike in demand in the power generation sector. The demand for solar cells has gained major traction owing to surge in rooftop installations, followed by increase in applications in the architectural sector.

SUBSIDY SCHEMES

A subsidy scheme is a government support for promoting the economic and social development by providing financial assistance. There are various schemes for installation of solar panels at subsidized rate launched by the central government. These include schemes for solar parks and ultra-mega solar power projects, for PV lightning systems, grid connected power systems on households etc. (Subsidies on Solar panels, 2023).

OVERVIEW OF SOURA SUBSIDY SCHEME

The ‘Soura’ rooftop solar energy project was launched by the state government with financial assistance from the central government. It is implemented by the Kerala State Electricity Board (KSEB). Under this project, roof top subsidies are provided by the Government for installing solar panels. It aims at promoting the use of sunlight among households as a renewable source of energy. This is done by converting sunlight into electricity using solar

panels at a low cost. The statistics have shown that the project has 43,000 beneficiaries with rooftop solar panels. The panel maintenance for 5 years will be undertaken by KSEB (Soura Project, 2020). The scheme consists of 2 models:

PART 1- SOLAR POWER PLANTS FOR DOMESTIC SECTOR WITH CENTRAL FINANCIAL ASSISTANCE

In this model, a subsidy of up to 40 per cent of the plant cost can be claimed by the customers, based on the solar plant capacity. The Ministry of Renewable Energy granted a sanction of 25 MV to ANERT for carrying out the first phase of rooftop solar power plant for domestic sector. Based on the average electricity consumption of consumers, 3 hybrid models are introduced, which give financial support to the weaker sections of society. Any one of these models can be chosen by the consumer for which he/she needs to pay only a part of the total implementation cost. The other part will be borne by KSEBL.

PART 2- INSTALLATION OF SOLAR POWER PLANTS GRID CONNECTED AND HYBRID

KSEBL has also launched the second phase of Soura Project with an aim of creating more beneficiaries, although its implementation is awaiting. The goal is to achieve higher solar consumption by introducing attractive subsidies to the consumers, which is provided by the Ministry of New and Renewable Energy. Under the scheme, installation charges are paid by the consumer, which can be recovered as savings on power installed over a duration of 3 and a half years. For the first 3 KW plant capacity, the consumers can claim a subsidy of 40per cent and 20per cent for additional KW. Consumers choose contractors from the empaneled list, who will be responsible for the maintenance of the panels for the next 5 years.

Under phase 2, the 'Kerala model' which makes solar power project more affordable is introduced by KSEB. Houses with less than 200 units of monthly electricity consumption are the beneficiaries of this scheme. KSEB shares the investment with the customer, provided the solar power generated is also shared. KSEB provides 25per cent of the power if the consumer covers 12per cent of the initial expense. Houses excluded in Phase 1 will be given priority during the 2nd phase. Slant of the roof, shaded area, no modification clause for the next 5 years and strength of roof are some of the criteria for being selected on a priority basis (Soura Thejas- Solar rooftop program with subsidy, 2017).

SOLAR ENERGY SITUATION IN THE WORLD

Discovery of PV technology in 1839 has set a drastic change in the global solar energy sector. All the countries are aiming at sustainable energy consumption since the need of the hour is to combat climate change by switching from non-renewable to renewable energy sources. They are also switching to renewable energy to achieve this goal. The global solar energy market was valued at $52.5 billion in 2018 and the current trends predict the market to reach $223.3 billion by 2026. According to recent estimates, by 2050, solar power is expected to become the greatest source of electricity in the world among all other energy sources (Zafar, 2022).

The two main kinds of technologies used in this field are the PV (photovoltaic) systems which use solar panels to convert sunlight directly into electricity, and the CSP (Concentrated Solar Power) that indirectly uses the solar thermal energy to produce electricity.

The growth of solar energy market has been accelerated by environmental pollution and government incentives and tax rebates are given to install solar panels. Government tariffs, mergers and acquisitions of local manufacturing have driven the emerging economies like China and Japan to increase production of solar technologies (Harihara and Prasad, 2019).

The growth of solar energy in China in the past decade has been phenomenal. In 2017, China became the first country to pass 100 GW of cumulative installed PV capacity, and it had 174 GW of cumulative installed solar capacity by the end of 2018. In 2010, China and Japan only contributes ten percent of the deployment of global solar power. However, by the end of 2018, they accounted for more than 50 percent of global solar power. (David Ray Griffin, 2020). China is forecast to make up 27 per cent of that demand owing to heavy governmental spending. The country's unprecedented growth rate has also borne heavy environmental costs for the last two decades. Currently, Japan is reviewing its solar subsidies, while the limited availability of suitable land has been a major factor curbing solar growth potential in India.

In Europe, other countries are witnessing a decline in their solar energy growth due to the slowdown in Germany. Moreover, North America and Europe have largely focused on research and development to maximize the solar potential. Increase in applications of solar energy for power generation, agriculture, and architecture have also stimulated solar energy

growth in the Middle East and Africa. The demand for solar cells has gained major traction owing to surge in rooftop PV installations, followed by increase in applications in the architectural sector (Hariharan and Prasad, 2019).

SOLAR PROJECTS AND SOLAR ENERGY STATUS IN INDIA

India is endowed with vast solar energy potential. Most parts of the country receive 4-7 kWh energy per sq. m per day with around 5000kWh energy being incident on the total land area every year. Solar photovoltaics power offers immense potential in India if it can be harnessed effectively. The National Institute of Solar Energy has assessed the Country's solar potential of about 748 GW assuming three percent of the waste land area to be covered by Solar PV modules. Solar energy occupies primary importance in India's National Action Plan on Climate Change with National Solar Mission being one of its key missions. The mission has set the target of installing 100 GW grid-connected solar power plants by 2022. The country's solar installed capacity was 60.813 GW_{AC} as of 30 September 2022.

In India, the states of Rajasthan and northern Gujarat receive the highest annual solar power radiation. As of September 2021, India occupies 4th position globally in solar power generation. Solar power capacity has increased by more than 11 times in the last five years from 2.6 GW in March 2014 to 30 GW in July 2019. Presently, solar tariff in India is very competitive and has achieved grid parity. There are more than 40 Major Solar power plants in India, which generates at least 10 MW of power. Some of the major solar power projects in India are Badla Solar Park, Kurnool Ultra Mega solar park, Rewa Ultra Mega Solar Park, NP Kunta Ultra Mega Solar Park, Charaka Solar Park, Kamuthia Solar Power Project and Kadapa Ultra Mega Solar Park.

Another project that aims to establish solar power throughout the country is 'Intended Nationally Determined Contributions (INDCs)'. Its target is to achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources and to reduce the emission intensity of its GDP by 33 to 35 percent from 2005 level by 2030. To achieve this, Government of India have launched various schemes like:

- Solar Park Scheme
- VGF Schemes
- CPSU Scheme
- Defense Scheme
- Canal bank & Canal top Scheme
- Bundling Scheme
- Grid Connected Solar Rooftop Scheme etc.

SOLAR ENERGY STATUS IN KERALA

As a part of solving the energy crisis, the government of Kerala aims to switch to solar energy, which is a form of renewable energy resource. Solar energy policy was released by the government of Kerala in 2013. Kerala released its Solar Energy Policy in 2013 with a mission to increase the installed capacity of solar to 500 MW by 2017 and 2,500 MW by 2030. Through effective policy implementation, the Kerala State Electricity Board aims at making solar power projects more affordable by installing rooftop solar panels at subsidized rates.

As of March 2019, the total installed capacity of solar in the state is 134 MW. Various reforms for promoting solar installations have been formulated by the government to achieve the targets. Recently, the Kerala State Electricity Regulatory Commission (KSERC) issued a regulation called the "Kerala State Electricity Regulatory Commission (Renewable Energy and Net Metering) Regulations", 2020". According to this regulation, the state-directed distribution licensees constitute an in-house renewable energy cell to promote the deployment of renewable energy projects in the state.

The Kerala Government have launched a program called "Soura", which aims to add 1,000 MW of solar projects to the existing capacity of Kerala State Electricity Board Limited (KSEBL) by 2022. Of the 1,000 MW, 500 MW will be from rooftop solar, 200 MW from ground-mounted solar, 100 MW from floating solar, 150 MW from the solar park, and 50 MW from canal top solar projects. To achieve the targets, KSERC issues the licenses on a first come, first serve basis.

In Kerala, electrical energy consumption has increased to 21,900 MU in 2017-18 from 20,453 MU in 2016-17 with a percent increase of 7.07 percent. As per the 19th Electric Power Survey conducted in the year 2018 by Central Electricity Authority, an increase of 74 percent in commercial consumption and a 60 percent increase in domestic consumption of energy is predicted by 2026-27.

In general, Kerala has a good scope of rooftop solar deployments in various sectors. The availability of net metering and widespread evolutionary reforms brought out by the government encourage the customers to choose solar PV solutions. This shows the willingness of the state to achieve its set targets of energy production from solar and renewable energy (Kalbinder, 2020).

