EVALUATION STUDY ON VARIOUS RENEWABLE ENERGY PROGRAMMES IMPLEMENTED BY ANERT

KERALA STATE
PLANNING BOARD

Centre for Management Development
Thiruvananthapuram-695 014, Kerala
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CONTENTS

ABBREVIATIONS

ANERT	Agency for New and Renewable Energy Research and Technology
APL	Above Poverty Line
AREAS	Association of Renewable Energy Agencies of States
BPL	Below Poverty Line
C	Celsius
CC	Carbon Credit
CFL	Compact Fluorescent Lamp
CO_2	Carbon dioxide
DPI	Directorate of Public Instruction
ERRC	Environmental Resources Research Centre
ETC	Evacuated Tube Collector
F	Fahrenheit
FGD	Focus Group Discussion
FPC	Flat Plate Collector
GBI	Generation Based Incentive
GD	Group Discussion
GW	Gigawatt
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
ISI	Indian Standards Institute
KREDL	Karnataka Renewable Energy Development Limited
KSEB	Kerala State Electricity Board Limited
KVIC	Khadi and Village Industries Commission
KW	Kilowatt
kWh	Kilowatt-Hour
LED	Light-Emitting Diode
LPD	Litre Per Day
LPG	Liquefied Petroleum Gas
LSGIs	Local Self Government Institutions
MDG	Millennium Development Goals
MNRE	Ministry of New and Renewable Energy, Government of India
MW	Megawatt
NGOs	Non-Governmental Organizations
NIWE	National Institute of Wind Energy
NRE	Non-Renewable Energy
PV	Photovoltaic
RE	Renewable Energy
REE	Renewable Energy Equipment
REN	Renewable Energy Policy Network
RPO	Renewable Purchase Obligation
SDG	Sustainable Development Goals
SEW	Self Employed Workers
SHGs	Self Help Groups
SWH	Solar Water Heating
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization

Executive Summary

Agency for Non-conventional Energy and Rural Technology (ANERT), an autonomous organization under the Power Department began its operation in 1986 with the objective of disseminating knowledge in the areas of non-conventional energy, energy conservation, rural technology, conducting studies, demonstrate and implement various non-renewable energy schemes and thereby deal with the problems arising out of the rapid depletion on non-renewable energy sources, update the technologies used in rural areas as well as introduce appropriate new technologies with an aim to reduce drudgery, increase production and improve the quality of life. It is the State Nodal Agency for the Ministry of New and Renewable Energy (MNRE), Government of India, to carry out the Centrally Assisted Programmes in Kerala. ANERT is headed by a Director appointed by the Government and guided by a Governing Body chaired by the Minister for Power, Kerala and an Executive Committee chaired by the Secretary to Government, Department of Power, Government of Kerala.

With the growing importance of renewable energy and ANERT being the nodal agency for implementation and propagation of use of Non-conventional energy sources in the state, it is essential to assess/evaluate its programmes/schemes and their functioning and providing suggestions/action plan for improving its performance. In this context, the State Planning Board entrusted the study titled, 'Evaluation study on various renewable energy programmes implemented by ANERT' to Centre for Management Development.

This study by Centre for Management Development has assessed the performance of ANERT as an implementing agency of various renewable energy schemes, identified causes for shortfalls in the performance and has appropriate suggestions for improvement and further action. The study has also assessed the impact of the scheme as carried out so far.

Methodology

The study adopted quantitative approach, as it involved assessing the performance of ANERT as an implementing agency. Qualitative information was collected to support the quantitative data and to gain in-depth understanding of various factors related to implementation and performance of ANERT as an implementing agency.

The study was conducted in 14 districts of Kerala. Samples were selected from the lists of schemes provided by ANERT from all the districts. The study involved collection of information from beneficiaries of various schemes, implementing officials, empanelled agencies and LSGIs. The demonstration work, consultancy work and deposit work undertaken by ANERT were also a part of the study. Focus Group Discussions and Group Discussions were conducted in all the districts.

Structure of the Report

Chapter 1 provides an overview of the basic concepts of renewable energy that have been promoted as a solution to the growing energy needs of communities while it alongside is satisfying environmental and resource scarcity problems.

Chapter 2 deals with the role of ANERT as the nodal agency for renewable energy in the state and the details of the schemes implemented by ANERT. The financial and workforce analysis are also provided in the chapter.

Chapter 3 provides an explanation on the process of research, the chosen approach, target population, sampling technique, sample size, data collection method and data analysis.

Chapter 4 The analysis and interpretation chapter is divided into three sections. The first section provides an overview of installations in households, second deals with the installation in institutions and third section deals with the renewable energy equipment installed as part of Demonstration, Deposit and Consultancy work. The household section is again divided in to seven sections. In the first section, an attempt has been made to analyse the socio-economic profile of the beneficiaries of ANERT. Second section deals with the awareness level of the beneficiaries on renewable energy, schemes of ANERT, subsidy component of various schemes and Generation Based Incentive for the beneficiaries of Off-grid solar system. Third section provides details of various schemes implemented by ANERT and its usage by the beneficiaries. Fourth part provides an insight into the perception of beneficiaries in selecting the renewable energy equipments and the process of installing the schemes. Fifth part includes an overview of the benefits received by the beneficiaries from the renewable energy equipments installed and its contribution to environment in general.

Chapter 5 presents in-depth analysis of four case studies describing various aspects of implementation of the schemes.

Chapter 6 provides the conclusion of the study and recommendations.

Key Findings

- While analysing the financial statements of ANERT it was found that the State funds were almost utilized and MNRE funds remained under-utilized. It was also found that there was an increasing trend in the amount of state funds utilized. In the year 2014-2015, there were no funds allotted to ANERT by the State government. So it incurred an amount of Rs. 12 lakh. Those funds were allotted only in the successive year. Resource assessment of Renewable energy sources was found to be the least utilized except for the financial year 2012-2013. Renewable energy programme of ANERT was found to be the most utilized among the all programmes of ANERT.

- It is observed that the beneficiaries who installed the equipment mostly belong to middle age and above, lives in rural and urban areas and mostly belong to general category. Majority of the household beneficiaries owns a white colour ration card and lives in pucca houses. The educational qualification of most of them is graduation and above having occupation either in Govt./private or retired from the government services. There are a few self-employed people also.
- The Discussions with the beneficiaries had revealed that majority of the households were well aware about renewable and non-renewable energy which they got mainly through newspaper and education. The beneficiaries got information on the schemes of ANERT mainly through newspaper and the empanelled agencies of ANERT. However, about 50 percent of the household beneficiaries are unaware of the subsidy component of their installed equipment. The awareness of Generation Based Incentive among the Off-grid rooftop beneficiaries was very poor. ANERT has to concentrate on more awareness generation activities to promote renewable energy sector in the state.
- Most of the household beneficiaries installed only single renewable energy equipment in their household with their own fund. Majority of the beneficiaries preferred renewable energy equipment to reduce the usage of conventional energy, thereby reducing the amount spend for conventional energy. Most of the renewable energy equipment installed in the households are functioning and more than three-fourth of the beneficiaries are satisfied with the equipment.
- Around three-fourth of the household beneficiaries rated the performance of the agencies as good to very good, whereas one-fourth of the household beneficiaries are not satisfied with the performance of the agencies. In majority of the households, agency who installed the equipment provided necessary information and training on how to use the renewable energy equipment.
- Portable biogas plant is more popular than fixed biogas plant due to its ease of installation and less cost. Even though most of the beneficiaries installed biogas to deal with the bio-degradable waste issues in households, it also helped them in reducing the usage of LPG considerably.
- Even though most of the beneficiaries installed biogas to deal with the bio-degradable waste issues in households, it also helped them in reducing the usage of LPG considerably. It is observed that due to improper waste dumping, the biogas plants are abandoned. Lack of Knowledge regarding the usage is reported as the main reason for this.
- Improved chulha aided the beneficiary to cook in a smoke free atmosphere in majority of cases. In about one-fourth of the total chulhas, cracks were formed as a result of poor quality. More than three-fourth chulhas were found abandoned by the beneficiaries that are constructed outside the house.

- Even though, Solar Lanterns work efficiently, frequent occurrence of battery complaints is also reported by the household beneficiaries.
- The solar water heater of capacity more than 100 LPD is not generally preferred as it is more costlier than 100 LPD.
- The number of household beneficiaries who installed On-grid solar system is very less as it is a new scheme compared to the Off-grid solar schemes. The long time duration for getting sanction and installation of On-grid power plants also makes the household beneficiaries to choose Off-grid over On-grid power plant.
- In considerable number of institutions, where deposit, demonstration and consultancy works are installed, uses the solar system only when there is a power failure. In more than three-fourth of the institution, the solar panel is not cleaned since the installation and 66 percent institutions did not refill battery water properly. Most of the installations in government institutions, the solar system were seen in abandoned condition.

Recommendations

- It is worthwhile to initiate more awareness activities in the tribal and coastal areas to popularise the schemes. Using social media as a platform to popularise schemes of ANERT will have a positive result among young people.
- Subsidies component may be increased for beneficiaries under SC/ST and BPL category.
- Linkage of ANERT with bank to get loan for Renewable Energy Equipment will be useful.
- Proper training to the beneficiaries of ANERT must be ensured. There is need to develop mechanisms to ensure quality of equipment and servicing.
- The maintenance of the equipment in Government office has to be ensured.
- The percentage of subsidy amount dispersed by the ANERT to the agency at the end of servicing period can be increased.
- Grading of agencies may be implemented on a regular basis according to quality of equipments supplied and the after sales services provided by the agencies.

CHAPTER 1
INTRODUCTION

Energy is an essential component in the development of nation. It supports economic growth, social progress and builds a better quality of life. Studies have revealed that economic growth goes hand in hand with increased access to energy supply. A study by the World Bank indicated that countries with underperforming energy systems may loose up to 1-2 percent of growth potential annually as a result of electric power outages, over-investment in backup electricity generators, energy subsidies and losses and inefficient use of scarce energy resources. Reliable and affordable energy enables access to wide range of modern facilities, products and services that enrich and extend life for developed nations. The need for reliable and affordable energy is more fundamental for developing and under developed nations. It can improve and even save lives by reducing poverty. It is the building blocks in human development and a key factor that influences the sustainable development of any nation which help people escape from poverty and create better lives.

In general, the energy sources are categorized as non-renewable and renewable resources.

Non-Renewable Energy: Non-renewable energy otherwise known as conventional energy generated from resources that are finite in supply on human time scale. It do not replenish in a short period of time. Today, most of the energy that the world consumes comes from conventional source of energy. Coal, petroleum and natural gas are conventional sources of energy. The known reserves of this energy are depleted to a great extent.

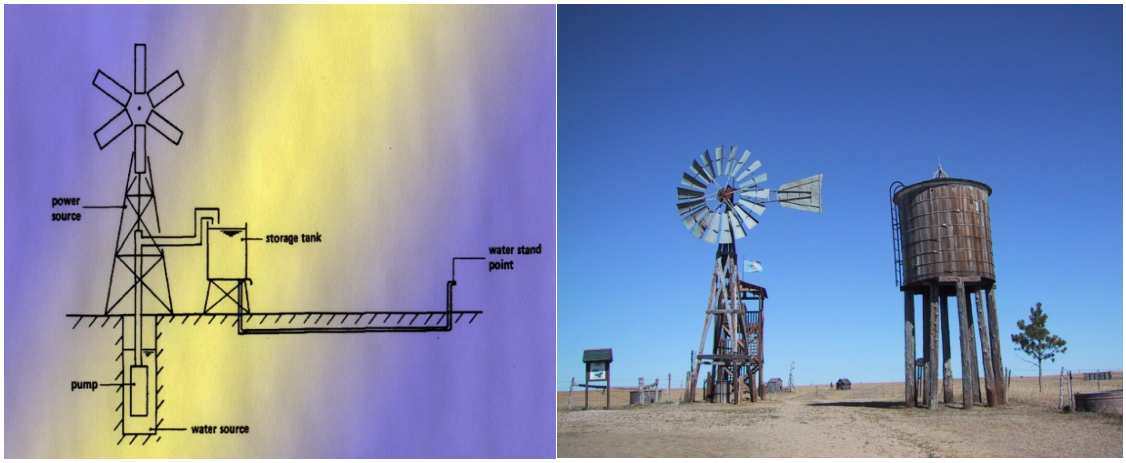
Renewable Energy: Renewable energy sources are naturally replenished within the lifetime of a human. Energy derived from such sources is known as green energy or clean energy as it does not cause pollution. The renewable energy analysis for the purpose of this study began with an understanding of available renewable energy resources.

Major Sources of Renewable Energy

The major source includes sunlight, geothermal heat, wind, tides, water and various forms of biomass. Most of these renewable energies depend in one way or another on sunlight. Solar energy is the direct conversion of sunlight using panels or collectors. Wind is the direct result of differential heating of the Earth's surface by sun. Biomass energy is the stored sunlight present in plants. Other renewable energies that do not depend on sunlight are geothermal energy, which is derived from extremely high temperature inside the earth generated from slow decay of radioactive material and tidal energy which is a conversion of gravitational energy.

Solar: Solar energy comes directly from the power of the sun and is used to produce electricity, heat and light. Solar-electric power can be produced by photovoltaic technology, which converts sunlight directly to electricity using solar cells. Solar thermal power systems use various techniques to harness solar energy and convert it into thermal energy. The thermal energy thus obtained is used to heat an intermediary fluid, known as heat transfer fluid which is directly used or used to generate steam.

Wind Power: The atmospheric pressure zones formed by heating and cooling of the earth surface make air flow from high to low pressure area. Wind turbines/mills are capable of harnessing the power derived from this air flow. It converts kinetic energy of the rotating shaft into mechanical energy. It is used for either mechanical energy needs (milling or water pumping) or converted to electric power by using a generator. Wind turbines/mills works both in horizontal axis and vertical axis. It will not work in winds below 13 km/hour. They work best where the average wind speed is 22 km/hour.



Picture 1.1 & 1.2: Water pumping using wind power

Hydroelectric Energy: Hydropower plants convert the energy of flowing water into electricity. This is primarily done by damming rivers to create large reservoirs and then releasing water through turbines to produce electricity. There are no emissions into the atmosphere in Hydropower projects.

Biomass: It is the term used for all organic material originating from plants (including algae), trees and crops that can be used as an energy source. Biomass gets its energy from the sun through the process called photosynthesis. Biomass energy or bio energy is the conversion of biomass into useful forms of energy such as heat, electricity and liquid fuels. It is a low carbon source of energy with little pollution when converted properly. If not managed correctly, it can have a negative impact on the environment.

Geothermal Energy: This energy is generated from the heat of the earth itself. This heat can be derived from the source close to the surface or from heated rock and reservoirs of hot water miles beneath our feet. Geothermal power plants harness these heat sources

to generate electricity. Continuous radiation from the natural decay of elements and residual energy from the earth's formation are the main sources of geo-thermal energy.

Hydrogen and Fuel Cells: These are not strictly renewable energy resources but are very abundant in availability and are very low in pollution when utilized. Hydrogen is a clean energy carrier that can be produced from any primary energy source and fuel cells are very efficient energy conversion devices. Fuel cells directly convert the chemical energy in hydrogen to electricity. The by-products of this process are only heat and water. Hydrogen powered fuel cells are not only pollution free, but also they are more efficient than traditional combustion technologies. But as hydrogen is not a primary energy source, it has to be produced using existing energy systems. High cost coupled with pollution during the production of hydrogen has made this as a non-popular source of renewable energy. Other forms of renewable energy include energy from tides, oceans and hydrogen fusion.

Need for Renewable Energy

The main sources of energy have been mainly petroleum, coal and natural gas. The usage of these fuels results in the emission of greenhouse gases likeCO_2 and methane which contribute to climate change. They also emit a variety of pollutants like mercury, sulphur dioxide and nitrogen oxides which cause air pollution. The usage of non-conventional energy also results in water pollution, land pollution and phenomenon like acid rain. Reports show that the global annual temperature has increased at an average rate of 0.07°C (0.13°F) per decade since 1880 and at an average rate of 0.17°C (0.31°F) per decade since 1970. Thus, there is a need for shift to clean renewable energy sources such as biomass, solar, wind, geothermal and hydropower that will help in reducing greenhouse gases.

More than one-third of the world's population does not have access to clean and energy efficient cooking technologies. Biomass like wood, dung and agricultural residues are the most commonly used source of energy in rural areas worldwide. According to the World Health Organization (WHO, 2018), each year, close to 4 million people die from illness due to household air pollution from inefficient cooking practices.

The energy consumed is not equal all across the world. In isolated rural areas, the extensions of electrical grids are often not economical. As a consequence, many people are not able to avail the benefits of energy. According to the World Bank, an estimated 16 percent of the world's population, i.e. 1.2 billion people, have little or no access to electricity. According to International Energy Agency, by 2040 the world electricity demand will be increased by 70 percent and 800 million people will have no access to electricity supply by 2030 if current trend continues, keeping in mind that one of the objectives established by the United Nations is to achieve access to electricity for everyone by 2030.

Access to energy is a key requirement in almost all sectors of a society. It has significant role in the development of agricultural sector, commerce and industries. It is also important for providing services, such as education and health care. People around the world, especially the rural communities, struggle to break out from poverty because of lack of access to electricity and modern energy sources. It results in adverse effect on health, limited opportunities and widens gap the between the rich and the poor.