SITUATION IN ERNAKULAM

Among the districts in Kerala, Ernakulam has shown considerable progress in setting up rooftop solar panels contributing up to 1.8MW out of the target 3 MW set by ANERT (Agency for New and Renewable Energy and Research Technology). Most of the consumers have availed the service with the help of 'Urjamithra', an organization technically backed by ANERT (Good response to ANERT rooftop solar plant project in Ernakulam, 2022). The district has also been in the limelight regarding solar usage as the Milma Diary unit in Tripunithura is the first of its kind to become the country's fully solar powered diary unit. (Ernakulam dairy set to become nation's first fully solar powered plant, 2022).

CHAPTER 3

THE IMPACT OF SOURA SUBSIDY SCHEME ON THE DOMESTIC CONSUMERS IN ERNAKULAM

The main aim of the project is to study the influence of the Soura Subsidy Scheme among consumers. The analysis of the expenditure and the benefits involved in switching to solar power through the Soura subsidy scheme and the challenges faced by the consumers form the basis of this study. Overall, solar energy has a positive environmental impact. It lowers carbon emissions, reduces our dependence on finite natural resources, and helps fight climate change. SOURA Subsidy scheme is initiated by KSEB for domestic consumers. As part of this scheme, the consumers can install solar panels over the roof of their homes. The sample consists of 40 consumers from Ernakulam, who are selected by stratified sampling based on their area. The analysis is segregated into different parts- Social Profile of the respondents, factors that influenced the decision to adopt solar power, types and classes of Soura system, analysis of the benefits and drawbacks from Soura scheme and analysis of the economic viability of the scheme.

SOCIAL PROFILE OF THE RESPONDENTS

The social profile consists of various aspects such as the age of the respondents, size of the family and educational qualification. This helps in getting a comprehensive view of the respondents' demographic characteristics.

3.1. AGE OF THE RESPONDENT

Age plays an important role in determining the pattern of investment in the scheme. Awareness amongst youth about Soura subsidy is more as compared to other age groups.

Table 3.1: Age wise distribution of respondents

AGE	**Percentage (%)**
20 - 35	40
35 - 45	20
45 - 55	27.5
55 and above	12.5
GRAND TOTAL:	100

Source-Primary Data

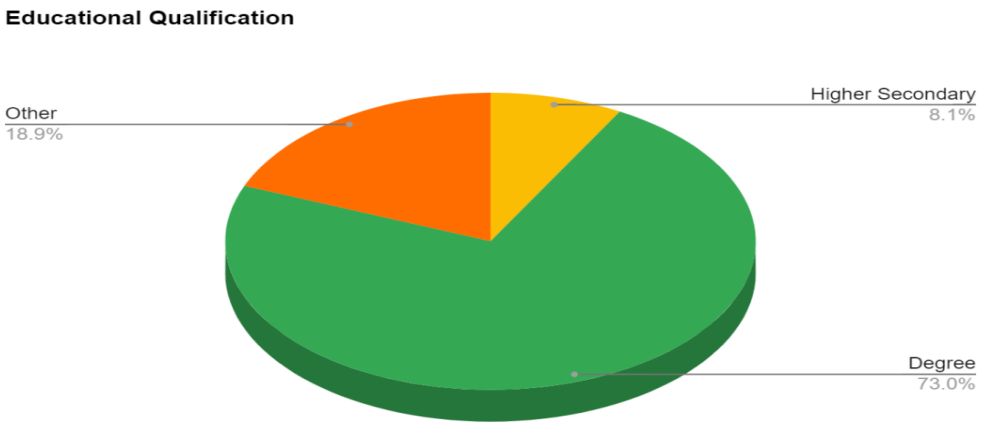
Among the total respondents, the young age population, consisting of 40 percent of the sample, are more interested in and aware of the Soura Subsidy scheme offered by the

government. The middle age groups consisting of 27.5 per cent are also aware of the scheme, as evident by the number of people who have installed the solar panels from this group. For the youth, this may be a way to start saving their income and plan their expenses at an early age to secure financial stability. It also shows that they are more interested in taking part in the incentives and schemes introduced by the government. A primary reason for less involvement of senior citizens in the scheme is that they might hesitate to change their existing level of comfort and services and adapt to new changes. More awareness about this scheme also needs to be made among senior citizens.

3.2 EDUCATIONAL QUALIFICATION OF RESPONDENTS

Literacy influences the choices that the consumer makes and their decisions. They easily understand and comprehend new alternatives and are more aware of the future.

Figure 3.1: Educational qualification of respondents



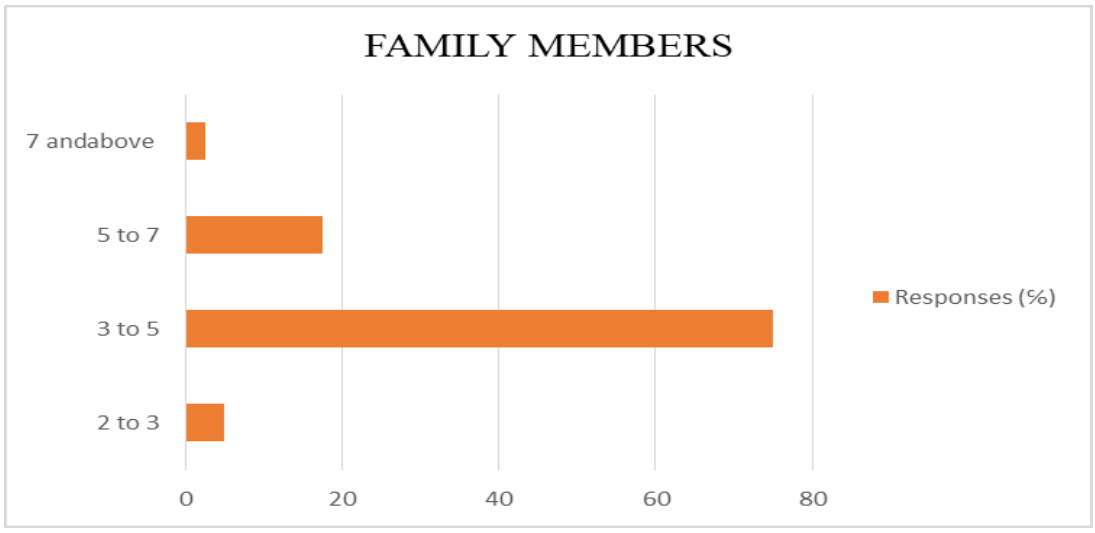
Source- Primary Data

All the respondents are literate and among them, 73 per cent are graduate holders and all of them have completed their higher secondary. This shows that more people are now aware of the developments happening around them and are literate to understand the technicalities and services offered under the scheme. They are also well-informed and responsible consumers.

3.3 SIZE OF FAMILY

The number of family members helps in determining the savings, expenditure and investment decisions of each household. It is the most relevant factor in deciding which power capacity to choose.

Figure 3.2: Number of family members



Source- Primary Survey

It is evident that 75 percent of the households consist of less than five (3-5) family members and only 2.5 per cent of consumers live in a joint family consisting of more than seven members. In the current scenario where, nuclear families are more prevalent, solar power is installed in households consisting of at least three to five members, suggesting that it is not too feasible, if the family size is either too small or large.

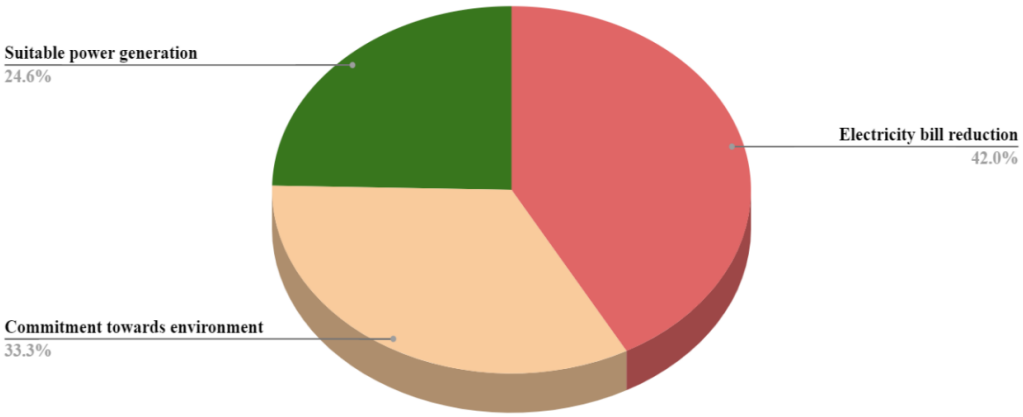
FACTORS THAT INFLUENCED THE DECISION TO ADOPT SOLAR POWER

There are numerous factors which influenced the consumer's decisions to switch to solar energy, the most significant one being the reduction in the electricity bills. Commitment towards the Environment and sustainable power generation also leads to a change in the decisions. Soura project meets environmental concerns and cost efficiency at the same time. Thus, it is a perfect combination which people look for.

3.4 REASONS TO ADOPT SOLAR POWER

The main reason for switching to solar power is to reduce electricity bills. As electricity is harvested directly from the sun, it is both renewable and sustainable. As a type of renewable energy, generation produces no greenhouse gas emissions, compared to fossil fuels. The reasons among the consumers vary in accordance with their priorities.

Figure 3.3: Reasons for adopting solar power



Source- Primary Data

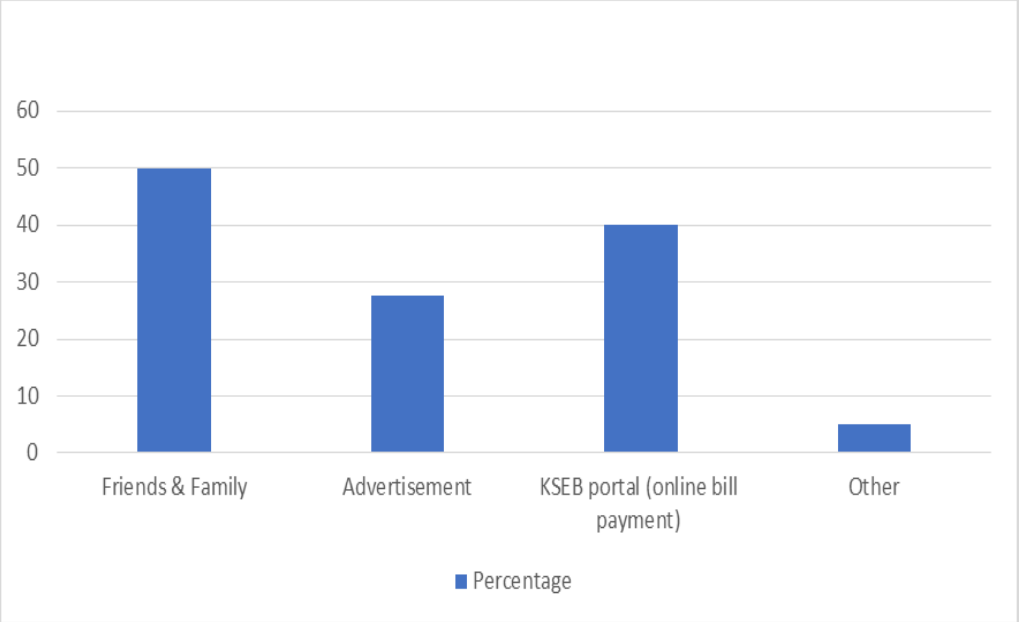
The reason for adopting the Soura scheme for installing solar power shows the preference of the consumers. It is found that the major reason among the consumers to switch to solar power is the reduction in electricity bill and around 42 per cent chose this option. The primary aim of consumers is to save and in the event of rising electricity charges, this has

become a favorable option. For 33 per cent of the respondents, commitment towards the environment is the main reason for them to switch to this mode of power generation and sustainable power generation has induced 24.6 per cent to adopt solar energy. This shows that people are more concerned about conserving the environment and sustainable development and have started acting upon it.

3.5. AWARENESS ABOUT KSEB SOURA SUBSIDY SCHEME

SOURA Subsidy scheme is initiated by KSEB for domestic consumers. Most people come to know about soura through their friends and family. As part of this scheme, the consumers can install solar panels over the roof of their homes. There are two phases under the scheme. KSEB provides subsidies up to 40 percent of the installation cost for up to three kilo watt (3kW) and 20 per cent for up to ten kilo watt (10 kW).

Figure 3.4: Awareness about KSEB Soura Subsidy Scheme



Source- Primary Data

Figure 3.4 shows the statistics that 39 per cent of the participants came to know about the scheme through family and friends, 22 percent through advertisement, another 35 per cent through KSEB online portals and less than 5 per cent through other methods such as leaflets or brochures.

3.6 DISTRIBUTOR COMPANIES OF SOLAR POWER

The Kerala State Electricity Board (KSEB) provides a list of empaneled service providers, from which the consumer selects any one provider based on their locational convenience and preferences. KSEB provides the maintenance facility through the empaneled service provider. In Model 1, maintenance will be done for 25 years and for Model 2, maintenance will be done for 5 years. The majority of the consumers are under the first phase of Soura Subsidy Scheme.

Table 3.2: Service providers of the respondents

Name	**Percentage (%)**
TATA	15
Sunrise Solars	2.5
IDEAL Power Solutions	2.5
Renewable Energy Solutions	7.5
Green Hygrotech	12.5
RAICO	5
Havells	2.5
Blue bell	2.5
Kammath Electric	2.5
Wattson Energy	5
Sukam	2.5
Alpha Zee	2.5
Others	7.5

Source- Primary Survey

The survey data reveals the preference for TATA among the empaneled list of service providers, by the respondents. All these companies are providers in Ernakulam and the consumers choose the company based on its popularity and the quality of service and panels that they offer.

TYPES AND CLASSES OF SOLAR SYSTEM

The scheme consists of various types of subsidies. This enables the users to select scheme according to their rooftop area and model of grid selected. This will ensure reduced costs with best returns.

3.7. SOLAR POWER SYSTEM CAPACITY SELECTED

Solar power system capacity refers to the measure of solar panels (solar systems) potential to generate power. In the case of off-grid models, which require batteries for storing solar power, the capacity refers to the ability to generate power and store electricity. The capacity depends on the daily power consumption by households and the actual capacity is obtained when the solar PV receives sunlight throughout the day.

Table 3.3: Solar power system capacity selected by consumers

Type of Subsidy	Percentage of subscribers (%)
2 KW	7.5
3 KW	57.5
4 KW	12.5
5 KW	22.5

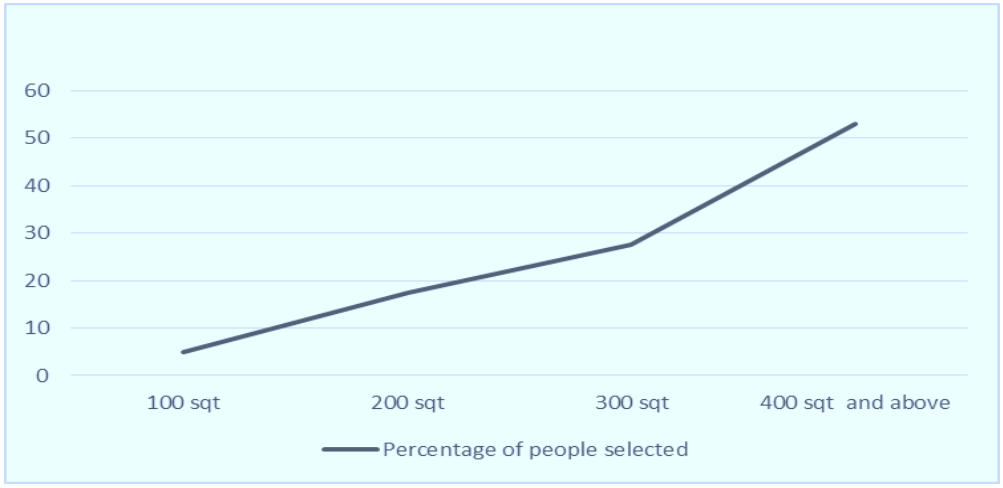
Source- Primary Survey

Table 3.2 depicts that 58 percent of participants opted for the three-kilowatt (3kW) capacity and only 7.5 percent have a capacity of two kilowatt (2kW) under the Soura scheme. Many factors influence this decision such as their electricity consumption, income of the consumers and size of family. Most of them have solar panels with a capacity of 3kw, which is on par with their electricity consumption.

3.8 SHADE FREE ROOFTOP AREA

The shade free rooftop area determines the size of the panels and shows whether further structural changes are to be made in the house. This also influences the power capacity of the solar panels.

Figure 3.5: Shade free rooftop area of the respondents



Source- Primary Survey

Figure 3.5 shows a steep incline for rooftop area beyond 400 sq ft. The survey concludes that 53 percent have more than 400 sq ft of rooftop area and only 5 percent of the people have 100 sq ft rooftop area. This implies that people with larger rooftop areas are more inclined to adopt this scheme as they would get more electricity in return. The minimum area required under the current phase of Soura Subsidy Scheme is 200 sq ft. The rooftop area is an important component for the easy installation and structuring of the rooftop panels.

3.9 MODEL OF GRID SELECTED

The residential solar power plant consists of three models- on-grid, off-grid and hybrid models. Under the on-grid model, one kilowatt (1kW) will result in four units of electricity production which remains for 8 hours, and it consists of a bi-directional meter. This facilitates the transfer of excess power to the KSEB grid lines or acquiring additional power from KSEB. Off grid models require batteries to store solar power and one battery can produce 12-watt electricity. The provision for storage entails the continuous working of the inverters and as such, the maintenance cost under this model is high. The hybrid model possess the main features of both on-grid and off-grid models and it is considered to be the best model. However, the installation cost is higher in hybrid models.