Renewable energy is one of the cleanest sources of energy options with least carbon emissions or pollution. It produces little or no waste products such as carbon dioxide or other chemical pollutants. Using renewable energy is one of the easiest ways to reduce carbon footprint. It has potential to significantly reduce reliance on coal and other fossil fuels. It is a critical part in reducing global carbon emissions. Promoting renewable energy which is affordable can improve air quality, reduce global warming, and move world towards a cleaner and safer place to live in.

Renewable energy projects generate both direct and indirect employment opportunities. Most of the direct jobs are in the field of installations and maintenance of renewable energy equipments. Indirect opportunities arrive from development of business and industrial sector by applying the renewable source of energy. Jobs in this sector increased by 5.3 percent in 2017 worldwide, i.e. five lakh new jobs were created. There are a total of 10.3 million people employed worldwide in renewable energy sector. Employment remains highly concentrated in countries like China, Brazil, United States, India, Germany and Japan. China alone accounts for 43percent of all renewable energy jobs (Renewable Energy and Jobs - Annual Review 2018, by IRENA).

In rural areas, where the extension of electrical grids is often not economical, Off-grid renewable technologies provide optimal alternative, which is sustainable and cost-effective. It helps rural areas in attaining energy independence. As renewable energy source available everywhere in the world, every local economy can become self-sufficient in terms of energy.

Compared to finite conventional energy sources such as coal, gas, oil and nuclear, renewable energy sources are infinite in nature. This makes them an essential element in a sustainable energy system that allows development today without risking future generations.

There are many types of renewable energy equipments that can be used in individual households such as solar panel, small wind turbines and biogas, etc. This helps each individual household in attaining self-sufficiency in energy and in reducing energy wastage when transporting it from major stations.

Realising the relevance of renewable energy in the present scenario, countries all over the world initiated new programmes and policies to harvest energy from renewable sources. It has helped in the expansion of renewable energy technologies by attracting

investment and creating markets. Since 2004, the number of countries promoting renewable energy with direct policy support has nearly tripled, from 48 to over 140. The numbers of developing and emerging countries which are setting renewable energy targets and enacting support policies have also increased (10 years of renewable energy progress by REN21). According to International Energy Agency, the world needs a clean energy revolution in order to break dependence on fossil fuels. Such a revolution would enhance global energy security, promote enduring economic growth and tackle environmental challenges such as climate change.

Initiative towards Renewable Energy

Realising the positive impact of renewable energy on environment, poverty alleviation and helping in attaining energy self-sufficiency globally, countries are devising strategies to promote energy production through renewable energy sources. Various summits and conferences are held and institutions are established at various point of time in this regard. Major steps taken by the international community is discussed below.

The International Energy Agency (IEA)

IEA is an autonomous intergovernmental organization based in Paris was initially designed to help countries in responding to major disruptions in the supply of oil. Presently, IEA has 30 countries as its members. IEA examines the full spectrum of energy issues, advocating policy toward reliability, affordability and sustainability of energy. Its main areas of focus are energy security, economic development, environmental awareness and engagement worldwide.

Kyoto Protocol

The Kyoto Protocol is an international agreement that mandates its member countries to reduce emission of six greenhouse gases (carbon dioxide, methane, nitrous oxide, per fluoro carbons, hydro fluoro carbons, and sulfur hexafluoride) which contribute to global warming. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The protocol was developed under the United Nations Framework Convention on Climate Change (UNFCCC). The goal of Kyoto protocol was to reduce the emissions of greenhouse gases by 5.2 percent below the emission levels of 1990 by 2012. At the 18th Conference of the Parties, held in Doha, Qatar, in 2012, delegates agreed to extend the Kyoto Protocol until 2020. In order to reduce the emission of these greenhouse gases, member countries initiated new renewable energy projects and thus stimulate the renewable energy investment in a wide range.

Millennium Development Goals (MDG)

Energy was not part of the MDG but its input was an important factor in achieving the MDGs. The implementations of renewable energy technologies have direct and indirect relation with the goals.

Renewable Energy Policy Network for the 21st Century (REN21)

Series of institutional changes with regard to promotion of renewable energy were brought in last decade. The prominent one was the formation of REN21 in 2004. It was formed based on the decision taken in the Renewables 2004 conference held at Bonn in Germany. REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors which include government, non-governmental organisations, research and academic institutions, international organisations and industry. The goal of REN 21 is to facilitate knowledge exchange, policy development and joint actions towards a rapid global transition to renewable energy. REN21 was the first international organisation to begin tracking renewable energy development after it was found in 2004.

The International Renewable Energy Agency (IRENA)

IRENA is the world's platform for cooperation on renewable energy. It is an intergovernmental organization headquartered in Abu Dhabi established in 2009 and its statute entered into force on 8 July 2010. IRENA aims in promotion of renewable energy on a global scale. It provides practical advice and support for both industrialized and developing countries to help them improve their regulatory frameworks and build capacity in the area of renewable energy. The agency facilitates access to all relevant information including reliable data on the potential of renewable energy, best practices and effective financial mechanisms. Initially 75 countries signed the statute of IRENA. Presently, there are 158 countries as its members, demonstrating the high level of global interest in advancing renewable energy.

Sustainable Development Goals (SDG)

In 2015, international community agreed a new set of global goals to end poverty, protect the planet and ensure prosperity for all. They are known as the Sustainable Development Goals (SDGs). These goals are built as succession to the Millennium Development Goals. SDG focuses in addressing the root causes of poverty and the universal need for development that works for all people. It also focuses in balancing the three dimensions of sustainable development which are environmental, social, and economic. According to SDG, the management and development of energy resources is an absolute priority from a sustainable development perspective. Renewable energy is core to the implementation of SDG 7 and 13. SDG 7 commits UN member states to ensure "access to affordable, reliable, sustainable and modern energy for all," and SDG 13 commits to "take urgent action to combat climate change and its impact". In the broader recognition renewable energy will be key in achieving almost all of the SDGs. In particular, improving energy access will be critical in progressing towards agreed global targets in areas of poverty reduction, industrialization, economic growth, health, and education.

World Climate Summit

In the World Climate Summit held in Paris in December 2015 around 200 signatory countries pledged to reduce their emissions so that the average temperature of the planet at the end of the current century remains 'well below 2°C', the limit above which climate change will have catastrophic effects. The summit decided to try to keep the average temperature of the planet to 1.5°C.

Various global agreements and summits related to renewable energy and policies by the countries resulted in a positive change in renewable energy sector all over the world.

Present Status of Renewable Energy

- At the end of 2017, global renewable generation capacity was increased by 167 GW and reached 2,179 GW worldwide. The share of renewables in global power generation increased from 7.4 to 8.4 percent.
- China is the country with the greatest renewable capacity in 2017 at 6,18,803 MW and also continued to lead global capacity additions, installing nearly half of all new capacity in 2017.
- Asia accounted for 64percent of new capacity additions in 2017, up from 58 percent in 2016. Europe added 24 GW of new capacity in 2017, followed by North America with 16 GW.
- In 2017, Off-grid renewables had positive growth, with an estimated 6.6 GW serving off-grid customers, with around 146 million people.
- Asia continued to dominate the global solar capacity expansion in 2017, with a 72 GW increase. Three countries accounted for most of this growth, with increases of 53 GW in China, 9.6 GW in India and 7 GW in Japan.
- Three-quarters of wind energy capacity in 2017 was installed in five countries: China (15 GW), USA (6 GW), Germany (6 GW), UK (4 GW) and India (4 GW).
- Asia continued to account for most of the increase in bio-energy capacity, with increase of 2.1 GW in China, 510 MW in India and 430MW in Thailand.
- Geothermal power capacity increased by 644 MW in 2017, with major expansions in Indonesia (306 MW) and Turkey (243 MW).
- Brazil and China continued to account for most of the expansion in hydropower (12.4 GW or 60% of all new capacity) (Renewable energy statistics 2018, IRENA).
- The world has invested $2.9 trillion in the renewable energy source since 2004 (The Global Trends in Renewable Energy Investment 2018 report, released by the UN Environment Programme).

Initiatives to Promote Renewable Energy in India

In India, economic growth, growing rate of urbanization and rising per capita energy consumption has led to increased demand for energy and thus require more energy than the total energy consumed today to meet the energy requirement. Simultaneously, the country is facing the global threat of climate change and different environment related issues. At present, India depends heavily on coal and oil for meeting its energy demand. The state has realized the significance of promoting renewable energy as the key way to sustainable development. Number of initiatives is taken up by the Government of India to promote energy production through renewable sources.

Electricity Act, 2003

The Electricity Act (2003) mandates appropriate commissions and governments to take necessary steps to ensure promotion of renewable sources of energy. Following sections in the Act deals with promotion of renewable energy.

- Section 3 enables Central Government to prepare policies which would ensure optimal utilization of renewable sources.
- Section 4 authorizes the Central Government to prepare and notify a national policy permitting stand-alone systems.
- Section 61 implies that the Commission shall take into consideration the promotion of cogeneration and generation of electricity from renewable sources while determining the tariff.
- Section 86 Specify Renewable Purchase Obligation (RPO) from renewable energy sources.

National Electricity Policy, 2005

The policy observed Hydroelectricity as a clean and renewable source of energy. It suggested to emphasis on the full development of the feasible hydro potential in the country. It also pointed out that making use of water resources speedily will facilitate economic development of States, particularly the North-Eastern States, Sikkim, Uttaranchal, Himachal Pradesh and J&K, since a large proportion of the hydro power potential is located in these States.

National Tariff Policy

One of the objectives of National Tariff Policy is to promote generation of electricity from Renewable sources. It emphasizes on Hydroelectric Power generation including Pumped Storage Projects (PSP) and integration of variable renewable energy sources. The National Tariff Policy in order to promote renewable energy also determines that any

generating company proposing to establish a coal/lignite based thermal generating station after a specified date shall be required to establish renewable energy generating capacity or procure and supply renewable energy equivalent to such capacity, as may be prescribed by the Central Government from time to time after due consultation with stakeholders. In order to further encourage renewable sources of energy, the policy also scraps inter-State transmission charges. Government has amended the Policy several times and those amendments were in favour of renewable energy sector.

National Renewable Energy Act, 2015

This Act was drafted with the aim to promote production of energy by using renewable energy sources and reduce dependence on fossil fuels, emissions of CO_2 and other greenhouse gases. This Act in particular aims in fulfilling the national and international objectives on increasing the proportion of energy produced through renewable sources of energy.

National Action Plan of Climate Change (NAPCC)

NAPCC outlines 8 missions to advance India's development and to adhere to climate change related objectives. One of which is related to renewable energy sources, i.e. National Solar Mission- to increase the contribution on solar energy in total energy generation.

National Policy on Bio-fuels

As part of promoting bio-fuels in the country, a National Policy for Bio-fuels was framed by Ministry of New and Renewable Energy in the year 2009. The objective of the Policy is to establish a central role for bio-fuels in energy and transportation sectors of the country in coming decades. The goal of the Policy is to ensure a minimum level of biofuels become readily available in the market to meet the demand at any given time. An indicative target of 20 percent blending of bio-fuels, both for bio-diesel and bio-ethanol, by 2017 is proposed.

National Wind-Solar Hybrid Policy

National Wind Solar Hybrid Policy was framed with an objective to provide a framework for promotion of large grid connected wind-solar PV hybrid system in order to reduce variability in renewable power generation. The Policy also aims to encourage new technologies, methods and way outs involving combined operation of wind and solar PV plants.

Various programmes and activities undertaken by Government of India to promote energy production from renewable sources are:

- Fiscal incentives such as accelerated depreciation, concessional custom duty, excise duty exemption, income tax holidays for 10 years to promote renewable energy.
- Clean environment cess on coal, lignite and peat has been doubled from Rs. 200 per tonne to Rs. 400 per tonne.
- Renewable energy projects included in priority sector lending norms of commercial banks.
- INR 5,000 crore has been approved for implementation of Grid Connected Rooftops systems over a period of five years up to 2019-20 under National Solar Mission (NSM).
- Various projects of total 356 MW capacity have been sanctioned and projects of 84 MW capacity have been tendered for Indian defense and Para military forces using solar cells and modules manufactured in India.
- Inter-state transmission charges and losses for Wind and Solar projects have been waived off.
- Provision of rooftop solar and 10 percent renewable energy is now mandatory under Mission Statement and Guidelines for development of smart cities.
- A Joint Indo-US PACE Setter Fund has been established, with a contribution of USD 4 million from each side to enhance clean energy cooperation.
- India has the fourth largest wind power installed capacity in the world after China, United States and Germany. To further boost this segment, the National Off-Shore Wind Energy Policy 2015 was announced to facilitate offshore wind farms in the territorial waters of India.
- Government is implementing the Green Energy Corridor Project for Strengthening inter-state and intra-state transmission system along with other control infrastructure to facilitate integration of large scale renewable energy generation.
- Renewable energy has been re-classified as 'white category' from 'green category'. The re-classification will enable ease of doing business as setting up of solar and wind power plants are exempted from seeking environmental clearances from Ministry and consent from State Pollution Control Boards.
- A Geographic Information System (GIS) based software tool named Wind Atlas 2015was launched in September 2015. The tool identifies regional and local wind energy potential in India to help policy planners and developers. This data is made freely available by Government on public domain.
- The National Institute of Solar Energy (NISE) is organizing 'Suryamitra' skill development programmes in collaboration with State Nodal Agencies, at various locations across the country. The programme aims to develop the skills of youth, considering the opportunities for employment in the growing Solar Energy Power

project's installation, operation & maintenance in India and abroad. The target is to achieve 50,000 'SuryaMitras' of skilled manpower in solar energy sector by 2019-20. As part of the implementation of Suryamitra program, a total of 6653 SuryaMitras were trained as on February, 2017. More than 150 institutes across the country are implementing the Suryamitra program and creating job opportunities for unemployed youth.

Thus it is understood that the country's energy strategy is moving strongly in favour of renewable energy technologies. India has established itself as a leader in a number of renewable energy technology applications such as grid connected wind energy generation and decentralized solar photo voltaic programme, etc. The UN Environment Program's (UNEP) 'Global Trends in Renewable Energy Investment 2016' report ranks India among the top ten countries in the world investing in renewable energy and according to the renewable energy attractiveness index 2017 by EY, Indian renewable energy sector is the second most attractive renewable energy market in the world.

The government of India through Ministry of New and Renewable Energy (MNRE) is playing a proactive role in promoting the adoption of renewable energy resources and has an ambitious target of 175 Gigawatts (GW) of solar, wind and other renewable energy by 2022. It includes 60 GW of large and medium-scale grid-connected solar power projects, 60 GW of wind, 40 GW of solar rooftop projects, 10GW of bio-power and 5GW of small hydro. As a result, renewable energy in India has seen more passionate investments and a steeper fall in per unit energy supply tariff than any other energy source in the country.

Status of Kerala in Renewable Energy

The conventional sources of energy in Kerala are hydro power, petroleum products and fire woods. As the consumption of energy in the state is increasing, the state will have to continue buying power from other states and agencies or have to install thermal and nuclear power plants. Owing to widespread popular opposition, because of high population density and fragile ecology, nuclear stations could not be installed in Kerala. The other alternatives are fossil-fuelled thermal stations like Brahmapuram and Kayamkulam, which is also not capable of providing all our energy needs. Hydro stations are also not feasible because of the lack of favourable sites and unfavorable ecological impact. As these projects are facing social protests, the only way to achieve self-sufficiency in power generation is to concentrate in renewable energy sources where there is significant potential in the state to meet the basic energy requirements of the people in an economically efficient manner. In order to cater the ever-increasing demand of power, Government of Kerala has decided to encourage power generation from Non-conventional Energy Sources.

Kerala's Approach towards Renewable Energy

Kerala Solar Policy, 2013

Realizing the need to have a structured approach to tap existing renewable energy sources the Government of Kerala drafted Solar Policy in the year 2013, with the vision to mainstream use of solar energy and ensure optimal usage of solar potential of the State. The Solar Policy aimed at increasing the installed capacity of the solar sector in the state and ensures long term energy and ecological security.

Kerala Renewable Energy Policy

The policy was formed to develop, propagate and promote non-conventional energy sources and exploit natural sources. It also aimed at developing eco-friendly projects and decentralized power generation. The target aimed through policy is self sufficiency. The Kerala Renewable Energy Policy was formulated based on the legal, financial and administrative frame work for promotion of investments in this sector.

The renewable energy programmes of MNRE are implemented in close coordination with State Nodal Agencies for renewable energy. In Kerala, Agency for Non-conventional Energy and Rural Technology (ANERT) is the state nodal agency and the schemes related to renewable energy equipments are being implemented by ANERT. ANERT is an autonomous organization established during 1986 under Societies Act by the Government of Kerala, now functioning under Power Department is the State Nodal Agency for the Ministry of New and Renewable Energy (MNRE), Government of India.

The role of ANERT as the nodal agency for renewable energy is presented in the following chapter.

Status of Renewable Energy: Kerala - a Comparison

Renewable Energy Potential

The various sources of renewable energy as its potential in different states of India is presented in table 1.1.