Table 3.4: Model of grid selected by respondents

Model of grid	**Percentage**
Grid tied/ Connected	87.5 per cent
Off grid	2.5 per cent
Hybrid model	10 per cent

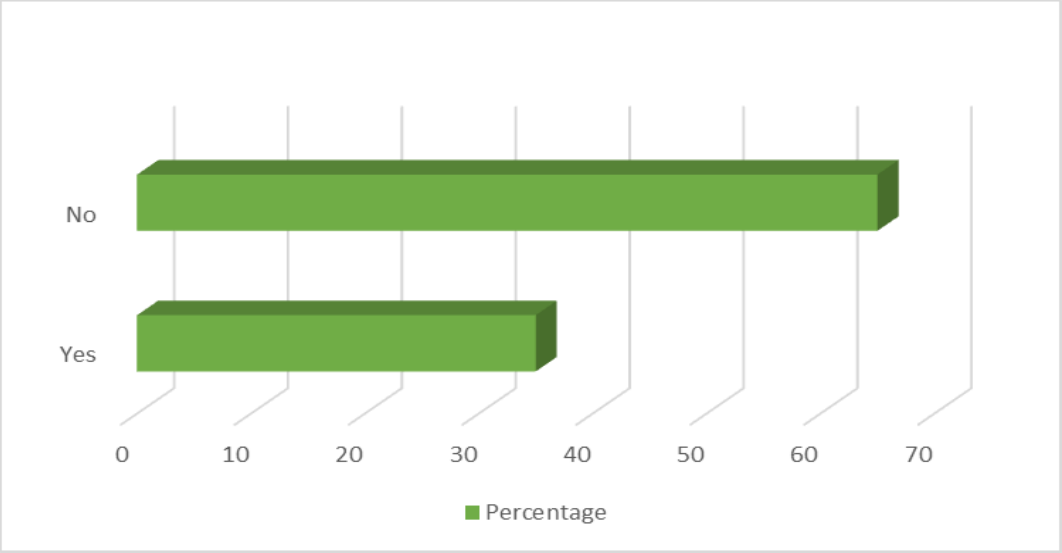
Source- Primary Data

The survey result shows that 87.5 per cent of the consumers chose on-grid model since it allows them to save money through better efficiency rates, less maintenance, net metering and having lower equipment and installation cost as compared to off-grid models. 10 percent of consumers chose hybrid models and only less than three per cent (2.5%) chose off grid models. Off grid models require more maintenance due to the usage of batteries and hence their popularity have been decreasing over the years.

3.10 PROVISION TO STORE SOLAR POWER

A proper plan to store excess solar energy will promote the efficient usage of solar panels. This occurs mainly due to the incidence of direct sunlight on the panels throughout the year and storing excess power, thereby proving beneficial to the users. There are two kinds of solar panels- on grid and off grid. Those who chose on-grid models have an added advantage as they do not create a need for storing solar power since it is connected to the KSEB voltage through bi-direction meter. The off-grid and hybrid models of solar panels can store solar energy through batteries.

Figure 3.6: Provision to store solar power



Source: Primary Data

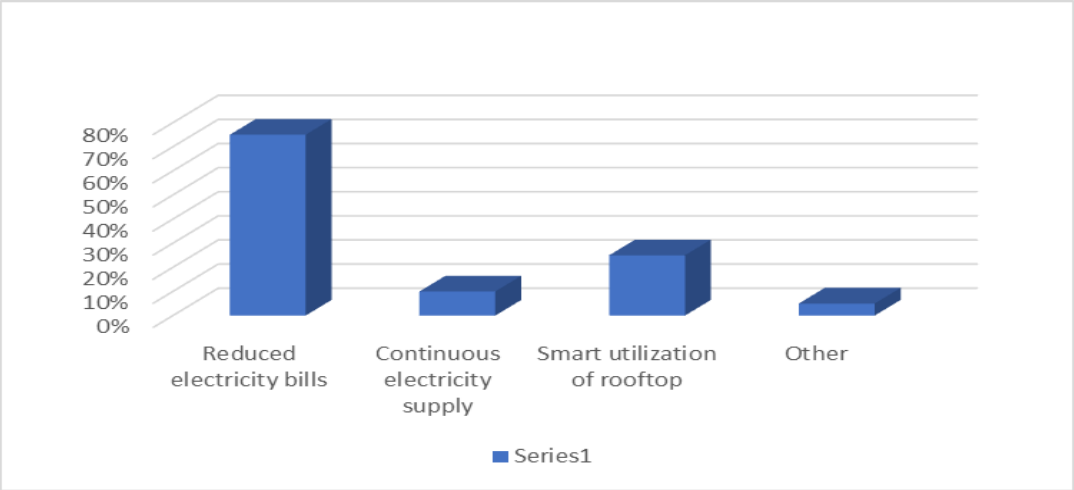
The above data depicts that more than half of the consumers under study, i.e., 65 per cent do not have a provision to store solar energy and only 35 percent of them are able to store it. The main reason for this is that most of the consumers are using on-grid model of the solar panels. The consumers using both off-grid and hybrid models are able to store solar energy through batteries. The on-grid model requires less maintenance as compared to off-grid since under the latter, the battery life will terminate after 5 years and requires more maintenance.

ANALYSIS OF THE BENEFITS AND DRAWBACKS FROM SOURA SCHEME

The common understanding about Soura Scheme is that it results in high installation costs. This section covers the benefits and limitations faced by the consumers of the scheme. It includes the economic, time and maintenance aspects faced while installing and adapting the scheme.

3.11 BENEFITS RECEIVED FROM THE SOLAR PV UNDER THE SCHEME

Figure 3.7: Benefits received from solar PV under the scheme



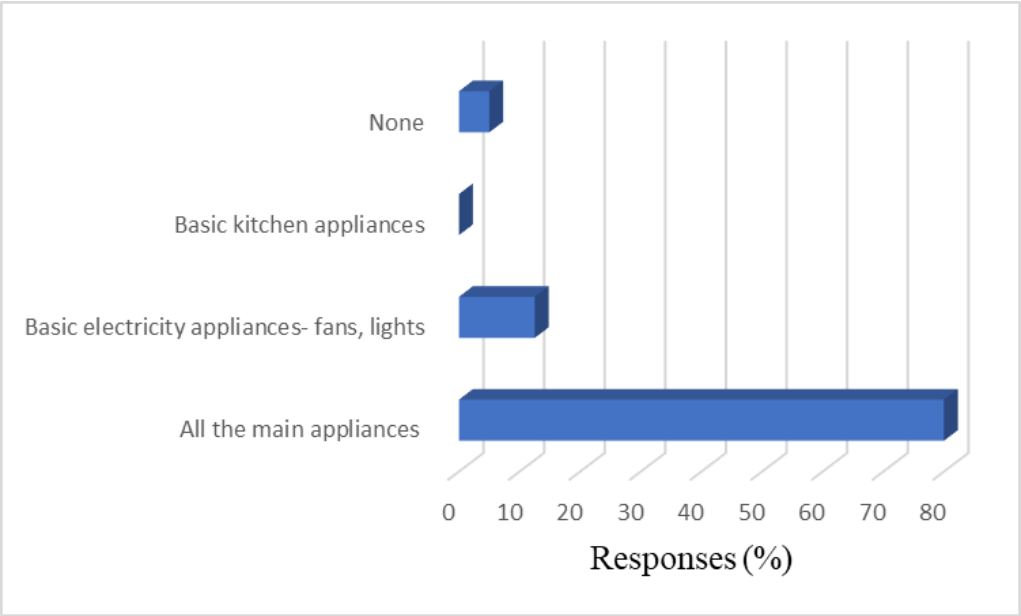
Source- Primary Data

It is obvious that 75 percent of the consumers receive benefits mainly from reduced electricity bills. Around 25 per cent of households use solar power for smarter utilization of rooftops. The survey results of Figure 3.3 show that electricity bill reduction is the main reason among the respondents for switching to rooftop solar panels since it helps in saving their income and reducing their expenditure in the long run. This analysis corresponds with the earlier survey results that reducing electricity bill has been both the primary objective and benefit that the consumers have received from the scheme.

3.12 UTILITY OF SOLAR POWER IN HOUSEHOLDS

The usage of solar power to run various appliances portrays the extent to which it benefits the consumers. The basic kitchen appliances mentioned include blenders, cutters, juicer, et cetera while basic electricity appliances are commonly found electric home machines such as fans, LED lights, lamps, television, and air coolers. The 'all the main appliances' option is a combination of both the aforementioned options as well as electric water pumps and motors.