Table 1.1

Source-wise and State-wise Estimated Potential of Renewable Power in India

Sl. No.	States/ UTs	Wind Power @ 100m	Small Hydro Power	Biomass Power	Cogeneration-bagasse	Waste to Energy	Solar Energy	Total Estimated Reserves	Distribution (%)
1	Andhra Pradesh	44229	978	578	300	123	38440	84648	7.72
2	Arunachal Pradesh		1341	8			8650	10000	0.91
3	Assam		239	212		8	13760	14218	1.30
4	Bihar		223	619	300	73	11200	12415	1.13
5	Chhattisgarh	77	1107	236		24	18270	19714	1.80
6	Goa	1	7	26			880	913	0.08
7	Gujarat	84431	202	1221	350	112	35770	122086	11.14

Cont'd …

Sl. No.	States/ UTs	Wind Power @ 100m	Small Hydro Power	Biomass Power	Cogeneration-bagasse	Waste to Energy	Solar Energy	Total Estimated Reserves	Distribution (%)
8	Haryana		110	1333	350	24	4560	6377	0.58
9	Himachal Pradesh		2398	142		2	33840	36382	3.32
10	Jammu & Kashmir		1431	43			111050	112523	10.27
11	Jharkhand		209	90		10	18180	18489	1.69
12	Karnataka	55857	4141	1131	450		24700	86279	7.87
13	Kerala	1700	704	1044		36	6110	9595	0.88
14	Madhya Pradesh	10484	820	1364		78	61660	74406	6.79
15	Maharashtra	45394	794	1887	1250	287	64320	113933	10.39
16	Manipur		109	13		2	10630	10755	0.98
17	Meghalaya		230	11		2	5860	6103	0.56
18	Mizoram		169	1		2	9090	9261	0.84
19	Nagaland		197	10			7290	7497	0.68
20	Odisha	3093	295	246		22	25780	29437	2.69
21	Punjab		441	3172	300	45	2810	6768	0.62
22	Rajasthan	18770	57	1039		62	142310	162238	14.80
23	Sikkim		267	2			4940	5209	0.48
24	Tamil Nadu	33800	660	1070	450	151	17670	53800	4.91
25	Telangana	4244					20410	24654	2.25
26	Tripura		47	3		2	2080	2131	0.19
27	Uttar Pradesh		461	1617	1250	176	22830	26333	2.40
28	Uttarakhand		1708	24		5	16800	18537	1.69
29	West Bengal	2	396	396		148	6260	7202	0.66
30	Andaman & Nicobar	8	8				0	16	0.00
31	Chandigarh					6	0	6	0.00
32	Dadar& Nagar Haveli						0	0	0.00
33	Daman & Diu						0	0	0.00
34	Delhi					131	2050	2181	0.20
35	Lakshadweep	8					0	8	0.00
36	Puducherry	153				3	0	156	0.01
37	Others*					1022	790	1812	0.17
All India Total		**302251**	**19749**	**17536**	**5000**	**2554**	**748990**	**1096081**	**100.00**
Distribution (%)		**27.58**	**1.80**	**1.60**	**0.46**	**0.23**	**68.33**	**100.00**	

(Source: Energy Statistics 2019)

The total estimated potential of Renewable Energy power in India as on 2018 is 10,96,081 MW of which 3,022,51 MW (27.58%) is from wind power, 19,749 MW (1.80%) from small hydro power, 17,536 MW (1.6%) from Biomass power, 5000 MW (0.46%) from Co-generation-bagasse, 2554 (0.23%) from waste to energy and 7,48,990 MW (68.33%) is from solar energy. According to Energy Statistics 2019, Ministry of Statistics and Programme Implementation, Government of India, the estimated potential of Rajasthan is 14.80 percent which is the highest in the country. The estimated potential of Kerala is only 0.88 percent. The position of Kerala in terms of solar power potential is 23rd and wind power potential is 10$^{th.}$

Grid- Interactive Renewable Energy Systems

Grid-Interactive renewable energy systems are rooftop solar systems which are connected to the public electricity grid. The generated power is exported directly onto the electricity grid. The status of Grid-Interactive energy systems is presented in table 1.2.

Table 1.2

Source-wise and State-wise Installed Capacity of Grid- Interactive Renewable Energy Systems

States/UTs	Bio-Power				Wind Power	
	Biomass Power & Bagasse Cogeneration		Waste to Energy			
	31.03.17	31.10.18	31.03.17	31.10.18	31.03.17	31.10.18
Andhra Pradesh	378.20	477.18	58.16	23.16	3618.85	4074.35
Arunachal Pradesh	-	-	-		-	
Bihar	113.00	121.20	-		-	
Chhattisgarh	228.00	230.50	-		-	
Goa	-	-	-		-	
Gujarat	65.30	77.30	-		5340.62	5852.67
Haryana	96.40	205.66	-		-	
Himachal Pradesh	-	7.20	-		-	
Jammu & Kashmir	-	-	-		-	
Jharkhand	-	4.30	-		-	
Karnataka	1452.00	1798.80	1.00	1.00	3751.40	4672.30
Kerala	-	0.72	-		51.50	52.50
Madhya Pradesh	93.00	105.35	3.90	15.40	2497.79	2519.89
Maharashtra	2065.00	2186.40	12.72	12.59	4771.33	4788.13
Manipur	-	-	-		-	
Meghalaya	-	13.80	-		-	
Mizoram	-	-	-		-	
Nagaland	-	-	-		-	
Odisha	50.40	59.22				
Punjab	179.00	317.10	9.25	9.25		
Rajasthan	119.30	121.30			4281.72	4299.72
Sikkim	-	-	-		-	
Tamil Nadu	878.00	954.55	8.05	6.40	7861.46	8594.39
Telangana	158.10	159.10		18.50	100.80	128.10
Tripura	-	-	-		-	
Uttar Pradesh	1933.00	2117.51	5.00			
Uttarakhand	73.00	130.50	-		-	
West Bengal	300.00	319.92	-		-	
Andaman & Nicobar	-	-	-		-	
Chandigarh	-	-	-		-	
Dadar & Nagar Haveli	-	-	-		-	
Daman & Diu	-	-	-		-	
Delhi	-	-	16.00	52.00		
Lakshadweep	-	-	-		-	
Puducherry	-	-	-		-	
Others	-	-	-		4.30	4.30
All India Total	**8181.70**	**9407.61**	**114.08**	**138.30**	**32279.77**	**34986.35**
Distribution (%)	**14.29**	**12.83**	**0.20**	**0.19**	**56.39**	**47.70**

(Source: Energy Statistics 2019)

Cont'd…

Table 1.2 - Continuation

States/ UTs	Small Hydro Power		Solar Power		Total	
	31.03.17	31.10.18	31.03.17	31.10.18	31.03.17	31.10.18
Andhra Pradesh	241.98	162.11	1867.23	2641.76	**6164.42**	**7378.56**
Arunachal Pradesh	104.61	107.10	0.27	5.39	**104.87**	**112.49**
Assam	34.11	34.11	11.78	12.70	**45.89**	**46.81**
Bihar	70.70	70.70	108.52	142.45	**292.22**	**334.35**
Chhattisgarh	76.00	76.00	128.86	231.35	**432.86**	**537.85**
Goa	0.05	0.05	0.71	0.91	**0.76**	**0.96**
Gujarat	16.60	28.60	1249.37	1647.55	**6671.89**	**7606.12**
Haryana	73.50	73.50	81.40	216.85	**251.30**	**496.01**
Himachal Pradesh	831.81	858.61	0.73	3.36	**832.54**	**869.17**
Jammu & Kashmir	158.03	179.03	1.36	9.85	**159.39**	**188.88**
Jharkhand	4.05	4.05	23.27	32.07	**27.32**	**40.42**
Karnataka	1225.73	1230.73	1027.84	5230.40	**7457.97**	**12933.23**
Kerala	213.02	222.02	74.20	138.49	**338.72**	**413.73**
Madhya Pradesh	86.16	95.91	857.04	1531.81	**3537.89**	**4268.36**
Maharashtra	346.18	373.57	452.37	1419.18	**7647.60**	**8779.87**
Manipur	5.45	5.45	0.03	2.17	**5.48**	**7.62**
Meghalaya	31.03	31.03	0.01	0.06	**31.04**	**44.89**
Mizoram	41.47	36.47	0.10	0.20	**41.57**	**36.67**
Nagaland	30.67	30.67	0.50	1.00	**31.17**	**31.67**
Odisha	64.63	64.63	79.42	117.75	**194.45**	**241.60**
Punjab	170.90	173.55	793.95	905.62	**1153.10**	**1405.52**
Rajasthan	23.85	23.85	1812.93	3079.99	**6237.80**	**7524.86**
Sikkim	52.11	52.11	0.00	0.01	**52.11**	**52.12**
Tamil Nadu	123.05	123.05	1691.83	2220.95	**10562.39**	**11899.34**
Telangana		90.87	1286.98	3405.13	**1545.88**	**3801.70**
Tripura	16.01	16.01	5.09	5.09	**21.10**	**21.10**
Uttar Pradesh	25.10	25.10	336.73	805.15	**2299.83**	**2947.76**
Uttarakhand	209.32	214.32	233.49	302.99	**515.81**	**647.81**
West Bengal	98.50	98.50	26.14	37.97	**424.64**	**456.39**
Andaman & Nicobar	5.25	5.25	6.56	6.56	**11.81**	**11.81**
Chandigarh			17.32	30.35	**17.32**	**30.35**
Dadar & Nagar Haveli			2.97	5.46	**2.97**	**5.46**
Daman & Diu			10.46	13.01	**10.46**	**13.01**
Delhi			40.27	106.56	**56.27**	**158.56**
Lakshadweep			0.71	0.75	**0.71**	**0.75**
Puducherry			0.08	1.71	**0.08**	**1.71**
Others			58.31	0.00	**62.61**	**4.30**
All India Total	**4379.86**	**4506.95**	**12288.83**	**24312.60**	**57244.23**	**73351.81**
Distribution (%)	**7.65**	**6.14**	**21.47**	**33.15**	100.00	100.00

(Source: Energy Statistics 2019)

According to Ministry of New and Renewable Energy, total installed capacity of Grid-Interactive renewable power is 73,351.81 MW as on 2018 of which 9,545.91 MW (13.02%) is from Biogas power, 34,986.35 MW (47.70%) from Wind power, 4506.95 MW (6.14%) is from Small hydropower and 24,312.60 MW (33.15%) is from Solar power. Karnataka contributes 12,933.23 MW of Grid interactive renewable powers and Tamil

Nadu contributes 11,899.34 MW which is the highest and second highest in the country respectively. Kerala stands in sixteenth position by contributing only 413.73 MW. The highest contribution of Grid- interactive renewable energy in Kerala is from Small- Hydro (222.02 MW) and Solar power contributes only 138.49 MW even though Solar power is the second highest grid interactive renewable source of energy in the country.

The data from MNRE shows that the grid interactive renewable energy capacity in India has increased by 28 percent from 2017 to 2018. The increase is seen highest from solar power (86%). In the case of the Kerala, the grid interactive renewable energy capacity has been increased by 22 percent from 2017 to 2018. The increase is seen highest from Solar Power (86.6%).

Off-grid Renewable Energy Systems

The status Off-grid renewable energy systems in India are presented in table 1.3.

Table 1.3

Installation of Off-grid/Decentralised Renewable Energy Systems/Devices

Sl. No.	State/UT	Biogas Plants No. in Lakh	SPV Pumps (No.)	Solar Photovoltaic (SPV) Systems				Aerogen/ systems (KW)	Biomass Gasifier (MW)	Waste to Energy (MW)
				SLS (No.)	HLS (No.)	SL (No.)	PP (KWP)			
1	Andhra Pradesh	5.49	33,226	8,992	22,972	51,360	3815.6	272.5	22.9	23.88
2	Arunachal Pradesh	0.03	22	5,008	35,065	18,551	963.2	6.8	0.0	
3	Assam	1.28	45	9,441	46,879	2,13,364	1605.0	6.0	2.9	
4	Bihar	1.30	2,107	27,270	12,303	7,97,775	4361.6	-	5.9	1
5	Chhattisgarh	0.54	41,964	2,042	7,754	3,311	30230.9	-	1.2	0.33
6	Goa	0.04	15	707	393	1,093	32.7	193.8	0.0	
7	Gujarat	4.33	11,522	2,004	9,253	31,603	13576.6	20.0	20.1	15.66
8	Haryana	0.62	1,293	22,018	56,727	93,853	2321.3	10.0	4.5	4.46
9	Himachal Pradesh	0.48	6	78,000	22,592	33,909	1905.5	-	0.0	1
10	Jammu & Kashmir	0.03	39	14,156	1,44,316	51,224	8129.9	95.6	0.2	
11	Jharkhand	0.07	3,857	9,856	9,450	5,97,184	3769.9	-	0.5	
12	Karnataka	4.90	5,695	2,694	52,638	7,781	7754.0	39.2	6.3	10.05
13	Kerala	1.49	818	1,735	41,912	54,367	15825.4	8.0	0.0	0.23
14	Madhya Pradesh	3.64	12,903	10,833	7,920	5,29,101	3654.0	24.0	9.9	0.72
15	Maharashtra	8.99	3,315	10,420	3,497	2,39,297	3857.7	1,779.5	7.2	27.71
16	Manipur	0.02	40	11,205	24,583	9,058	1580.5	140.0	0.0	
17	Meghalaya	0.10	19	4,900	7,844	24,875	1084.5	201.5	0.3	
18	Mizoram	0.05	37	5,325	12,060	10,512	2955.6	21.2	0.0	
19	Nagaland	0.08	3	6,235	1,045	6,766	1506.0	20.0	0.0	
20	Odisha	2.70	8,937	14,181	5,274	99,843	567.5	13.1	0.3	
21	Punjab	1.77	1,857	42,758	8,626	17,495	2066.0	50.0	0.0	7.4
22	Rajasthan	0.71	42,581	6,852	1,87,968	2,25,851	10850.0	14.0	2.6	3.91
23	Sikkim	0.09	-	504	15,059	23,300	850.0	15.5	0.0	

Cont'd…

Sl. No.	State/UT	Biogas Plants No. in Lakh	SPV Pumps (No.)	Solar Photovoltaic (SPV) Systems				Aerogen/ systems (KW)	Biomass Gasifier (MW)	Waste to Energy (MW)
				SLS (No.)	HLS (No.)	SL (No.)	PP (KWP)			
24	Tamil Nadu	2.23	4,459	39,413	2,89,333	16,818	12752.6	256.7	14.9	15.96
25	Telangana	0.24	424	1,029	-	-	7450.0	-	0.0	3.5
26	Tripura	0.04	151	1,199	32,723	64,282	867.0	2.0	0.0	
27	Uttar Pradesh	4.41	14,696	2,55,783	2,35,909	5,23,306	10638.3	-	31.9	49.81
28	Uttarakhand	0.21	26	22,119	91,595	93,927	2935.5	24.0	2.2	8.49
29	West Bengal	3.67	653	8,726	1,45,332	17,662	1730.0	74.0	29.8	1.17
30	Andaman & Nicobar	0.00	5	390	468	6,296	167.0	-	0.0	
31	Chandigarh	0.00	12	898	275	1,675	730.0	-	0.0	
32	Dadar & Nagar Haveli	0.00	-	-	-	-	0.0	-	0.0	
33	Daman & Diu	-	-	-	-	-	0.0	-	0.0	
34	Delhi	0.01	90	301	-	4,807	1269.0	-	0.0	
35	Lakshadweep	-	-	2,465	600	5,289	2190.0	-	0.0	
36	Puducherry	0.01	21	417	25	1,637	121.0	5.0	0.0	
37	Others*	0.02	4,621	9,150	1,40,273	1,25,797	23885.0	-	0.0	
	Total	49.57	1,95,459	6,39,026	16,72,663	40,02,969	187998.8	3,292.4	163.4	175.28

(Source: Energy Statistics 2019)

As on 31.10.2018, 49.57 lakh Biogas plants, 1,95,459 SPV pumps, 6,39,026 Street Lighting Systems, 16,72,663 Home Lighting System, 40,02,969 Solar Lantern, 1,87,998.8 KWP of Power Plants, 3292.4 KW of Aerogen Systems, 163.4 MW of Biomass Gassifier and 175.28 MW Waste to Energy type Off-grid energy systems was installed in the country.

- Highest number of Biogas plants was installed in the state of Maharashtra. Kerala has installed 1.49 lakh Biogas plants.
- Rajasthan has installed 42,581 SPV pumps which is the highest while Kerala has installed 880 SPV pumps.
- The state of Uttar Pradesh has installed 2,55,783 of Street Lighting System and Kerala has installed only 1735 Street Lighting system.
- Tamil Nadu has installed 2,89,333 Home Lighting System which is the highest in the country. Meanwhile Kerala has installed 41,912.
- Highest number of Solar Lantern is distributed in the state of Bihar (7,97,775) and Kerala has distributed 54,367.
- Chhattisgarh has installed 30,230.9 Kilowatt peak (KWP) of Power Plants which is the highest in the country while Kerala has installed 15,825.4 KWP.
- Maharashtra has installed 1779.5 KW Aerogen systems which is the highest in the country. Meanwhile Kerala has installed only 8 KW.

- Highest MW of renewable energy through Biomass Gasifier is produced by West Bengal (29.8 MW). Kerala do not Produce renewable energy through Biomass Gasifier.
- Uttar Pradesh produces highest energy from waste (49.81 MW) and Kerala produces only 0.23 MW.

It is seen that Kerala is lacking in contributing to renewable energy when compared to other states in the country.