Figure 3.8: Usage of solar power in households



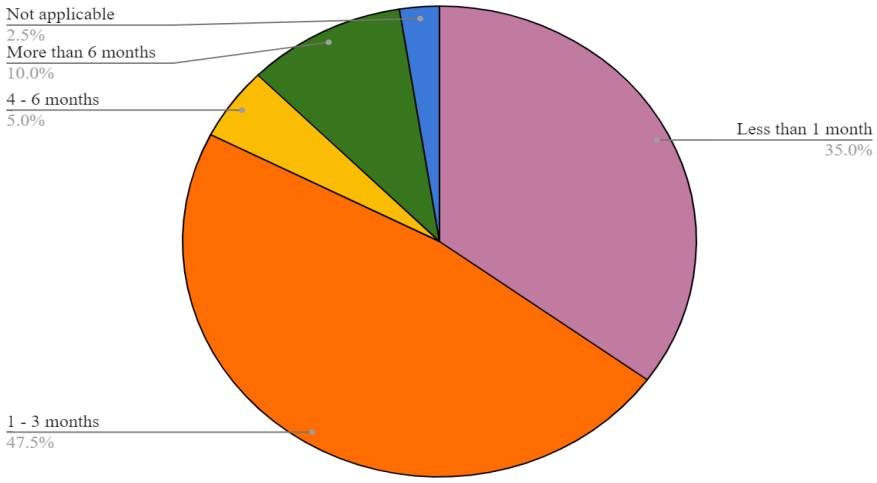
Source: Primary Data

This means that 80 percent of the population who operate all the appliances using solar power are benefitting completely from rooftop solar. It is found that 12.5 percent of the consumers operate only their basic appliances using solar power. This shows that it is beneficial to most consumers.

3.13 TIME DURATION BETWEEN REGISTRATION UNDER THE SCHEME AND RESPONSE FROM CONCERNED AUTHORITIES

The response time taken by the concerned authorities shows whether the whole process is cumbersome or easy to the consumers. It also portrays the probable inconvenience faced by consumers while registering under the scheme.

Figure 3.9: Time lag between registration under the scheme and response from concerned authorities



Source- Primary Survey

After registering in the scheme, for 47.5 per cent consumers, the authorities took around less than three months to respond back to the consumers and for 35 per cent of the respondents, it even took less than a month. This shows that the government services are being offered without much time lag and proves to be comfortable for the respondents. For two point five per cent (2.5%) of the respondents, this was not applicable since they have availed the scheme indirectly through their solar service provider as under the empaneled list issued by ANERT .

3.14 REQUIREMENT FOR STRUCTURAL CHANGES

Installation of solar panels may necessitate structural changes to the rooftop at times. A slope of the roof and an open direction with sunlight is necessary for installing the panels.

Table 3.5: Requirement for structural changes to be made for installing solar panels.

Options	**Percentage (%)**
YES	25
NO	75

Source: Primary data

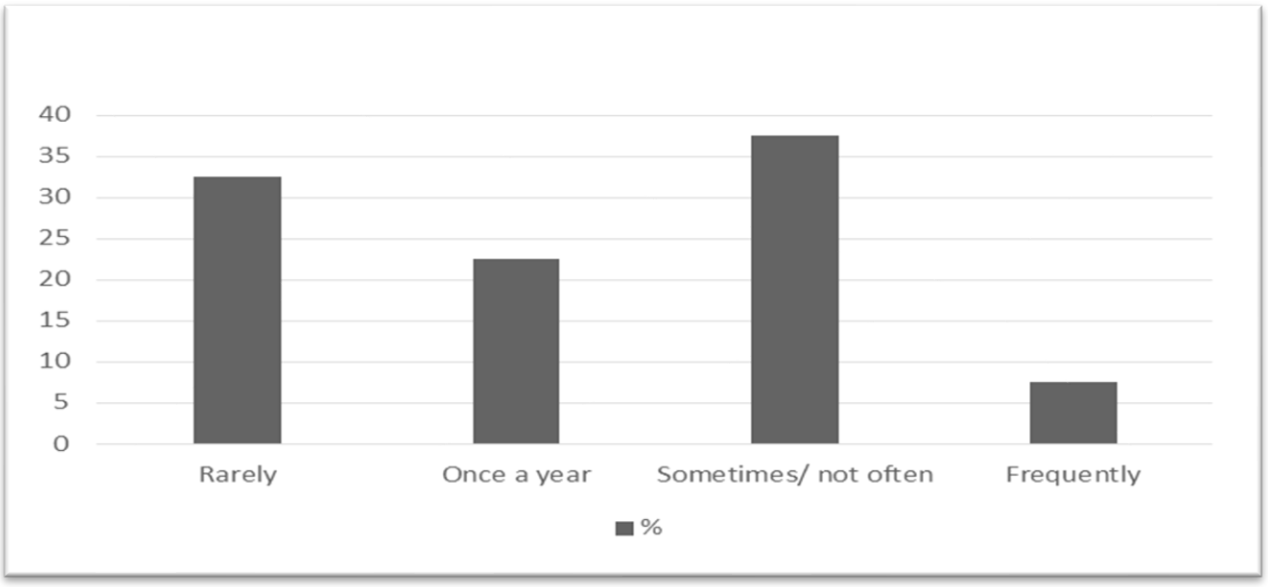
By analyzing the data, we find that 62.5 per cent of the respondents do not require to make any structural change to their houses and the remaining 37.5 per cent had to incur some expenditure for modifying their existing structure. These structural changes include building

a frame, installing additional frames and making additional structure for placing the panel etc. Structural changes add to the cost of installation, and this may prove to be a major drawback. We can conclude that changes are made only in certain conditions where installation becomes difficult without altering the structure. Adequate slope of the roof avoids the need to have any structural change. This reduces the cost of installing the rooftop solar panels through this scheme.

3.15 FREQUENCY OF MAINTENANCE OF THE PANELS

Low maintenance work of solar panels supports rooftop solar. Proper maintenance can help in ensuring that the panels remain in good condition in the long run.

Figure 3.10: Frequency of maintaining rooftop solar power



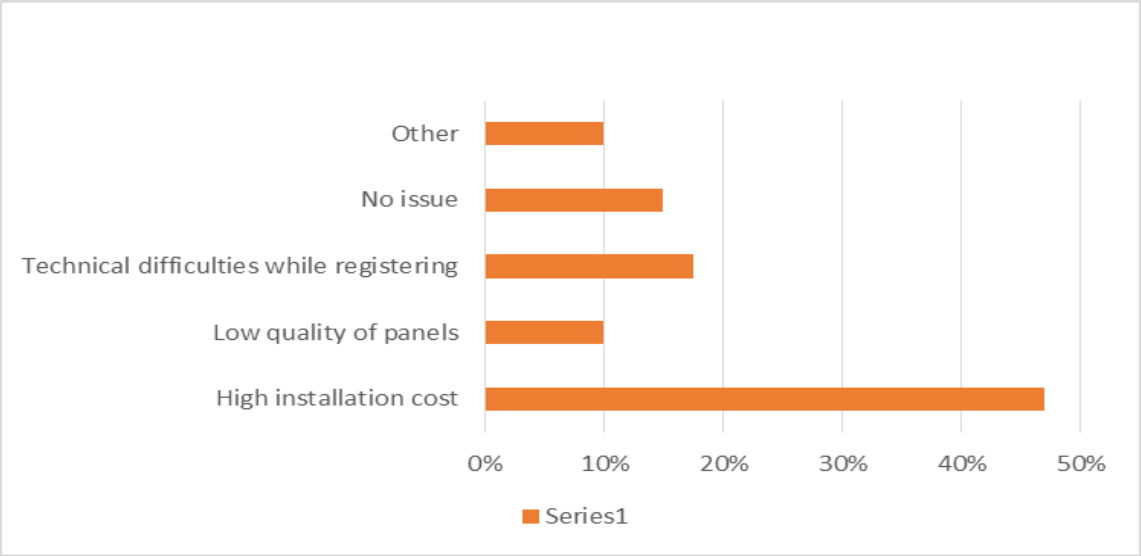
Source: Primary data

The frequency of maintaining the rooftop panels determines the operational cost incurred by the respondents and high maintenance is a drawback of the scheme and low maintenance supports the installation of the panels. 37.5 per cent of the respondents incur these expenses a few times in a year and only 7.5 percent respondents frequently incur this expense. The analysis shows that the maintenance of panels is less frequent for many consumers.

3.16 CONSTRAINTS IN ADOPTING SOURA SCHEME

The constraints involved in adopting the scheme are likely to act as a main deterrent in encouraging people to adopt the scheme. It is well known that high installation cost is a major deterrent to setting up a solar scheme. This is consistent with our data analysis.

Figure 3.11: Challenges/barriers faced in adopting the scheme



Source: primary data

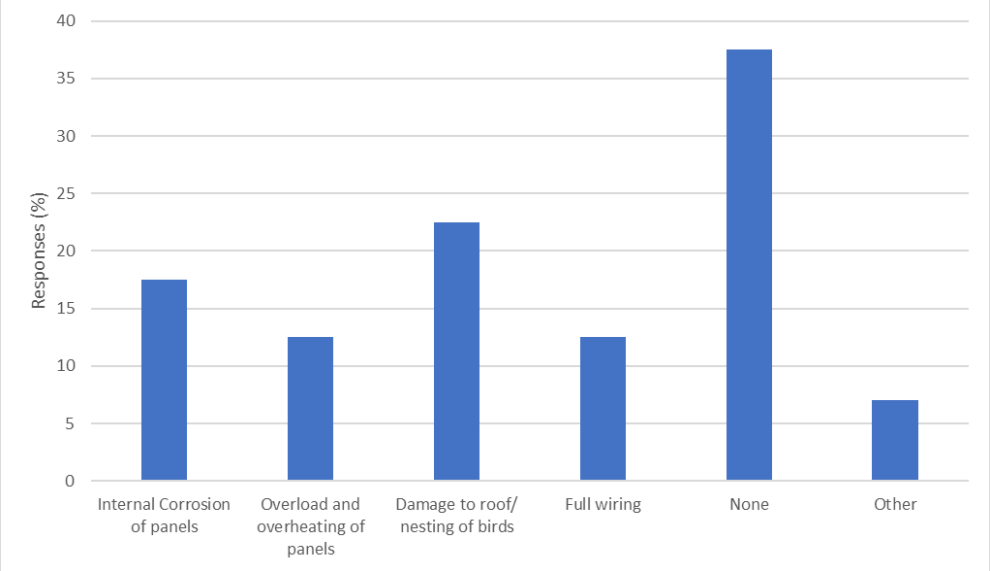
According to the data, 47 per cent of respondents cites high installation charges as the main challenge while adopting a solar scheme. 10 percent of the consumers under the study identify poor quality of panels as one of the challenges faced while registering for the solar subsidy scheme.