CHAPTER 2
AGENCY FOR NON-CONVENTIONAL ENERGY AND RURAL TECHNOLOGY (ANERT) AS AN IMPLEMENTING AGENCY

Agency for Non-conventional Energy and Rural Technology (ANERT), an autonomous organization under the Power Department began its operation in 1986 with object of disseminating knowledge in the areas of non-conventional energy, energy conservation, rural technology, conducting studies, demonstrate and implement various non-renewable energy schemes thereby deal with the problems arising out of the rapid depletion on Non-renewable energy sources, update the technologies used in rural areas as well as introduce appropriate new technologies with an aim to reduce drudgery, increase production and improve the quality of life.

It is the State Nodal Agency for the Ministry of New and Renewable Energy (MNRE), Government of India, to carry out the Centrally Assisted Programmes in Kerala. ANERT is headed by a Director appointed by the Government and guided by a Governing Body chaired by the Minister for Power, Kerala and an Executive Committee chaired by the Secretary to Government, Department of Power, Government of Kerala.

The Vision of ANERT is to harness maximum possible Renewable Energy to offset consumption of conventional electricity and fossil fuels and Mission to:

- Acquire develop and demonstrate suitable renewable energy technologies
- Estimate resources put in place conducive policies
- Identify barriers, introduce policy options and popularize use of renewable energy
- Increase capacity through renewable sources
- Enhance energy efficiency by energy conservation and management efforts
- Maximize the renewable energy mix.

ANERT engages in following activities, to achieve its objectives.

- Liaison with agencies in the country and abroad in the fields of Non-conventional Energy, Energy Conservation, and Rural Technology.
- Co-operate and affiliate, if necessary with institutions, associations or bodies in India or abroad.
- Establish and to maintain technical libraries and/or information centers, and to collect and collate information regarding alternative sources of energy, energy conservation and rural technologies.
- Develop and support centers of documentation, publication service, maintenance and supply of data including patent literature, current status reports, etc. in the area of energy sources, energy management, and rural technology.
- Act as Nodal Agency for externally sponsored projects on Non-conventional Energy and Rural Technology.

- Take special steps including that of conducting training courses to develop a group of Scientists and technologies working in the field of energy sources and rural technologies and to identify and encourage research and development in the related areas, as also to institute and award fellowships, prizes, and medals and to issue certificates.
- Establish and maintain workshop and manufacturing units to further the objects of the Agency.

Organisation Structure

The organisation structure of the ANERT is presented in the chart 2.1.

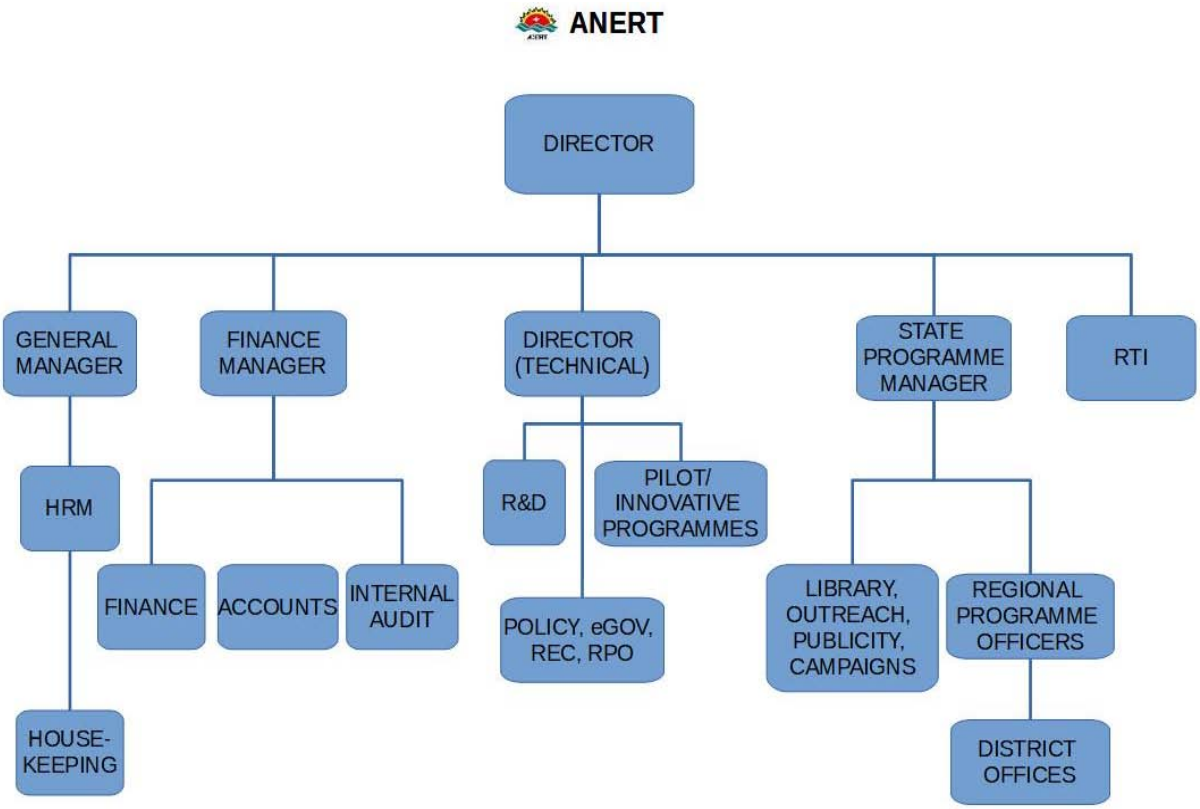


Chart 2.1
Organisation Structure

Availability of Workforce in ANERT

Availability of sufficient workforce in any organisation is necessary for effective functioning. Sufficient workforce is an important asset for any organisation, with most organisations spending significant amounts of resources on staff hiring, management, and development. Sufficient workforce at various levels is required for effectively implementing the renewable energy programmes. This availability of personnel in ANERT for planning and effectively implementing programmes and schemes is presented here. The details of available workforce for various posts are presented in table 2.1.

Table 2.1

Availability of Workforce in ANERT

Sl. no.	Name of the post	Sanctioned post	Occupied positions	Vacancy	Deputation	Employment exchange
1	Director	1	1	0	0	0
2	Finance Manager	1	1	0	0	0
3	General Manager	1	1	0	0	0
4	State Programme Manager	1	1	0	0	0
5	State Technical Director	1	1	0	0	0
6	Senior Programme Officer	1	1	0	0	0
7	Scientist D	4	4	0	0	0
8	Programme Officers	14	9	5	0	0
9	Technical Officers	3	2	1	0	0
10	Junior Manager	5	1	4	0	0
11	Junior Technical Officer	1	0	1	0	0
12	Scientist B	4	2	2		0
13	District Engineers	14	2	9	3	0
14	Technical Officer (Documentation)	1	0	1	0	0
15	Technical Officer (Portal)	1	0	1	0	0
16	Senior Accountant	1	0	0	1	0
17	State Co-ordinator (CPIM)	1	0	1	0	0
18	State Co-ordinator (Field Imp) (Personal Scale)	1	0	1	0	0
19	State Co-ordinator (Logistics) (Personal Scale)	1	0	1	0	0
20	Office Assistant	13	4	0	2	7
21	Sr. Technician	2	0	2	0	0
22	Technician	2	2	0	0	0
23	Cashier	1	0	0	1	0
24	Clerk/Typist	4	1	3	0	0
25	Driver cum Cleaner	2	0	0	0	0
26	Driver	2	2	0	0	2
27	Field Assistant	11	6	2	2	1
28	Peon	2	2	0	0	0
29	Helper	3	1	2	0	0
30	Watchman	1	0	1	0	0
31	PTS	5	2	3	0	0
	Total	**105**	**46**	**40**	**9**	**10**

According to the information provided by ANERT, 105 posts at various levels have been sanctioned by the government of Kerala. Out of these 105 sanctioned posts, 46 positions have been filled through PSC. This includes 1 Director, 1 Finance Manager, 1 General Manager, 1 State Programme Manager, 1 State Technical Director, 1 Senior Programme

Officer, 4 Scientist D, 9 Programme Officers, 2 Technical Officers, 1 Junior Manager, 2 Scientist B, 2 District Engineers, 4 Office Assistants, 2 Technicians, 1 Clerk/Typist, 2 Drivers, 6 Field Assistants, 2 Peons, 1 Helper and 2 PTS. This forms the Permanent Staff structure of the organisation. 40 posts remain vacant. 10 posts are hired through Employment exchange on 6 months contract. 9 positions are filled by deputation from other departments which includes 3 district engineers, 1 Senior Accountant, 2 Office Assistants, 1 Cashier and 2 Field Assistants. The key positions like Programme Officers, Junior Managers and District Engineers which is about 18 positions are still remaining vacant. Thus about 50 percent of the middle level positions are vacant.

The shortage of district engineers in many districts has resulted in one district engineer taking charge of several districts, thereby adversely affecting the implementation of the schemes. Discussion with ANERT officials revealed that currently, the organisation is running short of work force at various levels, which has been identified as one of the factors that hampers the effective and efficient implementation of the ANERT schemes and projects. Therefore, steps may be initiated to provide sufficient manpower at various levels.

Training/Awareness Programmes

Training allows employees to sharpen their existing skills, acquire new skills, perform better and increase productivity. It is beneficial to both employees and organisation. ANERT has provided various training programmes for their staffs and empanelled agencies during the period 2012-13 to 2016-17. The major trainings include the following.

- Training programmes for technicians of Improved Chulha for installation of chulha
- Training programmes for technicians of biogas for installation of biogas
- Training programmes for technicians for servicing Solar Photovoltaic Programmes
- In-house training for technical staff of ANERT
- Awareness programmes of schemes for public through clubs/residential associations
- Exhibition for popularizing the schemes
- Providing internship for technical students
- Financial aid to student projects related to renewable energy
- Training programme for engineers in KSEB and Department of Electrical Inspectorate
- Orientation training for empanelment agencies of Solar Photovoltaic Programmes
- Support Suryamitra Skill Development Programme sponsored by MNRE
- TOT for engineering college professors on Solar Photovoltaic electric system.

Schemes Implemented by ANERT

ANERT involved in the implementation of wide range of renewable energy programmes which include Solar Photovoltaic programme, Solar Thermal programme, Biogas programme, Wind Energy programme and Improved Chulha programme.

Solar Photovoltaic Programme

Solar Photovoltaic is the process by which the light energy is converted into electrical energy. PV gets its name from the process of converting light (photons) to electricity (voltage), which is called the *PV effect*. When the sun light falls on the solar panel, it produces electric current which is either stored in batteries or fed in to the grid, if connected or in applications like solar pumping systems. This programme of ANERT includes various schemes that adopt Solar Photovoltaic technique. Off-Grid and On-Grid Rooftop power plants are major schemes under this. Off-Grid Rooftop Solar Power Plants includes two schemes namely, 10,000 rooftop programme and Solar Smart. On-Grid Rooftop power plants include the scheme Solar Connect. Solar Lantern and Solar Home Lighting System are other programmes come under Solar Photovoltaic programme.

i) 10,000 Rooftop Programme

It was a pioneer programme of ANERT for decentralized stand alone rooftop solar power generation as part of the Jawaharlal Nehru National Solar National Mission in the year 2012-13. This programme aimed at installing 10,000 off-grid solar system of capacity 1 KW in 10,000 rooftops. Installations of the solar power plants are through a panel of agencies, selected from channel partners of MNRE whose financial and technical credibility are confirmed by MNRE, Govt. of India. This programme won the National Award for Innovative Programme from Association of Renewable Energy Agencies of States (AREAS), MNRE (Govt. of India) in 2015. This is presented in table 2.2.

Table 2.2

Subsidy component of 10,000 rooftops

MNRE (Govt. of India)	Rs. 53,262
State	Rs. 39,000
Total	**Rs. 92,262**

The Subsidy component of MNRE was reduced for the systems installed after December 2014 by 1 percent March 2015 by 2 percent.

ii) Solar Smart

This programme aimed in installing off-grid solar power plants of capacity 1 KW - 5 KW. Household applicants can install solar power plant up to 3 KW and other applicants like institutions, industries, etc. can install up to 5 KW. Shade free space of

10 sq.m. is required for installing the power plant of 1 KW. An average of 3 to 3.5 units is produced from 1 KW solar plant.

Beneficiary gets the subsidy amount according to the capacity of battery. For solar power plant of capacity 1 KW, The Subsidy component of Solar Smart is presented in table 2.3.

Table 2.3

Subsidy Component of Solar Smart

Battery Capacity	MNRE Subsidy	State Subsidy
7200 Wh	45000	22500
4800 Wh	22500	22500

Beneficiary has to refund the subsidy received, in case fails to maintain the solar system properly at least for five years from the date of installation. Beneficiary should not be in receipt of any other subsidy from MNRE for this system.

iii) Solar Connect

This programme aimed in installing Grid connected solar power plants of capacity 2 KW - 100 KW. The maximum capacity of solar power plant in a single site is limited to 100 KW. Shade free space of 10 sq.m. is required for installing 1 KW power plant. An average of 4 units is produced from 1 KW. The electricity generated can be directly used by the beneficiary and the excess power can be fed in to main power grid. The quantity of electricity distributed is calculated through an energy meter having net metering facility. Beneficiaries who transfer the excess electricity produced to the power grid are paid for each unit by the main power distribution agency. The generation and distribution of electricity is possible only when there is power in the main power grid. The Subsidy component of Solar Connect is presented in table 2.4.

Table 2.4

Subsidy Component of Solar Connect

Subsidy type	Capacity	2014-15	2015-16	2016-17
State subsidy	1 KW	10000	10000	7200
MNRE subsidy		22500	22500	22500

**Either 22500 or 30% of the cost of equipment, whichever is less*

Private, industry and commercial establishments, registered under Companies Act are not entitled to the subsidy under MNRE. Beneficiary should not be in receipt of any other subsidy from MNRE for this system. More over the beneficiaries who fails to maintain the solar system properly at least for five years from the date of installation are bound to refund the subsidy received.

Warranty:

The beneficiaries of the schemes 10,000 rooftop programme, Solar Smart and Solar Connect get five years warranty for the entire system by the supplier as per the conditions of the contract. PV modules used in solar power plants/systems is warranted for their output peak watt capacity, which should not be less than 90 percent at the end of 10 years and 80 percent at the end of 25 years.

iv) Solar Lantern

A Solar lantern is a simple application of solar photovoltaic technology consisting of a solar PV panel, storage battery and lamp. Over the years, ANERT has distributed thousands of solar lanterns across the state. The equipment got a wide acceptance in rural regions where the power supply is irregular and scarce. In urban areas, the equipment is considered as a simple solution for power cut. Lantern can operate for about 4-5 hours after charging. This program also includes free distribution of lanterns to differently-abled and plus one, plus two students whose houses are not electrified. Suppliers of the solar lantern provide two years warranty for its battery, five years for electronic system and ten years for solar module. The Subsidy component of Solar Lantern is presented in table 2.5.

Table 2.5

Subsidy Component of Solar Lantern

Year	Category	2012-13	2013-14	2014-15	2015-16	2016-17
Solar Lantern	General	1000	750	500	750	500
	BPL/SC/ST/Fisherman			1000	1500	1000

v) Solar Home Lighting System

Solar Home Lighting System is a mini version of off-grid solar system. Home Lighting System of ANERT comprises of lights, fan, battery and a solar panel. As a part of total electrification program, the equipment is distributed free of cost to eligible applicants in Wayanad, Idukki and Palakkad districts. Solar Home Lighting System including battery has a warranty period of 5 years and PV Modules have a minimum period of 25 years.

Subsidy:

The subsidy component for this programme is Rs. 4000/-.

Solar Thermal Programme

This Programme supplements thermal energy requirements for different applications by harnessing solar energy and converting it into heat using various solar thermal devices and systems. The Solar Thermal Programme of the ANERT includes the following scheme.

i) Solar Water Heater

This programme is aimed at promoting solar thermal energy thereby, decreasing the usage of electricity and fossil fuels. There are two types of Solar Water Heater under this programme. Evacuated Tube Collector (ETC) based and Flat Plate Collector based Solar Water Heater. The minimum capacity of Solar Water Heater under this programme is 100 LPD. The solar collectors of FPC based solar water heater should contain ISI mark. The channel partners provide 5 year warranty for the equipment. The Subsidy component of Solar Water Heater is presented in table 2.6.

Table 2.6

Subsidy Component of Solar Water Heater

Scheme	Type	2012-13	2013-14	2014-15	2015-16	2016-17
SWH	FPC	6000	4000	4000	4000	4000
	ETC	3000	3000	3000	3000	3000

Biogas Programme

This objective of this programme is conversion of waste into fertilizer through scientific disposal of waste thereby extracting energy. This programme also aims in improving sanitation and protect environment. It also helps in generating employment opportunities.

i) Biogas State Scheme

This program includes portable and fixed biogas plant of size 0.75 cubic metre and 1 cubic metre. Proper working of 0.75 cubic metre plant needs 4 kg of bio-waste and 1 cubic metre plant needs 6 kg waste daily. Only one plant is allowed for one house/ institution. The stove supplied along with biogas plant should bear ISI mark. Agencies should provide 5-year warranty for the equipment.