These challenges highlight that high installation costs remain a major challenge despite the government subsidies, thereby undermining the potential benefit of the project. The authorities should bring about more radical changes in the cost of installing the panels and making it more affordable, excluding the subsidy, so that more people can benefit from the subsidies offered under the scheme. They should also correct technical issues to simplify the entire process.

3.17 CHALLENGES FACED BY THE RESPONDENTS FROM THE ROOFTOP PANELS

Rooftop panels used by solar consumers as part of a solar project provides scope for various hindrances.

Figure 3.12: Challenges faced by the respondents from the rooftop panels



Source: primary data

It is evident that 22.5 per cent of the respondents cite roof damage as a major drawback faced while installing roof layers, while 17.5 per cent find internal corrosion of panels and microcracks as another obstacle. These challenges reduce the benefits from the solar project and thereby compromise the quality of services provided by the government. However, a majority (37.5%), do not face any problems with installation of rooftop solar panels.

ANALYSIS OF THE ECONOMIC VIABILITY OF THE SCHEME

To promote the adoption of the scheme, it is imperative that the scheme is cost effective to the users. Hence this section covers the expenses incurred by the users of the scheme – their electricity charges, installation and maintenance cost and ultimately whether they were satisfied with the scheme.

3.18 EXPENDITURE INVOLVED IN INSTALLING ROOFTOP SOLAR PV UNDER SOURA

The expenditure incurred by the respondents shows the feasibility of the scheme. It aids in analyzing the costs incurred and whether the subsidy provided under the scheme proves to be useful for the consumers in terms of their cost.

Table 3.6: Expenditure incurred for installing rooftop solar PV

Costs (in rupees)	Percentage (%)
Less than ₹50,000	2.5
₹50,000 - ₹1,00,000	20
₹1,00,00 - ₹1,50,000	22.5
₹1,50,000 - ₹2,00,000	35
Other	20

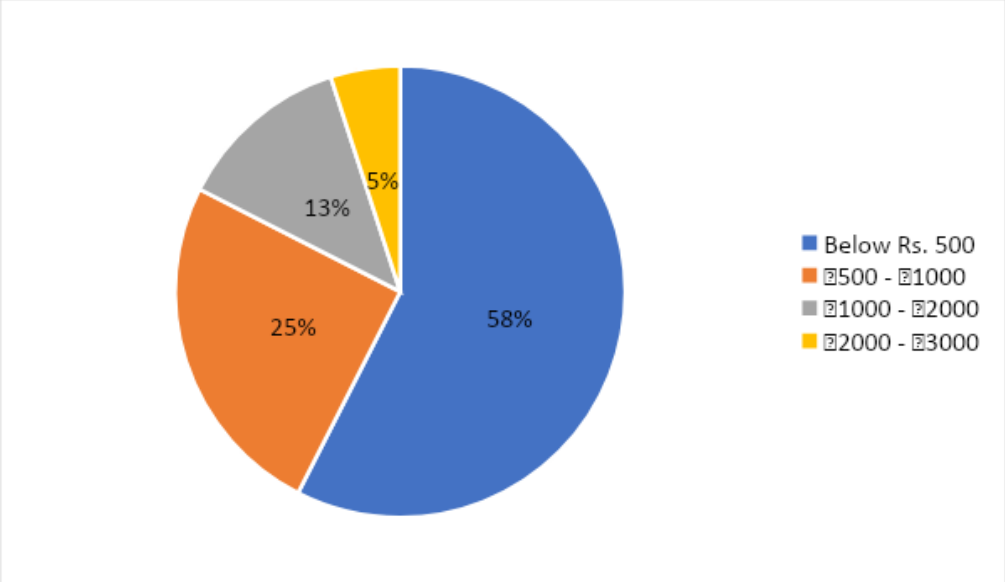
Source- Primary Data

The information given in table 3.6 states that less than three per cent (3%) have incurs costs not greater than ₹50,000 and 35 percent have an expenditure ranging between ₹1, 50,000 - ₹2, 00,000. This depicts that most people have to bear a cost around ₹1,50,000 and ₹2,00,000. This also shows their expenditure for structural changes made to their homes or any other kind of changes that were necessary while installing solar panels.

3.19 MAINTENANCE AND CLEANING COST

The maintenance and cleaning costs associated with the panels are an expense for the consumers. The frequency of maintenance determines the amount of expenditure incurred for it.

Figure 3.13: Maintenance and cleaning cost



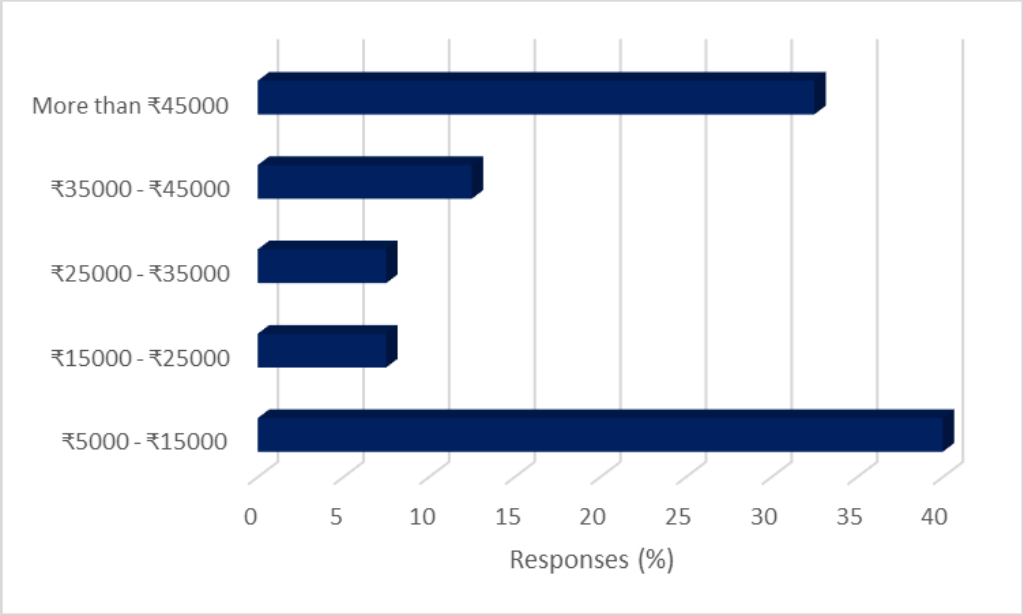
Source: Primary data

It is evident that around 57.5 per cent of the sample under study incurs expenses less than 500/- for cleaning and maintenance of solar panels, under the scheme. However, only a meager share of five per cent respondents incurred a cost above 2000/-. It is inherent that the rooftop solar panels installed through the Soura scheme have comparatively less maintenance and cleaning expenses for more than half of the respondents. Maintaining the rooftop panels is feasible to many consumers.

3.20 SAVINGS FROM THE SCHEME THROUGH SUBSIDY

The major incentive of the Soura Scheme is the subsidy that the consumers receive for the solar panels. The expenditure incurred for the equipment and materials inbuilt in the solar panels, such as high-grade silicon for the panels and the soft costs, which include sales cost, labor costs and safe installation together contribute to the high installation cost of rooftop solar panels. However, the monetary benefit that consumers receive by means of subsidy can help in covering these costs to an extent, thereby providing affordability.

Figure 3.14: Financial savings from the scheme by means of subsidy



Source- Primary Data

This shows that 42.5 percent of the consumers are able to save between 5000 and 15000/- and 25 percent consumers between 15000/- and 45000/- through the subsidy offered by the KSEB. This shows that installing rooftop solar panels have been made more feasible under the Soura Scheme and the affordability that the scheme provides is the major feature which attracts more people into opting for it.

3.21 COMPARISON OF THE DIFFERENCES IN ELECTRICITY CHARGES

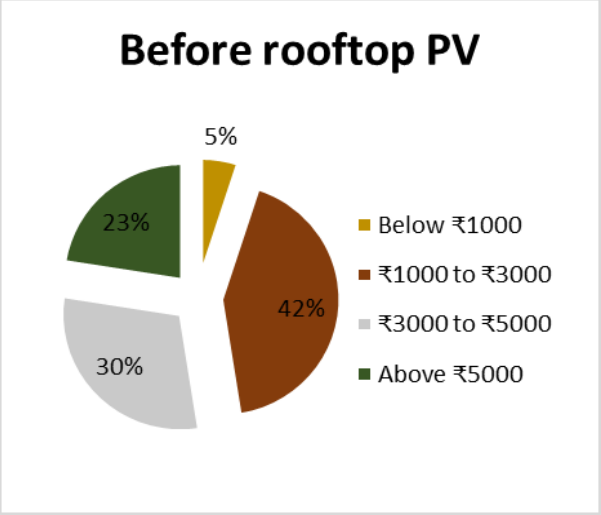
The comparison of electricity charges is the predominant factor in depicting the advantage of acquiring the Soura Subsidy Scheme. Here, the expenses for electricity bills prior to the installation of rooftop PV and the cost following the installation of the same is shown to cross-examine the data gathered from the interviewees. The result of this can help to prove the claim that using the subsidy and installing solar panels will reduce electricity bills over time.

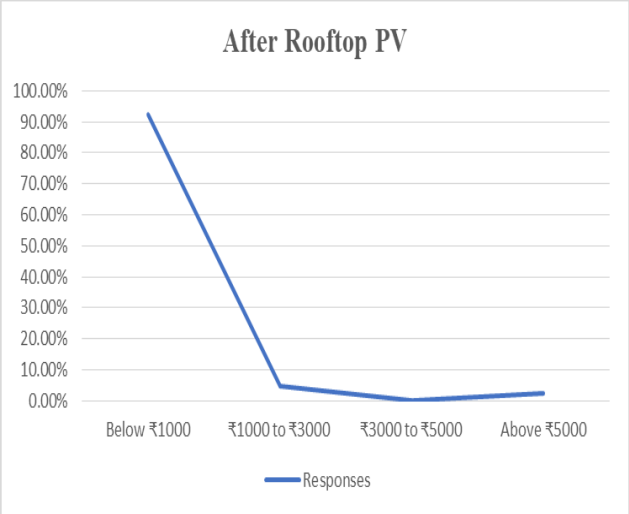
Table 3.7 Electricity charges before and after installing rooftop solar PV under Soura

Electricity Charges	Before installation (percent)	After installation (percent)
Below ₹1000	5	92.5
₹1000 to ₹3000	42.5	5
₹3000 to ₹5000	30	Nil
Above ₹5000	22.5	2.5

Source: Primary Data

Figure 3.15: Cross study of the difference in electricity charges before and after installation of solar PV





Source: Primary Data

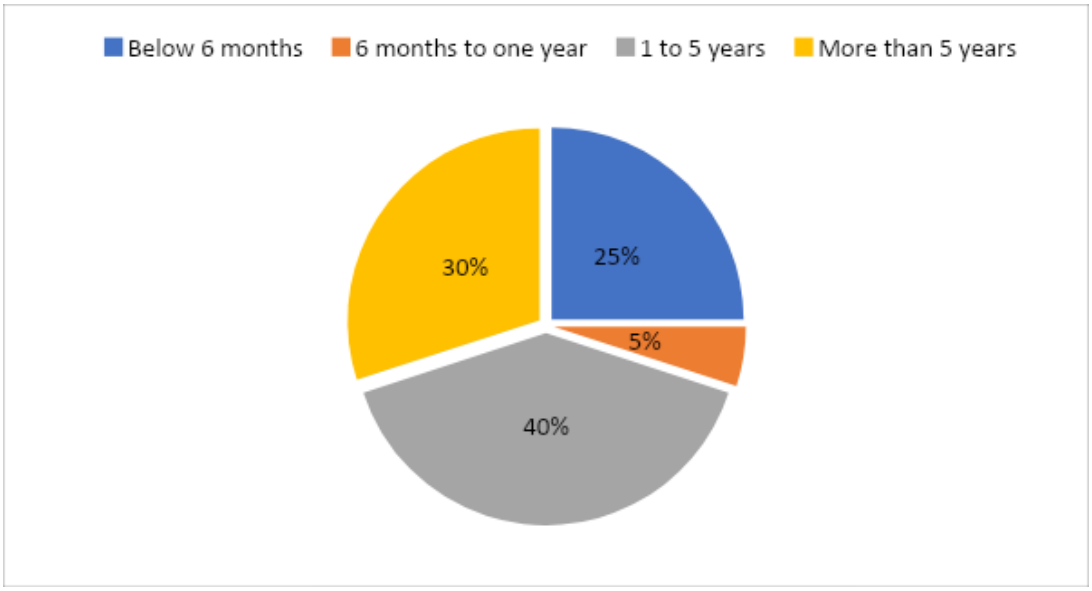
The survey shows that the monthly electricity charges of above rupees 5000/- prior to adopting the Soura scheme is sustained by 23 percent of the responses. The majority (42 percent) of the consumers under the scheme revealed that their charges vary between rupees 1000/- and 3000/-. The high expense of electricity bill borne by the consumers is shown here and this ultimately led to the adoption of the Soura Subsidy scheme for installing rooftop solar PV as a means of reducing electricity bill.

The superiority of the subsidy scheme can be seen from the high number of consumers whose electricity bills were reduced to below rupees 1000 after they adapted to rooftop PV. It is around 92.5 per cent. Only a meager two point five per cent of the respondents are still charged above rupees 5000/- for their electricity bills. This explicitly shows how the rooftop solar are beneficial to the consumers by reducing their monthly electricity charges.

3.22 TIME PERIOD FOR COVERING THE INITIAL INVESTMENT EXPENDITURE

The long-term suitability and economic viability of the scheme also depends on the time taken by the consumers to cover their initial expenditure. This aids in analyzing the economic benefit to the consumers and the time taken by them to cover their initial investment.

Figure 3.16: Time period for covering the initial expenditure



Source: Primary data

The above data reveals that 40 per cent of the consumers took less than five years to cover the cost of installation through the scheme. It took more than five years for 30 percent to cover their initial expenditure. The remaining 30 per cent took a period of less than one year to cover their installation cost. This highlights the fact that covering the installation cost takes a longer time period for majority of the consumers by means of savings through reduced electricity bills and reimbursements from KSEB for the excess electricity. In the long run, this can be beneficial to the consumers.

3.23. SATISFACTION LEVEL OF RESPONDENTS UNDER THE SOURA SCHEME

Solar energy is very environmentally suitable. Solar panels are used in an environmentally friendly manner. More customers like it and are willing to recommend it to others. Consumer surveys are consistent with this.

Table 3.8: Whether the respondent would recommend the scheme to other based on his/her experience and satisfaction

Options	Percentage (%)
Yes	95
No	5

Source: primary data

It proves the success and failure of the project. 95 per cent of consumers under the study recommend the solar scheme and only 5 per cent react negatively to it. Most of the

beneficiaries under the scheme realize that they are ready to recommend it to others, thereby proving the success of the scheme among the people. Despite facing some challenges in adopting the scheme and installing the panels, people prefer Soura over other methods of installing solar panels in their home.

3.24 CONCLUSION

As a renewable energy source, solar energy plays an important role in reducing greenhouse gas emissions and mitigating climate change, which is critical to protecting humans, wildlife, and ecosystems. Solar energy improves air quality and reduce water use from energy production. A survey conducted among solar energy consumers reveal that most of them are very interested in using solar energy. They recommend the solar plan to others. There are very few people who are not interested in using solar and do not recommend it to others. This could be due to the challenges they faced. High installation cost, structural arrangement for installing solar panels and roof top challenges are major challenges faced by solar users.

CHAPTER 4

FINDINGS, RECOMMENDATIONS, AND CONCLUSION

Soura Subsidy scheme is the subsidy program of KSEB for promoting solar power among domestic consumers. As part of this scheme, the consumers can install solar panels over the roof of their homes. The main aim of the project is to study the influence of the Soura Subsidy Scheme among consumers. The sample consists of 40 consumers from Ernakulam district. The analysis of the expenditure and benefits, as well as the challenges of Soura scheme, helps in ascertaining the effectiveness of this subsidy scheme. Overall, solar energy has a positive environmental impact. It lowers carbon emissions, reduces our dependence on finite natural resources, and helps fight climate change. The findings also support the overall efficiency and effectiveness of the scheme as it is beneficial to majority of the consumers.

4.1 FINDINGS

Youth and people of early thirties are the major recipients of the scheme and are willing to make changes in traditional methods. People with either too big or too small family size are less likely to adopt this scheme. Many factors influence this decision, such as their electricity consumption, consumer's monthly income, and their family size. The scheme has more popularity by word of mouth as most of the consumers got to know about the scheme through their friends and family. Most of the people who had electricity charges from above ₹1000 are the main beneficiaries from the scheme. Roof top area is an important factor for easy installation and structural arrangement of roof panels. Large rooftop area has been found to provide more advantage while adopting the scheme. The minimum area in the current phase of the solar subsidy scheme is 200sq.ft. Most of the households chose 3kw power capacity and this depends on the per unit electricity consumption. The on- grid models are more prevalent as they are bi-direction meters and provide the consumers with the added advantage of less maintenance and more income, through the supply of excess electricity to KSEB. The service providers of the scheme are companies in Ernakulam and the consumers choose the company based on its popularity and the quality of service and panels that they offer.