Subsidy:

The subsidy component for this programme is Rs. 8000/-.

ii) Biogas MNRE Scheme

This program includes fixed biogas plant of size 2 cubic metre to 6 cubic metre. There are two types of biogas plant model under this program- KVIC model and Deenbandhu model. Applicants have the choice to select either of the two. Agencies should provide 5-year warranty for the equipment. The subsidy component of Biogas (fixed) is presented in table 2.7.

Table 2.7

Subsidy Component of Biogas (fixed)

Scheme	Category	2012-13	2013-14	2014-15	2015-16	2016-17
Biogas	General	8000	8000	9000	9000	9000
	SC			1100	1100	1100

Additional subsidy of Rs. 1200 is available to the biogas plants which are connected to toilets.

Wind Energy Programme

ANERT conducted a detailed study of the wind potential of Kerala in association with MNRE, prepared a detailed Project Report for establishing a Wind farm at Ramakkalmedu in Idukki district and collected wind data of 21 sites in the State.

Improved Chulha

Improved chulhas are modified forms of conventional chulhas which is more efficient and smoke free. In such chulhas, the smoke is directed out using a pipe thereby assuring the person using the chulha a healthy atmosphere free from smoke, dust and heat. Efficiency of this type chulha is very high as it allows free flow of air ensuring complete combustion of the firewood. Thus the expenses are also less.

This program includes installation of 1+1 and 2+1 model chulha in households and community chulhas in institutions. Recognised Self Employed Workers (SEW) of ANERT are only allowed to install the chulhas under this programme. NGOs can also install improved chulha through recognised SEW. SEW installs improved chulha with ordinary finishing. Beneficiary can install chulha with cast iron finish and steel finish with their own fund. In the case of community chulhas, 2 chulhas can be installed in same institution under this program. The Subsidy component of Improved Chulha is presented in table 2.8.

Table 2.8

The Subsidy Component of Improved Chulha

Scheme	Category	2012-13	2013-14	2014-15	2015-16	2016-17
Improved Chulha	General	1000	1000	0	0	0
	SC/ST/THS	2500	2500	2500	2500	2500
	Community Chulha	6250	6000	6000	6000	6000

Consultancy Work, Deposit Work and Demonstration Work

ANERT undertakes renewable energy projects of local self governments under consultancy work and deposit work. Under consultancy work, if 6 percent of the estimate amount is paid, ANERT prepares and submit technical specification, and tender

document. Further tender evaluation and work supervision are done. Here the tender process is carried out by the respective institution.

Under deposit work, if 10 percent of the estimate amount with surcharge is deposited with ANERT, the entire procedure including issuing of the tender is completely done by the ANERT.

ANERT undertakes demonstration works for displaying and demonstrating a new scheme for making it popular.

This study titled 'evaluation study on various renewable energy programme implemented by ANERT' was to assess the performance of various schemes and identify reasons for poor performance if any. The next chapter provides the brief note on significance, objectives and the methodological approach followed to achieve the said objectives of the study.

Process of Implementation of the Schemes

The process of implementation of renewable energy equipments is same for almost all schemes of ANERT. Beneficiary has to submit the application to ANERT either directly or through other mediums like agency, ward members, etc. Once ANERT receives the application, application number is allotted to the beneficiary. Then the beneficiary should select an empanelled agency of ANERT for installing the equipment. The site inspection for installing the equipment is carried out by the agency. The feasibility report for installing the equipment is submitted to ANERT office. Beneficiary gets sanction for installing the scheme only if the site is suitable for installation. Otherwise, the scheme will not be sanctioned. If the site is suitable for installation, beneficiary gives work order to the agency. In the case of the scheme Solar Connect, which is an On-Grid rooftop solar programme, beneficiary has to submit feasibility report from the utility and acquire approval from Electric Inspectorate if required. Technical persons appointed by ANERT will also inspect the scheme Solar Connect. A registration number is allotted to the beneficiary by ANERT after receiving the agreement between agency and beneficiary. After receiving the registration number, the agency installs and commissions the renewable energy equipment. Then the commissioning report is submitted to ANERT. The subsidy component is released to agency/beneficiary after the inspection by ANERT officials. In the case of the scheme Solar Lantern, the beneficiary could buy the equipment directly from ANERT district offices with ration card. Beneficiaries are entitled for one solar lantern per ration card. The scheme Home Lighting System could also buy from ANERT district offices and the equipment is installed by the agency members later. The process of implementation of schemes is presented in the chart 2.2.

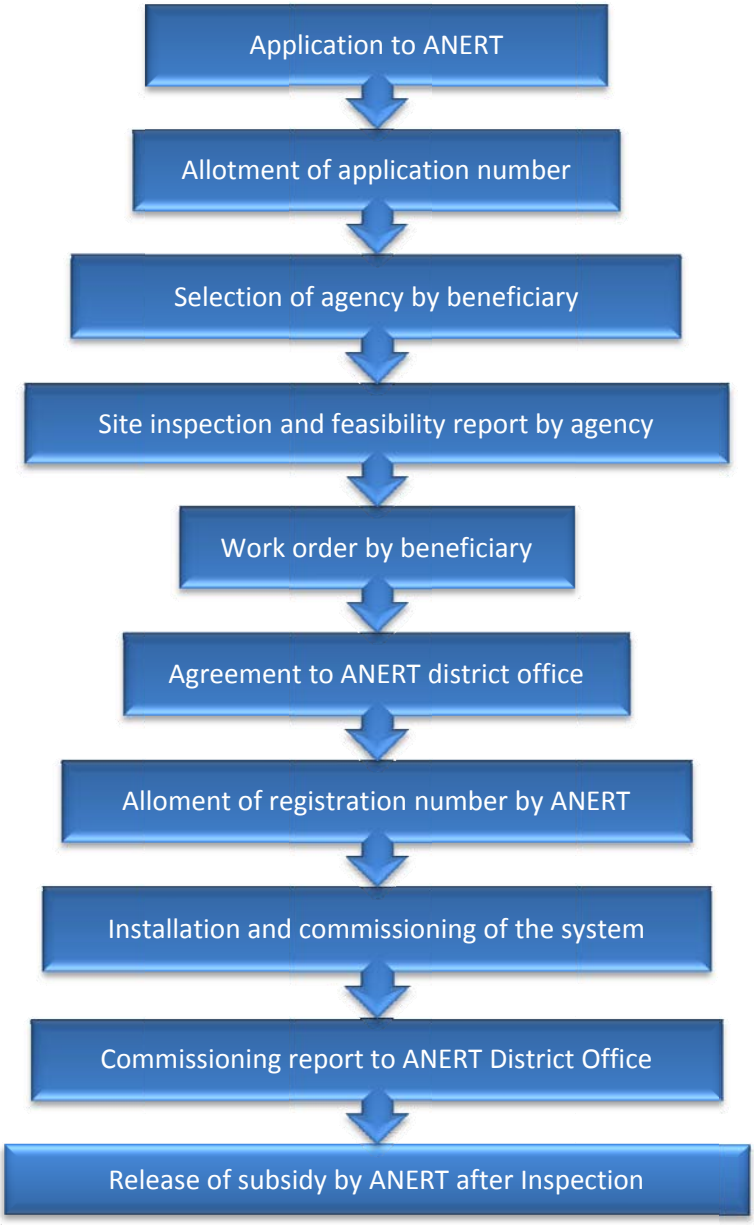


Chart 2.2

Thus the chapter includes an overview of Agency for Non-conventional Energy and Rural Technology (ANERT) as a nodal agency of Ministry of New and Renewable Energy (MNRE) in implementing renewable energy programmes in the state, details of various schemes implemented by ANERT and the process of Implementation.

Financial Report of ANERT during the Year 2012-2017

Financial analysis was identified as one of the objectives to be done in order to evaluate the funds utilized by ANERT in the different heads. The financial performance of ANERT in terms of fund utilization for the period of 2012-2016 is presented here. From 2012

onwards ANERT has been mainly receiving funds from MNRE and State government under these specific heads and as the scope of our study we are limiting the financial analysis to these heads only.

1. Electrification using Renewable Energy sources
2. Renewable Energy Programmes of ANERT
3. Resource Assessment of Renewable Energy Sources
4. Testing and innovation, Lab Facilities and other infrastructure
5. Training, Extension and Publicity.

Funds received here are mentioned as funds received from state as well as funds which is transferred from un-spend balances or funds obtained through sales or funds transferred through other departments.

Funds Allotted to ANERT through MNRE and State Government

The table 2.9 shows the total funds provided by the state government and MNRE for various programmes conducted by ANERT from 2012-2017.

Table 2.9

Funds Received and Utilized from 2012-2017 by ANERT (in Lakh of INR)

Year	Total funds received	Percentage of funds allotted by MNRE	Percentage of funds allotted by state	Total expenditure	Percentage of utilization of funds from MNRE	Percentage of utilization of funds from State Government
2012-2013	2385.12	32.37%	67.63%	966.31	15.66	87.49
2013-2014	2212.69	6.45%	93.55%	2043.22	31.54	97.80
2014-2015	2454.56	100.00%	0.00%*	2288.25	3.61	96.12
2015-2016	3448.16	50.45%	49.55%	1722.35	1.87	98.11
2016-2017	4145.14	69.11%	30.89%	3244.64	43.55	61.54

* In 2014-2015 State government funds were not allotted to ANERT. The amount spent was through the unspent balances from previous years.

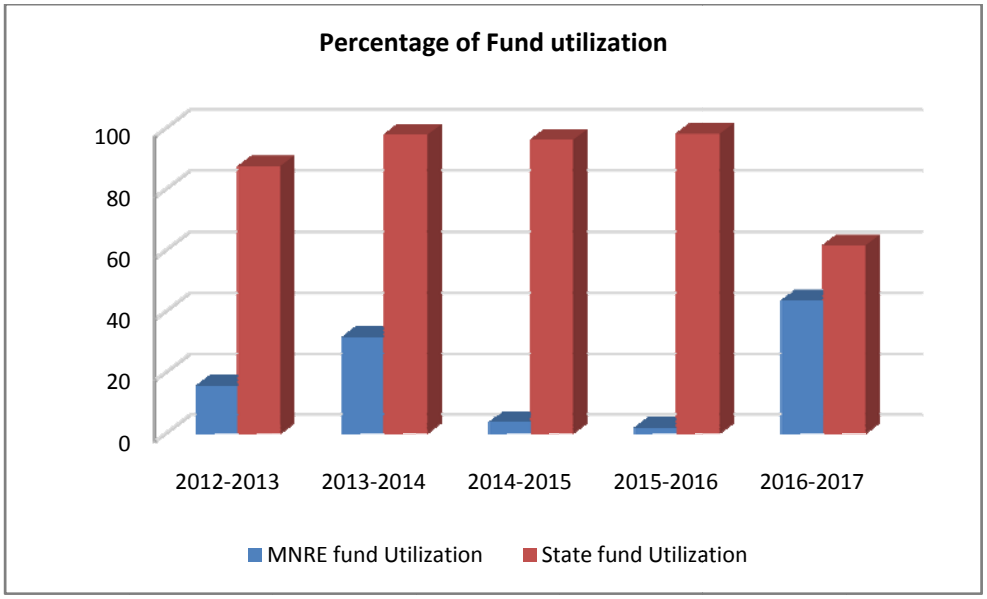


Chart 2.3

Funds Utilized from 2012-2017 by ANERT

While evaluating the funds utilized it was observed that the State fund utilization was found to be predominant when compared to the MNRE Fund Utilization. The maximum MNRE funds utilized was found to be in 2016-2017 which accounted to a little more than 43 percent. This implies that the programmes under MNRE funds are not enough for proper utilization of funds. Moreover, it was found that the state funds were almost completely utilized in 2013-2014 and 2015-2016. It is highly recommended that the fund allocation should be in accordance with the proposals given by ANERT.

Table 2.10

Financial Analysis for the Year 2012-2013 (in Lakh of INR)

Sl. no.	Name of schemes	Total fund received	Total expenditure	Balance amount	Percentage utilized
1	Electrification using Renewable Energy sources	580.00	39.64	540.36	6.83
2	Renewable Energy Programmes of ANERT	1005.00	783.39	221.61	77.95
3	Resource Assessment of Renewable Energy Sources	1.00	0.94	0.06	93.92
4	Testing and innovation, Lab Facilities and other infrastructure	4.00	2.09	1.91	52.13
5	Training, Extension & Publicity	23.00	19.36	3.64	84.17
	Total	**1613.00**	**845.41**	**767.59**	**52.41**

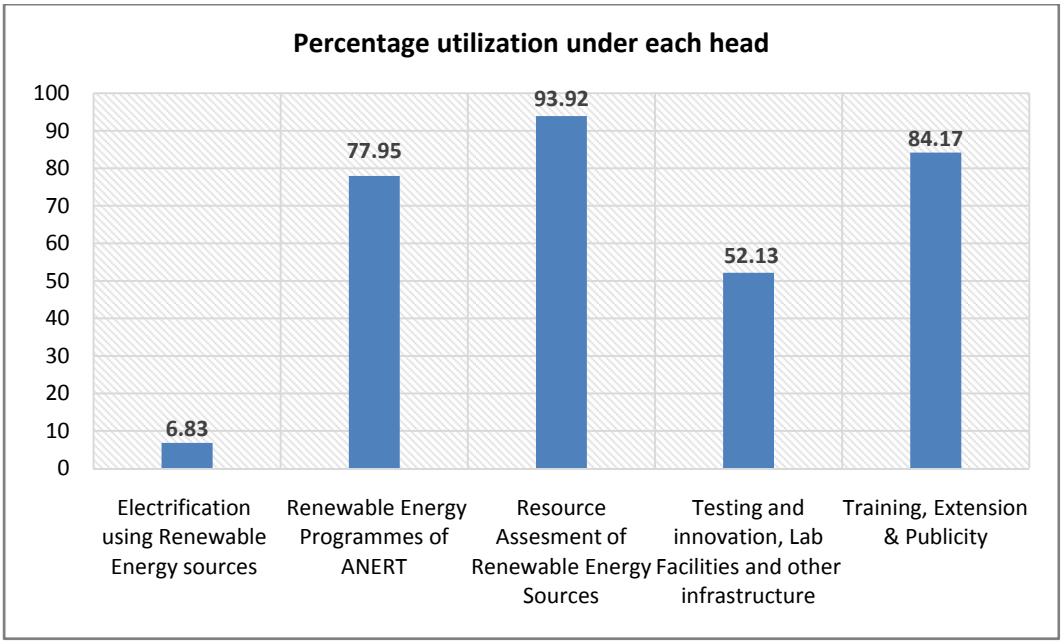


Chart 2.4

Percentage Utilization in 2012-2013

In the year of 2012-2013 it was observed that total funds received was 16.13 crore INR and it was observed that in this year the amount utilized in electrification using Renewable Energy sources programme was found to be the least utilized which accounts to nearly 6.83 percent of the funds allotted. This was due to the fact that this programme was being carried out in the subsequent years and the procedures and proceedings for implementing this programme requires more time. This has been reflected in the total percentage utilized in the financial year 2012-2013. Table 2.11 shows the financial analysis for the year 2013-2014.

Table 2.11

Financial Analysis for the Year 2013-2014 (in Lakh of INR)

Sl. no.	Name of schemes	Opening balance	Total fund received	Other receipts	Total expenditure	Balance amount	Percentage utilized
1	Electrification using Renewable Energy sources	540.36	1000.00	1.25	768.79	772.83	49.91
2	Renewable Energy Programmes of ANERT	243.78	1000.00	217.66	1212.50	248.94	97.49
3	Resource Assessment of Renewable Energy Sources	0.06	50.00		0.14	49.93	0.27
4	Testing and innovation, Lab Facilities and other infrastructure	1.91	10.00		3.15	8.76	26.46
5	Training, Extension & Publicity	3.64	10.00		13.64	0.00	100.00
	Total	**789.76**	**2070.00**		**1998.22**	**1080.46**	**69.87**

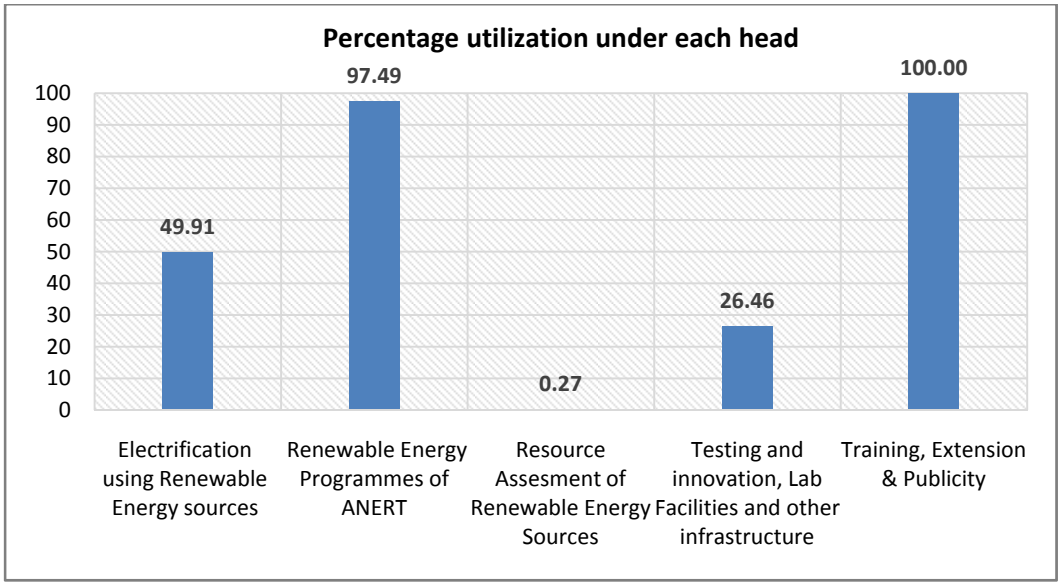


Chart 2.5

Percentage Utilization in 2013-2014

In 2013-2014 financial year it was observed that 20.70 crore INR was received as total fund granted and 1.25 lakh was been transferred from other non-utilised funds according to the G.O. (RT) No. 269/2013/PD dt. 30-09-2013 & G.O (Rt) No. 181/2013/PD dt. 26-06-2013. In Renewable Energy Programmes, programme sales from solar lantern which accounts to 217.66 lakh was been added to the fund for Renewable Energy Programmes of ANERT. It was observed that resource assessment of renewable energy sources programme was the least utilized which accounted to less than 1 percent and for Training, extension and publicity the funds was completely utilized. Table 2.12 shows the financial analysis for the year 2014-2015.