The findings made under the two objectives of the study are:

4.1.1 CHALLENGES FACED BY HOUSEHOLDS SWITCHING TO SOLAR ENERGY

The young people are more interested and aware of the Soura Subsidy scheme offered by the government, and this highlights the weakness of the scheme to attract consumers from other age groups. Among the respondents, it is found that 22.5 per cent cite roof damage as a major drawback faced while installing roof layers, while the remaining consumers find internal corrosion of panels, micro-cracks, overheating and faulty wiring as a challenge. This can cause hesitancy among other people to adopt the scheme. The constraints involved in adopting the scheme are likely to act as a main deterrent in encouraging people to adopt the scheme. High installation charges of the rooftop solar panels still continue to be the main deterrent in adopting the scheme.

The high cost of maintenance is also seen as a drawback of the scheme; however, a majority of the consumers require maintenance only yearly. The frequency of maintaining the rooftop panels determine the operational cost incurred by the respondents. High maintenance is a drawback of the scheme and low maintenance supports the installation of the panels. Consumers who have off-grid models require more maintenance due to the usage of batteries and this cause additional expense to the consumers, so their popularity have been declining over the years. Majority of the consumers have on-grid models which does not have any problems associated with battery or maintenance. However, these on-grid panels do not provide the option to store solar power as in off-grid models, which is also not favourable for those consumers who wish to store it using inverters.

The time taken by consumers to cover their initial expenditure vary between one to five years and this does not provide any benefit to the consumer in the short run. The cost recovery period for this scheme is quite cumbersome to the consumers. Some of the respondents made structural changes in their rooftop and this led to a rise in their expenditure. Despite some challenges in adopting the scheme and installing the panels, people prefer Soura over other methods of installing solar panels in their home.

4.1.2 THE EXPENDITURE AND BENEFITS OF THE BENEFICIARIES OF SOLAR SUBSIDY SCHEME

KSEB provides subsidies up to 40 percent of the installation cost for up to three kilo watt (3kW) and 20 per cent for up to ten kilo watt (10 kW). The registration under the scheme was found to be technically easy and convenient for the consumers due to quick response from the officials. Structural changes to the rooftop were less for most of the consumers. The respondents were also found to have adequate sloping in their roofs which avoids the need to have any structural change. This reduces the cost of installing the rooftop solar panels through this scheme.

The reduction of electricity bill is the main reason among the respondents for switching to rooftop solar panels since it helps in saving their income and reducing their expenditure in the long run. After switching to solar energy, many consumers experienced a reduction in their electricity bill, thus serving their purpose. After availing the scheme, most reported an electricity charge of less than ₹1000. The primary aim of consumers is to save and in the event of rising electricity charges, using solar panel as a renewable alternative has become a favourable option.

From the total options provided, less than three per cent (3%) have incurred costs not greater than ₹50,000 and 35 percent had incurred an expenditure ranging between ₹1, 50,000 - ₹2, 00,000. 42 percent of the respondents were able to save less than 15000/- through the subsidy offered by the government. Most of the consumers didn't have provision to store solar energy, only some were able to store it. This is because most of them have chosen on-grid model which do not provide the facility of storage, since they do not run on batteries. This type of model requires less maintenance and repair, compared to off grid because the battery life of off-grid models will be terminated after 5 years and requires further maintenance. On grid models are considered more adept for homes.

80 percent of them were found to run all their appliances and meet their electricity needs using solar energy. This shows that it is beneficial for the majority of the customers. Proper maintenance of the panels will help to ensure that the trails are in good condition in the long run. 95 per cent of the consumers would recommend this scheme to others as they have realised that despite requiring a few changes, the scheme is actually very beneficial for the environment as well as for meeting their requirements.

4.2 RECOMMENDATIONS

The study had drawn its attention to the benefits and conclusions of the Soura Scheme. Based on our observations, the following recommendations have been suggested

- The biggest concern for the sector is grid integration of growing renewable capacity followed by poor financial condition of the service providers. The quality of panels offered by these distributors must improve.
- Net metering implementation is the most important challenge and there must be boost to manufacturing capabilities, not only in solar modules but also in inverters and batteries.
- Development of off grid models which are more prevalent and accessible in rural and remote areas must be enhanced and the battery life must be improved. New legislations need to be brought out for making new public institution buildings grid connected.

4.3 CONCLUSION

The Soura subsidy scheme aims to make the solar power more affordable to low income families in Kerala. This can help in solving social and economic poverty and bring about energy efficiency in the state. Soura is a sustainable and long term solution for the state to curb carbon emissions and cut their imports on energy. It is an innovative way for the government to cut down their expenditure. The highlight of the scheme is the high level of public participation for its effective implementation. Kerala has more potential to brighten the future by popularizing and heavily tapping this clean energy source and bringing about further developments in the implementation of the scheme. The Soura Thejas – Solar Rooftop Program with subsidy is a major milestone in this area by attracting citizens to the scheme and bringing about a switch towards renewable energy. It helps in completing the targets of 450 GW target of renewable energy capacity, with share of solar at 280 GW, set by the central government and dominate the global supply chain. It also helps in fulfilling India's commitment to the Paris Agreement and Sustainable Development Goals by 2030 (V.R, Akshay, 2022).

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QUESTIONNAIRE

1. Name
2. Age of the Respondent
   - 20-35
   - 35-45
   - 45-55
   - 55 and above
3. Educational Qualification
4. How many family members are there in your family?
   - 2-3
   - 3-5
   - 5-7
   - 7 and above
5. Why do you think switching to solar energy is important?
   - Electricity bill reduction
   - Increasing popularity
   - Commitment towards environment
   - Sustainable power generation
6. How did you come to know about KSEB Soura Subsidy Scheme?
   - Friends and Family
   - Advertisement
   - KSEB portal (online bill payment)
   - Other
7. Which Soura Subsidy Scheme did you choose?
   - 2 KW
   - 3 KW
   - 4 KW
   - 5 KW
8. Which solar company was your provider?

9. How much is your shade free rooftop area?
    - 100 sqft
    - 200 sqft
    - 300 sqft
    - 400 sqft and above
10. How much cost did you incur for installing rooftop solar panels under Soura Scheme?
    - Less than ₹50, 000
    - ₹50,000 - ₹1,00,000
    - ₹1,00,00 - ₹1,50,000
    - ₹1,50,000 - ₹2,00,000
    - Other
11. How much were you able to save through means of Soura Subsidy?
    - ₹5000 - ₹15000
    - ₹15000 - ₹25000
    - ₹25000 - ₹35000
    - ₹35000 - ₹45000
    - More than ₹45000
12. After registering in the Soura Scheme, how long did it take for the concerned authorities to contact you back?
    - Less than one month
    - 1-3 months
    - 4-6 months
    - More than 6 months
    - Not applicable
13. Which model of grid di you choose for your rooftop panel?
    - Grid tied/ Connected
    - Off grid
    - Hybrid model
14. Depending on the grid connectivity, what is the main benefit that you receive from rooftop solar panel installed through Soura Scheme?
    - Reduced electricity bills
    - Continuous electricity supply
    - Smart utilization of rooftop

- Other

15. How many appliances do you operate using solar power?
    - All the main appliances
    - Basic electricity appliances - fans, lights
    - Basic kitchen appliances
    - Other
16. Before installing rooftop solar PV, how much was your monthly electricity charges?
    - Below ₹1000
    - ₹1000 to ₹3000
    - ₹3000 to ₹5000
    - Above ₹5000
17. After installation of rooftop solar PV, how much did your electricity bill cost?
    - Below ₹1000
    - ₹1000 to ₹3000
    - ₹3000 to ₹5000
    - Above ₹5000
18. Do you have any provision to store solar energy?
19. How long did it take to cover the cost of installing Solar PV?
    - Below 6 months
    - 6 months to one year
    - 1 to 5 years
    - More than 5 years
20. How frequent does rooftop solar PV require maintenance?
    - Rarely
    - Once a year
    - Sometimes/ not often
    - Frequently
21. How much do you spend for maintenance and cleaning?
    - Below Rs. 500
    - ₹500 - ₹1000
    - ₹1000 - ₹2000
    - ₹2000 - ₹3000

22. Was there any need for structural changes to your house? If yes, please mention the change.
23. What do you think are the main challenges of adopting Soura Scheme?
    - High installation cost
    - Low quality of panels
    - Technical difficulties while registering and time consuming
    - Other
24. What are the obstacles faced with the installation of rooftop solar panels?
    - Internal Corrosion of panels and micro cracks which require maintenance
    - Overload and overheating of panels
    - Fully wiring
    - Damage to the roof/ nesting of birds
    - Other
25. Based on your experience, would you recommend Soura Subsidy Scheme to others?