Table 2.12

Financial Analysis for the Year 2014-2015 (in Lakh of INR)

Sl. no.	Name of the schemes	Opening balance	Total fund received	Total expenditure	Balance amount	Percentage utilized
1	Electrification using Renewable Energy sources	772.83	1405.17	1278.66	899.34	58.71
2	Renewable Energy Programmes of ANERT	248.94	682.63	901.86	29.70	96.81
3	Resource Assessment of Renewable Energy Sources	49.93	5.17	1.76	53.33	3.20
4	Testing and innovation, Lab Facilities and other infrastructure	8.76	0.00	5.12	3.64	58.40
5	Training, Extension & Publicity	0.00	0.00	12.15	-12.15	
	Total	**1080.46**	**2092.97**	**2199.55**	**973.87**	**69.31**

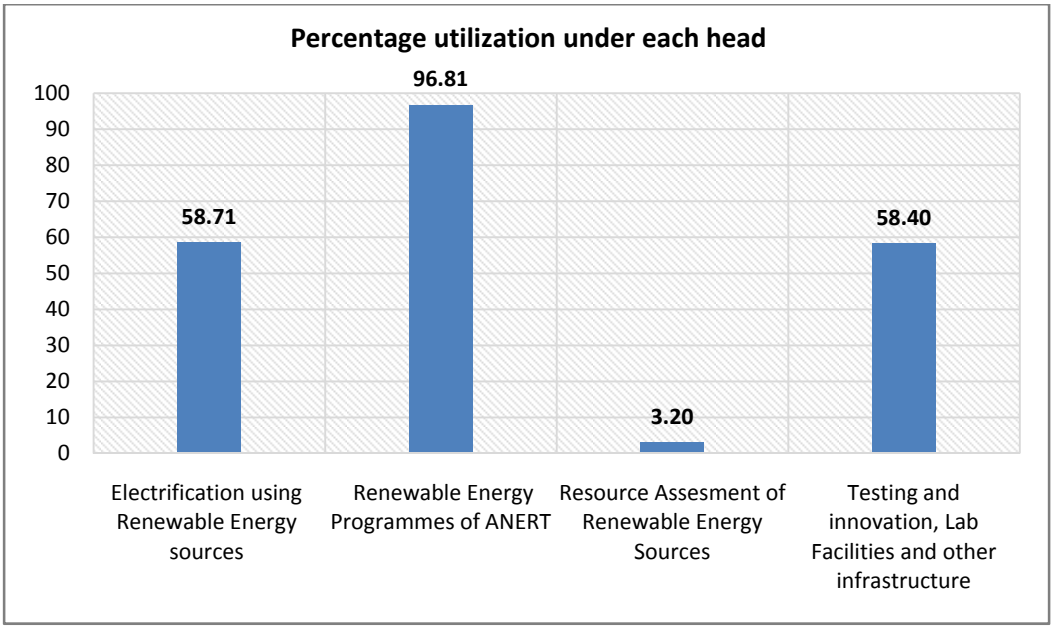


Chart 2.6

Percentage Utilization in 2014-2015

In 2014-2015 unutilized funds from the previous years were carried forward to this year. Moreover, in this year there were no state funds available so ANERT had to depend upon the un-spend balances as well. In this year an amount of Rs. 14.05 crore was been added to electrification using renewable energy programme by bank guarantee in solar off grid power plant and fund transfer as per G.O. Rt No. 74/2014/PD dt 24.03.2015. It was also observed that an amount of 6.82 crore was been added to renewable energy project. Fund transferred from un-spend balance which accounted to 3.5 crore, funds transferred through distribution of solar lantern 2.76 crore and funds transferred from KSEB 56 lakh. These three funds collectively contributed to 6.82 crore added to renewable energy project. Furthermore, 5.17 lakh INR was received from NIWE was also obtained. Training, extension and publicity programme incurred an amount of 12.15 lakh INR since there was no fund allotted to this programme for this year. Table 2.13 shows the financial analysis for the year 2015-2016.

Table 2.13

Financial Analysis for the Year 2015-2016 (in Lakh of INR)

Sl. no.	Name of the schemes	Opening balance	Total fund received	Total expenditure	Balance amount	Percentage utilized
1	Electrification using Renewable Energy sources	885.59	1693.17	2407.64	171.12	93.36
2	Renewable Energy Programmes of ANERT	29.70	1958.57	1423.12	565.16	71.58
3	Resource Assessment of Renewable Energy Sources	53.33	0.00	1.09	52.24	2.05

Cont'd...

Sl. no.	Name of the schemes	Opening balance	Total fund received	Total expenditure	Balance amount	Percentage utilized
4	Testing and innovation, lab facilities and other infrastructure	3.64	56.40	14.64	45.40	24.39
5	Training, Extension & Publicity	-12.15	62.00	19.00	30.85	38.11
	Total	**960.12**	**3770.15**	**3865.49**	**864.77**	**81.72**

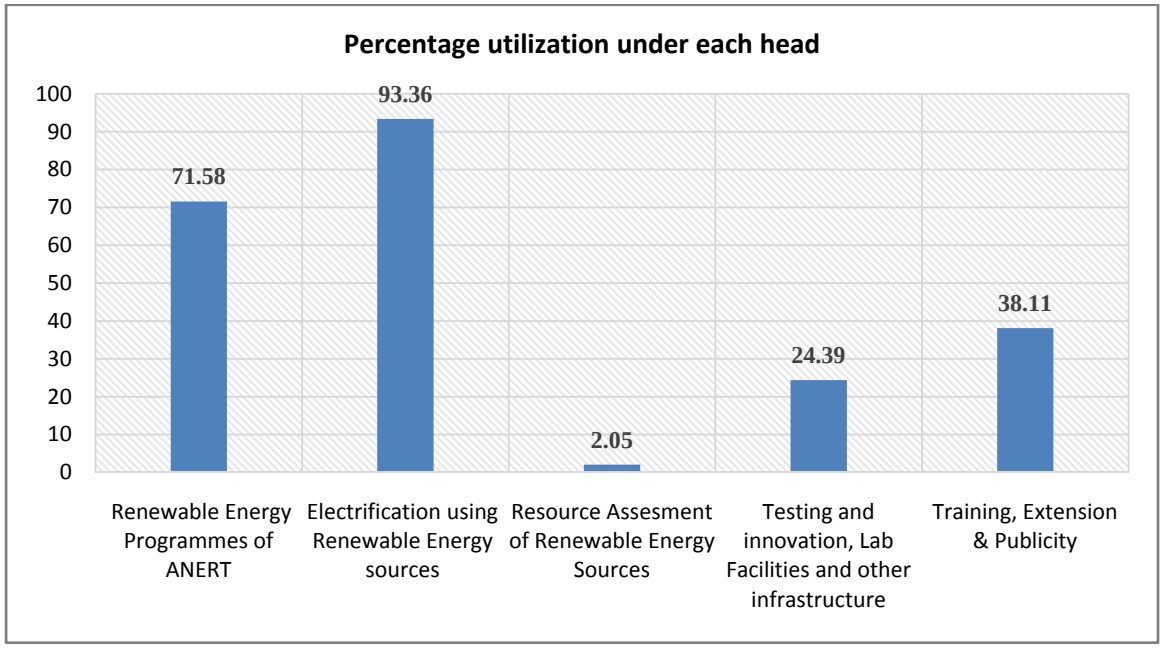


Chart 2.7
Percentage Utilization in 2015-2016

In this year also, there were 2 sets of carry over projects from previous years so inorder to calculate the financial analysis the previous year's carry over projects were also included to find out the total financial transactions in this year. Here funds from renewable energy programmes, beneficiary shares from solar lantern and funds received from G.O. (Rt) No. 235/2015/PD were added to the carry over projects renewable energy programme of ANERT. For Electrification programme actual fund transfer from government as 5.60 crore INR Fund from the previous year was also obtained which constituted 2.18 crore and 9.13 crore INR was also obtained from government. Altogether 16.93 crore were the funds received under this head. For training, Extension & publicity programme funds were transferred according to the G.O. (Rt) No. 235/2015/PD and also with G.O. (Rt) No. 76/2016/POWER totally an amount of 62 lakh was obtained as fund. Table 2.14 shows the financial analysis for the year 2016-2017.

Table 2.14

Financial Analysis for the Year 2016-2017 (in Lakh of INR)

Sl. no.	Name of the schemes	Opening balance	Total fund received	Total expenditure	Balance amount	Percentage utilized
1	Electrification using Renewable Energy sources	59.61	700.00	870.87	-111.26	114.65
2	Renewable Energy Programmes of ANERT	314.06	619.57	1056.98	-123.35	113.21
3	Resource Assessment of Renewable Energy Sources	102.24	188.00	2.38	287.86	0.82
4	Testing and innovation, lab facilities and other infrastructure	45.40	100.00	30.30	115.10	20.84
5	Training, Extension & Publicity	-9.15	40.00	36.36	-5.51	117.87
	Total	**512.15**	**1647.57**	**1996.89**	**162.83**	**92.46**

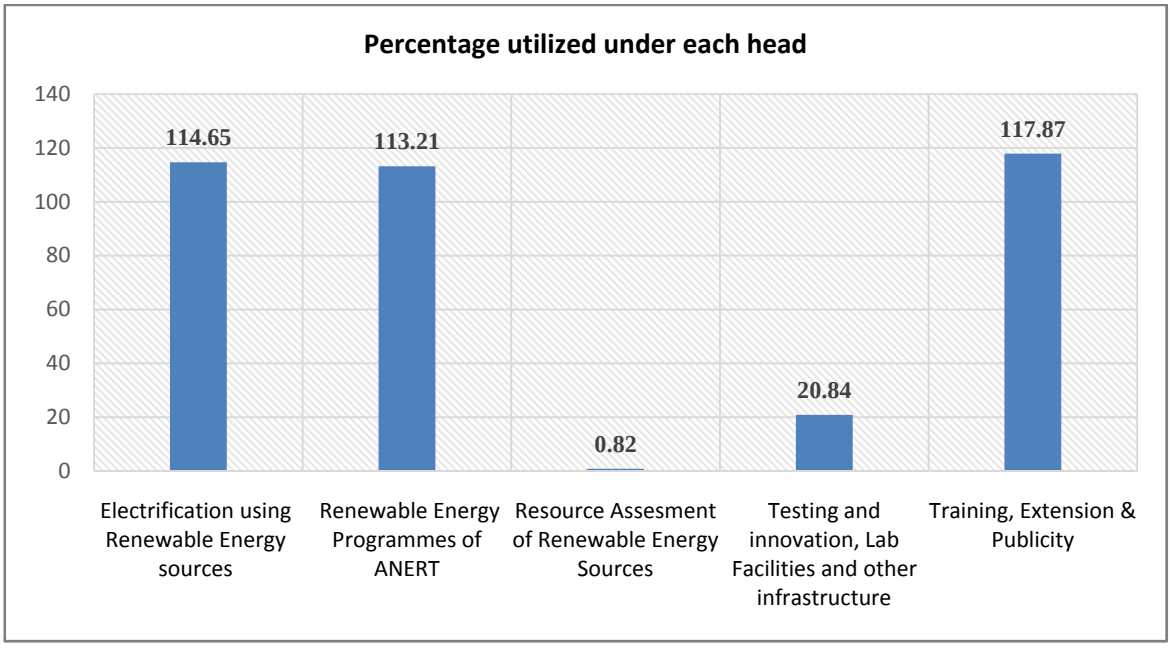


Chart 2.8

Percentage Utilization in 2016-2017

In 2016-2017 year, it was observed that there were more programmes in electrification using renewable energy sources and in renewable energy programme of ANERT, so ANERT incurred an amount of 2.34 crore INR in total for these two heads. Moreover, training also incurred an amount more than 5 lakh INR. In 7 crore which was allotted to ANERT for electrification using renewable energy sources 6 crore was allotted this year and remaining 1 crore which was sanctioned in the previous year but was allotted this year only. From this year onwards, government funds were received on the basis of proposals send by ANERT regarding the expenses which would likely to be occurred in the following year. From 2016-2017 onwards E-Lamps programme was introduced in which government would sanction the amount requested by ANERT but this amount would be released according to the requirement of ANERT. However, this year's financial statement was not audited so these figures are likely to change a little when the audited report is done.

To conclude with it can be said that over the years ANERT has been increasing the percentage of funds utilized from the state government this shows that the firm is constantly improvising and also increasing the number of programmes. However some programmes may take more than expected duration that is the reason why some funds are observed as under-utilized in the early years and most of the programmes which are under-utilized in the previous years become utilized in the next financial years. Resource assessment of Renewable energy sources was found to be the least utilized except for the financial year 2012-2013. Renewable energy programme of ANERT was found to be the most utilized among the all programmes conducted by ANERT.

Table 2.15

Comparison of Funds Allotted to KREDL (Karnataka Renewable Energy Development Limited) and ANERT for the financial Year 2014-2015, 2015-2016, 2016-2017

(in Lakh of INR)

Year	Funds allotted to ANERT	Funds allotted to KREDL
2014-2015	2454.56	849.765
2015-2016	1739.69	5245.577
2016-2017	2864.79	4387.286

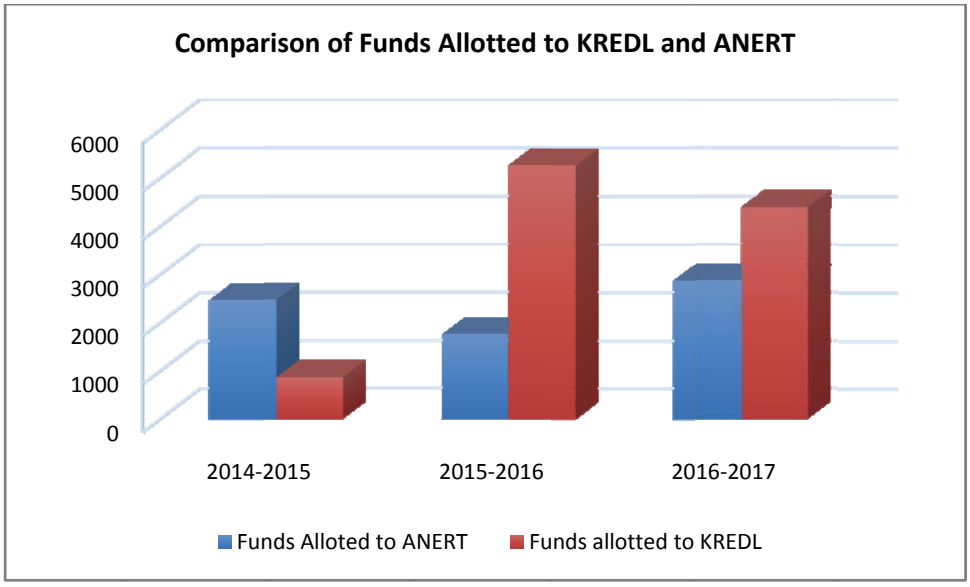


Chart 2.9
Comparison of Funds Allotted to KREDL and ANERT

While comparing the funds allotted to KREDL (Karnataka Renewable Energy Development Limited) and ANERT it was observed that during the 2014-2015 the funds allotted to ANERT was more than that of KREDL but later on the funds allotted to ANERT was found to gradually decreasing.

CHAPTER 3
METHODOLOGY

With the growing importance of renewable energy and ANERT being the nodal agency for implementation and propagation of use of Non-conventional energy sources in the state, it is essential to assess/evaluate its programmes/schemes and their functioning and providing suggestions/action plan for improving its performance. In this context the State Planning Board has entrusted the work of Evaluation study on various renewable energy programmes implemented by ANERT with Centre for Management Development.

Objectives of the Study

General Objective

The overall objective of the study was to assess the performance of ANERT as an implementing agency of various renewable energy schemes, identify causes for shortfalls in the performance and make appropriate suggestions for improvement and further action and also assess the impact of the scheme as carried out so far.

Specific Objectives

- To assess the sources of funding including state plan, MNRE subsidies, etc. and expenditure incurred in connection with various activities of ANERT for the last 5 years.
- To study the process of implementation of various schemes by ANERT and assess the sources of short falls in performance and utilization of allocated fund.
- To study the performance and the present status of equipment supplied by ANERT and the maintenance support provided by the agencies.
- To study the status of off grid/grid connected roof top solar power plants supplied by ANERT.
- To study the perception of beneficiaries of the activities undertaken by ANERT
- To assess the year-wise details of energy generated/saved from various renewable sources (solar, wind, wave, etc.) undertaken by ANERT.
- To suggest mechanism and action plans to improve the performance and efficiency of scheme implementation by ANERT.

This chapter provides an outline of research methods that were followed in the study which includes the chosen approach, target population, sampling technique, sample size, data collection method and data analysis.

Approach of the Study

This study mainly adopted quantitative approach, as it involves assessing the performance of ANERT as an implementing agency which includes describing the process

of implementation, current status and performance of the equipment, finding relationship with various variables through statistical analysis of data. Qualitative information is also collected to support the quantitative data. Qualitative data was also collected to gain in-depth understanding of various factors related to implementation and performance of ANERT as an implementing agency.

The study was conducted in 14 districts of Kerala. Both primary and secondary data was used for the study. The basic details of schemes implemented during the period 2012-13 to 2016-17 were collected from the head office of ANERT. Similarly, the beneficiary list of each schemes implemented under various districts were collected from the respective district offices. Samples were selected from the lists of schemes provided by ANERT from all the districts. Maximum care was given to ensure proportional representation of schemes and year during sampling. The study involved collection of information from beneficiaries of various schemes, implementing officials, empanelled agencies and LSGIs. The demonstration work, consultancy work and deposit work undertaken by ANERT were also a part of the study. Focus Group Discussions and Group Discussions were conducted in all the districts.

Pilot Study

The pilot study was conducted at Thiruvananthapuram district in the same setting by adopting the same data collection method and the same analysis technique as proposed. The pilot study covered all the schemes implemented by the ANERT and visited the installed sites of renewable energy equipments. Information were collected from the beneficiaries about the availed scheme and also interacted with agency members. A questionnaire was used to collect details from both household beneficiaries and industry/institution beneficiaries. Pilot study resulted in making essential modifications in the questionnaire and also aided in finding out the difficulties in conducting the study. It aided in creating a feasible and efficient plan to conduct the study.

Discussions at State Planning Board

After the completion of the pilot study, a meeting was arranged at the chamber of Member (Energy), Planning Board in the presence of Member (Energy) and the Chief, Industries and Infrastructure division, State Planning Board on 14th December 2017 to discuss the methodology and questionnaire. The questionnaire was approved with the suggestion to split it into household and institution/industry schedule.

Population

The district-wise number of beneficiaries of ANERT who installed the equipment in the time period 2012-13 to 2016-17 is indicated in the table 3.1.

Table 3.1

Districts	Population
Thiruvananthapuram	16460
Kollam	11586
Pathanamthitta	10339
Alappuzha	14140
Idukki	19191
Kottayam	13630
Ernakulam	14798
Thrissur	12031
Palakkad	17366
Kozhikode	13564
Malappuram	14149
Wayand	18089
Kannur	12757
Kasaragod	11183
Total	**199283**

(Source: ANERT)

Sampling

The samples were selected using simple random sampling method from the beneficiary list taken from the district offices of ANERT. If the drawn sample was not available, the very next person from the beneficiary list was considered as sample. Sample is derived from each scheme in each district in every specified year with 95% level of significance and confidence interval of 10. Sample size is derived using sample calculator (software) based on the below formula.

$$SS = \frac{Z^2 * (p) * (1-p)}{c^2}$$

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)

p = percentage picking a choice, expressed as decimal (0.5 used for sample size needed)

c = confidence interval, expressed as decimal (e.g. 0.04 = ±4)

District-wise sample used for the study is shown in the table 3.2.

Table 3.2

Districts	Samples
Thiruvananthapuram	564
Kollam	528
Pathanamthitta	514
Alappuzha	545
Idukki	663
Kottayam	501
Ernakulam	542
Thrissur	554
Palakkad	631
Kozhikode	581
Malappuram	467
Wayanad	530
Kannur	540
Kasaragod	447
Total	**7607**

Tool for Data Collection

Semi structured interview schedule was used for data collection from beneficiaries. Two types of interview schedules (see Annexure 1 & 2) were prepared, i.e. one for household beneficiaries and another for Institutional/Industrial beneficiaries for interviewing the beneficiaries. FGD guide was used for collecting information in Focus Group Discussion. Group Discussion was conducted with the help of GD guide.

Data Collection

Primary data was collected using Interview, Focus Group Discussion (FGD), and Group Discussion (GD).

- **Interview Method**

  Sample individual and institutional beneficiaries of various schemes of ANERT were interviewed in all the districts. As part of the interview, information on awareness of the scheme among the beneficiaries, the process involved in availing the schemes, transfer of subsidy and the present status and the performance of the equipments were collected. Respective sites of installation were visited for interviewing the beneficiaries. The data gathered through observation and direct interaction with the beneficiaries, empanelled agency members and officials of ANERT is also used in the analysis.

- **Focus Group Discussion (FGD)**

  FGDs were conducted in all the districts with the help of a FGD guide led by a moderator and a rapporteur. Participation of 10-12 beneficiaries with a maximum

time limit of 90 minutes was ensured in every FGD. The conduct of FGD revealed various experiences and views of beneficiaries regarding the scheme and it also aided in obtaining different perspectives about the topic. The discussion focused on various topics like awareness level of the schemes of ANERT, process of availing the schemes, present status and performance of the equipments, after sales services by the agencies and suggestions for improving the performance and efficiency of scheme implementation by ANERT.

- **Group Discussion (GD)**
  Group discussions were conducted in all districts to understand the perspectives of stakeholders of ANERT like officials, agency members and beneficiary on implementation of schemes and challenges. This was done to collect views and opinions on the performance of ANERT as an implementing agency of renewable energy schemes from the perspective of various stakeholders. This helped in identifying issues, and solutions were suggested for effective implementation.

Picture 3.1 & 3.2: Group Discussion and Focus Group Discussion Conducted in Districts

Secondary data for the study was collected from the district offices and head office of the ANERT. The basic details including number of schemes implemented in all the districts for deriving sample size, beneficiary details of various schemes for data collection, year wise funding to assess the sources of funding and expenditure incurred in connection with various activities and details of various training programmes conducted by ANERT during the period 2012-13 to 2016-17 were collected.

Analysis and Interpretation

The data collected using the semi structured interview schedule was analyzed using statistical methods and interpreted by incorporating the qualitative information gathered through Focus Group discussion, Group Discussion and observation during field visit.

Limitations

- The soft copies of beneficiary list of all the schemes were not available in some of the district offices of ANERT. Thus it was required to collect the details from the registers maintained at those district offices. This process consumed considerable amount of time.
- The categorized list of household, institution and industrial beneficiaries were not available with the ANERT. Thus it was not possible to derive proportionate sample of these categories.
- The contact details of the beneficiaries were not updated and thus it was difficult to survey the beneficiaries who installed the renewable energy equipment in the period 2012-13.
- As the study demanded visit to the installed sites of renewable energy equipment, convenience of the beneficiary was a prime factor in conducting field study. It affected pace of the study.
- Some of the beneficiaries were reluctant to disclose their socio-economic profile.
- Some of the beneficiaries did not remember the details of the earlier installed schemes.
- Government officials were ignorant of the scheme in most of the government institutions.

Organisation of the Study

Chapter 1 provides an overview of the basic concepts of renewable energy that have been promoted as a solution to the growing energy needs of communities while it alongside is satisfying environmental and resource scarcity problems.

Chapter 2 deals with the role of ANERT as the nodal agency for renewable energy in the state and the details of the schemes implemented by ANERT. The financial and workforce analysis are also provided in the chapter.

Chapter 3 provides an explanation on the process of research, the chosen approach, target population, sampling technique, sample size, data collection method and data analysis.

Chapter 4: The analysis and interpretation chapter is divided into three sections. The first section provides an overview of installations in households, second deals with the installation in institutions and third section deals with the renewable energy equipment installed as part of Demonstration, Deposit and Consultancy work. The household section is again divided in to seven sections. In the first section, an attempt has been made to analyse the socio-economic profile of the beneficiaries of ANERT. Second section deals with the awareness level of the beneficiaries on renewable energy, schemes of ANERT, subsidy component of various schemes and Generation Based Incentive for the

beneficiaries of Off-grid solar system. Third section provides details of various schemes implemented by ANERT and its usage by the beneficiaries. Fourth part provides an insight into the perception of beneficiaries in selecting the renewable energy equipments and the process of installing the schemes. Fifth part includes an overview of the benefits received by the beneficiaries from the renewable energy equipments installed and its contribution to environment in general.

Chapter 5 presents in-depth analysis of four case studies describing various aspects of implementation of the schemes.

Chapter 6 provides the conclusion of the study and recommendations.

CHAPTER 4
ANALYSIS AND INTERPRETATION

The chapter is divided in to 3 sections. The first section discusses the details of the schemes availed by the household beneficiaries, the second on the details of schemes availed by various institutions and the third focuses on the details of the schemes implemented as part of demonstration, deposit and consultancy work.

Household

There are individual household beneficiaries who have availed various schemes of ANERT. This section explains the details pertaining to household beneficiaries including the socio-economic profile of the beneficiaries, awareness regarding the scheme, the process of availing the scheme benefit, current status of the equipment installed and the benefits of the scheme.

Socio-Economic Profile

The socio-economic profile of the household beneficiaries is presented here.

Age of Beneficiary

The beneficiaries of ANERT include people from different age groups. The age of the beneficiaries is presented in table 4.1.1.

Table 4.1.1
Age of the Beneficiary

Age	Percent
21-40	20
41-60	52
Above 61	28
Total	**100**

More than half of the schemes of ANERT are availed by the household beneficiaries who are in the age group 41-60. There are only less than one-fourth of the household beneficiaries who are in the age group 21-40. This indicates that the installation of Renewable Energy Equipment among younger generation is relatively low. The discussion with the beneficiaries affirmed the need for spreading awareness among young people on renewable energy schemes of ANERT. This can be done through schools and colleges aiming more young people to become aware of the need of renewable energy in future.

Gender

The gender of the beneficiaries is presented in chart 4.1.1.

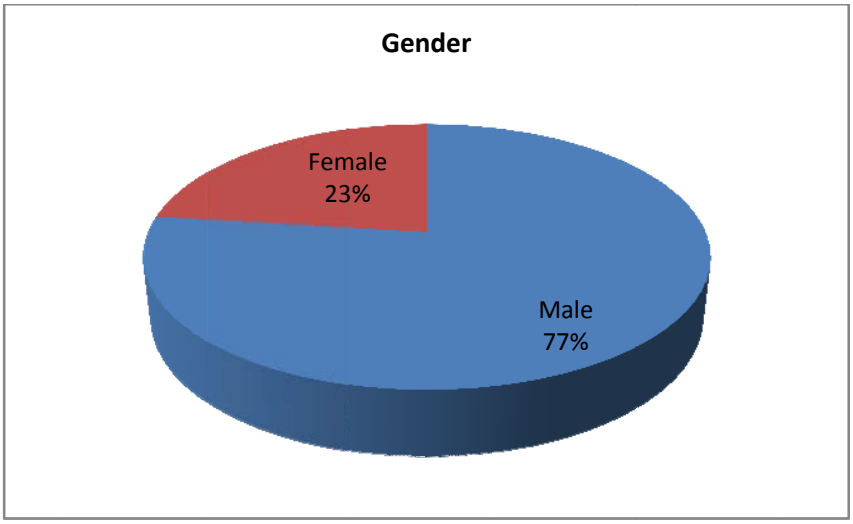


Chart 4.1.1

In majority cases, the equipment was installed due to the initiation of male members in the household. More than three-fourth of the beneficiaries are male. There are only less than one-fourth households, where female members initiated the installation of renewable energy equipment. The discussion with the beneficiaries revealed the need of awareness programmes among women, especially through Self Help Groups to promote renewable energy equipment.

Category

By analysing the category of beneficiaries, an understanding on categories which availed the schemes mostly and barely can be made. The reason behind that also can be found out. The category of the beneficiaries is presented in chart 4.1.2.

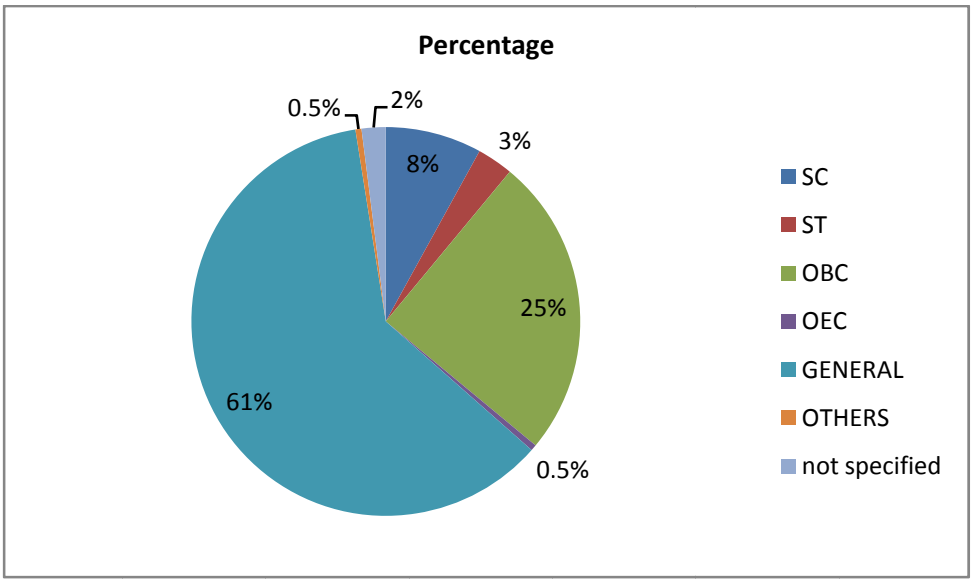


Chart 4.1.2
Category of the Beneficiaries

The majority of the household beneficiaries who availed the schemes belong to general category (61%). One-fourth of the total household beneficiaries belong to OBC category. These schemes are not so popular among SC/ST categories. It is observed that SC/ST category beneficiaries mainly preferred low investment schemes of ANERT like Improved Chulha, Solar Lantern and Biogas. The table 4.1.2 shows the rooftop schemes installed by the beneficiaries who belong to SC/ST category.

Table 4.1.2
Rooftop Solar Schemes Installed by SC/ST Category

Rooftop Solar Schemes	SC (in %)	ST (in %)
10,000 Rooftop	7	7
Solar Smart	1	2
Solar Connect	4	2
Total	12	11
Total SC/ST Households (in numbers)	**660**	**188**

It is seen that nearly 10 percent of the SC/ST category installed rooftop solar system which includes 10,000 rooftop programme, Solar Connect and Solar Smart which needed high investment. The lack of necessary awareness of the schemes of ANERT among tribal population and also the high investment for the schemes resulted in fewer installation of the schemes among SC/ST community.

Household Size

The consumption of energy depends on number of household members. The household size in the houses visited is presented in table 4.1.3.

Table 4.1.3
Household Size

Total Members	Percent
1	4
2	17
3	16
4	27
Above 4	20
Not Specified	16
Total	**100**

Nearly 50 percent of the households that have installed the equipment have family members of 4 and above. The number of installations is comparatively less where there is only one member in the household (4%). From the meetings with beneficiaries, they

opined that the equipment is more beneficial in the households where there are more members as the consumption of energy is high.

Location of House

The renewable energy equipments were installed in various locations in the state that includes rural, urban, tribal and coastal areas. Location of house of the beneficiaries is presented in table 4.1.4.

Table 4.1.4

Location of the Beneficiaries' Household

Location	Percent
Rural	44
Urban	36
Tribal Area	5
Rural Coastal Area	8
Urban Coastal Area	7
Total	**100**

The schemes of ANERT are popular among both rural and urban areas of the state. It is seen that the reach of the schemes in other areas especially in tribal areas are relatively less. The discussion with beneficiaries in these areas brings out the lack of proper awareness among the people regarding the scheme which could be the major reason for lesser number of installations in these areas. Awareness activities may be initiated in the tribal areas to popularise the schemes among them, similar is the case with coastal areas also.

Educational Status

The educational back ground and the awareness generated through this have a major role in selecting the renewable energy equipment. The educational status of the beneficiaries is presented in table 4.1.5.

Table 4.1.5

Educational Status of the Household Beneficiary

Educational Status	Percent
Non-literate	0.1
Literate	0.9
Primary	1
Middle	3
Matriculate	20
Plus Two	14
Degree	44
P.G.	12
Qualification above P.G.	5
Total	**100**

The educational background of the beneficiaries who have availed the scheme is generally high. Nearly two-third of the beneficiaries have an education of degree and above. Only 5 percent of the beneficiaries have education below matriculation. There are only 1 percent beneficiaries who have education below matriculation but installed rooftop solar power plants. It was found that educational qualification has an important role in selecting renewable energy equipments by beneficiaries.

Type of Ration Card

The colour of the ration card maintained by the beneficiary households indicates their financial status. There are four types of ration cards in Kerala. The yellow card holder is the most economically backward section of the society. They are the Antodaya Anna Yojana beneficiaries. The pink card holders are the priority card holders. Both the yellow and pink card holders come under BPL category. The blue and white colour ration card holders belongs to APL category where, blue ration card is the non-priority state subsidy cards and white is the general non-priority cards. The colour of the ration card of the beneficiary households is presented in table 4.1.6.

Table 4.1.6
Type of Ration Card of Beneficiary Households

Type	Percent
White	55
Blue	27
Pink	5
Yellow	1
Not willing to disclose	12
Total	**100**

Most of the household beneficiaries (55%) have white ration card. This is followed by blue colour card holders (27%). The schemes installed by the beneficiaries of pink and yellow colour cards are only below 10 percent of the total installations. The type of renewable energy equipment installed by different types of card holders is presented in table 4.1.7.

Table 4.1.7
Type of Renewable Energy Equipment and Number of Installation by Different Card Holders

Type of Card / Scheme	Yellow	Pink	Blue	White
Solar Lantern	11	69	201	518
Home Lighting System	21	32	25	70
Solar Water Heater	2	27	545	867
10,000 Rooftop	0	5	70	1471

Cont'd...

Type of Card / Scheme	Yellow	Pink	Blue	White
Solar Smart	0	0	8	127
Solar Connect	0	0	53	47
Chulha	10	70	216	75
Biogas (Portable)	2	6	364	696
Biogas(Fixed)	8	188	517	414
Total	**54**	**397**	**1999**	**4285**

(This table includes only those sample beneficiaries who have disclosed the type of ration card)

It is seen that the renewable energy equipment that involves higher cost is mostly installed by APL category people. Considering the case of BPL card holders (both yellow and pink) it is seen that they mostly purchase either Solar Lantern or Home Lighting System, which are relatively less expensive. Fixing of Improved Chulhas and Biogas plants are also preferred by these BPL cardholders as these equipments met their fuel requirements.

Among the BPL category beneficiaries, only 1 percent of the BPL beneficiaries installed rooftop solar systems, that too by taking loan from private lenders. Nearly half of the BPL households installed the scheme Biogas as most of them depends agriculture and cattle rearing as their means of livelihood. The beneficiaries suggested the need of enhancement of subsidy amount to BPL category and provision for availing low interest loans for BPL category from nationalised banks for purchasing renewable energy equipment.

Type of House

The type of house and the space availability is also a factor affects the installation of the equipment, especially rooftop equipments. The type of house of the beneficiaries is presented in table 4.1.8.

Table 4.1.8

Type of House

Type	Percent
Pucca	89
Semi-Pucca	10
Kutcha	1
Total	**100**

Majority of the household beneficiaries live in pucca and semi-pucca house. Only 1 percent lives in kutcha houses. The details of schemes installed in various types of houses are shown in the table 4.1.9.

Table 4.1.9

Schemes Installed in Various Types of Houses

Type of House / Scheme	Kutcha	Semi-Pucca	Pucca	Total
Solar Lantern	14	102	1067	1183
Home Lighting System	0	56	103	159
Solar Water Heater	0	107	1435	1542
10,000 Rooftop	0	10	1590	1600
Solar Smart	0	1	213	214
Solar Connect	0	2	105	107
Chulha	22	90	307	419
Biogas (Portable)	0	17	1317	1334
Biogas(Fixed)	0	417	710	1127
Total	**36**	**802**	**6847**	**7685**

In majority cases (99%), the rooftop solar system is installed in pucca houses. The better financial condition and adequate space for installation aided those beneficiaries to install the roof top solar system. The beneficiaries who live in kutcha house are the yellow and pink card holders which come under BPL category. They only availed Solar Lantern and Improved Chulha which need lower level of investment and meet their fuel requirements.

Occupation

The beneficiaries of ANERT are those who work in various field of the society including public sector, private sector, self-employed, etc. The occupation of the beneficiaries is presented in table 4.1.10.

Table 4.1.10

Occupation of the Household Beneficiary

Occupation	Percent
Govt. /Public Sector	10
Private/Organisation	19
Self-employed	9
Unorganised Skilled/ Unskilled Sector	1
Unemployed/NA	11
Retired	21
Not specified	29
Total	**100**

A large section of the household beneficiaries of ANERT are either retired employees or those who are working in government and private sector. There are only 9 percent of the beneficiaries who are self-employed.

Annual Income of the Household

As the cost of the equipments varies according to schemes, the annual income will provide insight on the selection of schemes based on their income. The details of annual income of the household which is collected from the beneficiaries as first time response is presented in table 4.1.11.

Table 4.1.11

Annual Income of the Household

Annual Income (In Rs.)	Percent
Below 15,000	18
15,000 - 29,999	4
30,000 - 49,999	5
50,000 - 99,999	7
1,00,000 - 4,99,999	32
5,00,000 - 1,00,0000	24
Above 10 Lakh	10
Total	**100**

The data regarding the annual income reflects that majority of the households earn an income above Rs. 1 lakh annually. Above 90 percentage of the rooftop solar systems are installed by the beneficiaries who earns above 1 lakh annually. Solar Lantern is the scheme mostly availed by the beneficiaries who has income below 1 lakh annually.

It is observed that the beneficiaries who installed the equipment mostly belong to middle age and above, lives in rural and urban areas and mostly belong to general category. Majority of the household beneficiaries owns a white colour ration card and lives in pucca houses. The educational qualification of most of them is graduation and above having occupation either in Govt./private or retired from the government services. There are a few self-employed people also.

Awareness

Awareness is a key factor in the promotion of renewable energy. This section analyses awareness and sources of information on renewable energy, various schemes, subsidy, and incentives.

Awareness on Renewable Energy (R.E.) and Non-Renewable Energy (N.R.E.)

As the beneficiaries of ANERT are using renewable energy equipments, it is necessary to assess their knowledge on renewable energy. Among the beneficiaries, it was found that about 60 percent are well aware about renewable energy and non-renewable energy. The Rest is not aware of the difference between renewable and non-renewable energy even after using the renewable energy equipment. Various stakeholders opined that creating awareness on renewable energy will help people to create a concern on environment and make them switch over to renewable energy equipment, which in turn will lead to increasing the demand of renewable energy equipment.

Source of Information on Renewable Energy and Non-Renewable Energy

Awareness creation on renewable energy among public is essential as renewable energy helps in securing the future for our selves by ensuring sustainable development. Various media plays a vital role in creating awareness on renewable energy. The source from which the beneficiaries of ANERT got information on Renewable Energy and Non-Renewable Energy is presented in table 4.2.1.

Table 4.2.1

Source of Information on R.E. and N.R.E.

Source	Percent
Print Media	44
Broadcast Media	5
Social Media	0.5
Academic Knowledge	42
Internet (Other than social media)	6.5
Others	2
Total	**100**

Among the sources, print media and academic knowledge have a major role in creating awareness on renewable and non-renewable energy. More than three-fourth of the beneficiaries became aware through these sources. Rest of the households got information through internet (other than social media), broadcast media and social media. Though the contribution of social media on renewable energy is negligible and social media should be made an important means of communication on renewable energy. Similarly the broadcast media can also contribute to this process.

Source of Information of Scheme

One of the factors which influence the success of a scheme is creating proper awareness among public. From interaction to modern means of communication, each source could play an important role in creating awareness. Various sources by which the beneficiaries were made aware on the schemes of ANERT are presented in chart 4.2.1.

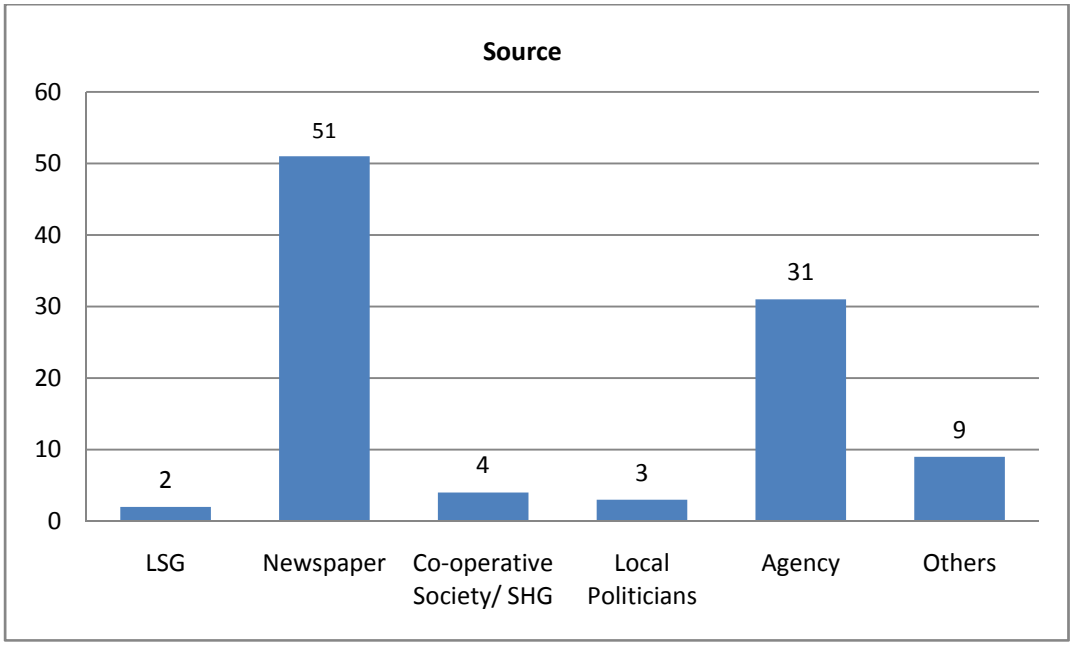


Chart 4.2.1
Source of Information of Scheme

The data regarding the source of information of the scheme reflects that more than half of the households got information on the scheme through newspaper. The empanelled agency of ANERT also plays a major role (one-third of the beneficiaries) in spreading awareness on schemes. The distribution of pamphlets and brochures by the agency had a considerable effect in creating awareness about the schemes of ANERT. The stalls set up by agencies during various exhibitions also aided in creating awareness. Other source of information includes LSGIs, SHGs and local politicians. One of the suggestions from the beneficiaries was that of using social media as a platform in making awareness on various schemes of ANERT as it will aid more young people to become aware and install renewable energy equipments.

Awareness on Subsidy

It is seen that only 50 percent of the household beneficiaries are aware on the subsidy component of the installed scheme, indicating that the 50 percent are not aware of it. While interacting with those household beneficiaries who are not aware on subsidy, it was understood that they did not maintain proper documents of the equipment and also could not recollect the subsidy component of the equipment. Some of them were not able to recollect the subsidy amount as the scheme was installed years back.

Awareness on Generation Based Incentive (GBI)

Generation Based Incentive is an incentive given to the beneficiaries of off-grid solar power plants to promote the installation. The beneficiaries get an amount of one rupee per unit produced from the solar power plant. Majority of the household beneficiaries (80%) who are the beneficiaries of Off-Grid solar power plant, were not aware of GBI.

Only one-fourth of the household beneficiaries were aware of GBI. Neither the agency members nor the officials of ANERT made them aware of this incentive scheme. Those who were aware of this incentive scheme got this information through newspapers. According to them, making public aware on various incentives attached to the renewable energy equipment installation will result in attracting more number of people for the installations of the equipment.

Thus from the above discussion it is seen that majority of the households were well aware about renewable and non-renewable energy which they got mainly through newspaper and education. The beneficiaries got information on the schemes of ANERT mainly through newspaper and the empanelled agencies of ANERT. However, about 50 percent of the household beneficiaries are unaware of the subsidy component of their installed equipment. The awareness of GBI among the Off-grid rooftop beneficiaries was very poor. ANERT has to concentrate in more awareness generation activities to promote renewable energy sector in the state.

To successfully implement the scheme which has the ultimate concern on the environment, a proper method of communication towards attaining the goal should be designed. This shall include the benefit derived by the beneficiaries as well as the impact on the environment.

Schemes

This section deals with the details of scheme installed by the beneficiaries including type of scheme, capacity, usage, various benefits and problems of the equipment.

Biogas Plant

Most of the household beneficiaries installed biogas plant as a solution to dispose the bio-degradable waste generated at home. Both portable and fixed biogas plants are preferred by the beneficiaries, however among the two, portable is preferred more (54%) due to the ease of installation and low cost compared to fixed type.

Picture 4.3.1 & 4.3.2: Portable Biogas Plant and Fixed Biogas Plant

Majority of the beneficiaries who has installed fixed type Biogas plant are maintaining cattles at home. Among the household that have biogas (fixed) model, three-fourth of the beneficiaries (77%) preferred Deenbandhu model plant and one-fourth beneficiaries preferred KVIC model biogas plant. Those preferred Deenbandhu model plant revealed that the cost of installation was low.

The beneficiaries of biogas plant use the equipment with different sizes that varies from 0.75 cubic metre to more than three cubic metres. The size is selected based on the quantity of waste generated at home. The size of the biogas plant installed by the beneficiaries is presented in the chart 4.3.1.

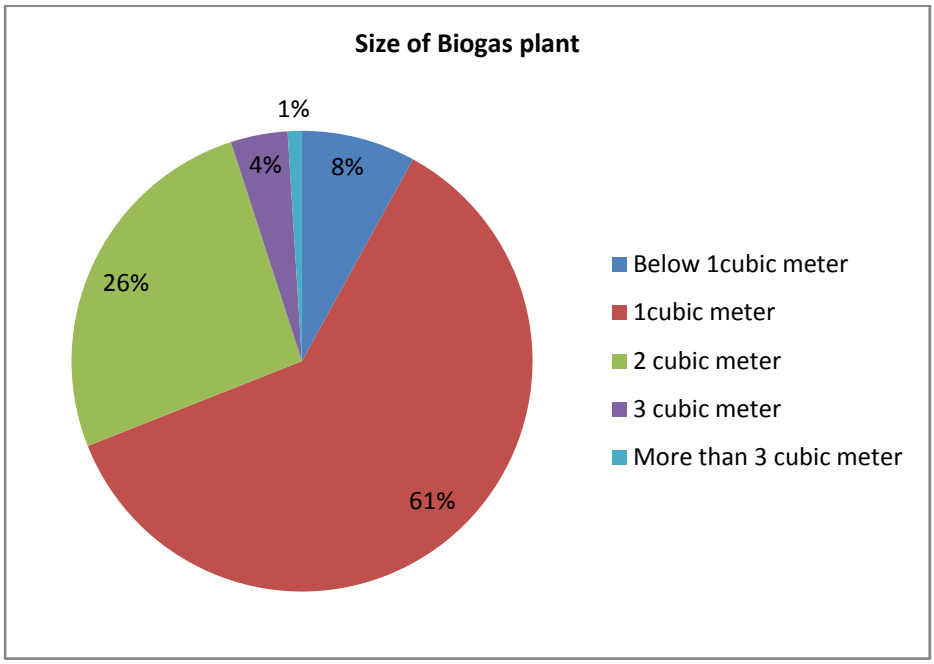


Chart 4.3.1
Size of the Biogas Plant

Nearly two-third of the household beneficiaries (61%) uses the biogas plant of size 1 cubic metre and rest of the beneficiaries uses biogas plant of size below 1 cubic metre, 2 cubic metre and 3 cubic metre. Thus it is seen that the most preferred size of Biogas plant is 1 cubic metre. The beneficiaries stated that they chose biogas plant of size 1 cubic metre for the reason that if the plant is too small (below 1 cubic meter) it will not be possible to hold all the waste of a household and adding additional quantity will lead to malfunctioning of the plant. The beneficiaries do not have enough waste to fill the larger plants. Therefore majority of them chose 1 cubic metre biogas plant.

Biogas has helped beneficiaries in reducing the usage of LPG considerably. In 12 percent cases the beneficiary gets sufficient cooking gas that reduces the consumption of LPG and even they need not use LPG, leading to a considerable savings in money.

Maintenance of Biogas Plant

The proper maintenance of biogas plant has contributed in proper waste management, thereby reducing the mosquito growth and preventing the chances of vector borne diseases. In about 60 percent of the households, the growth of mosquitoes has reduced.

Picture 4.3.3 & 4.3.4: Biogas Plants Covered with Net by the Beneficiary to Prevent Mosquito Growth

However, in about 40 percent of the households, the growth of mosquitoes is not controlled and some of the households (7%) have informed that the growth of mosquitoes has increased after the installation of the biogas plant. The reason for the same was the water stagnated around the water jacket in the portable biogas plant and less awareness regarding the maintenance of biogas plants.

Picture 4.3.5 & 4.3.6: Biogas Plant which are kept Untidy by Beneficiary which is a Breeding Place of Mosquitoes

During the visit, it is observed that some of the biogas plants (5%) are abandoned due to improper waste dumping. This could be due to lack of awareness of beneficiaries on usage of the plant.


Picture 4.3.7 & 4.3.8: Malfunctioned Biogas Plants due to Improper Waste Dumping

Sagging of Pipeline from Biogas to Stove

The pipe line from the biogas to stove should not be allowed to sag as the water gets stagnated and it affects the gas flow through the pipeline. More than two-third of the household beneficiaries (72%) are aware of the stagnated water in a sagged pipeline connecting biogas plant to stove. They did not allow the pipeline to sag. The households where the agency members gave proper training to use the equipment had kept the pipeline properly. But, there are households (28%) in which the pipeline is sagged. In those household where proper training was not given, they were unaware of the issue of stagnated water in a sagged pipeline.

Improved Chulha

Improved chulha aids the beneficiary to cook in a smoke free atmosphere. Here the smoke is directed out using a pipe thereby assuring the person using the chulha a healthy atmosphere to cook. There are two types of chulha. One is ordinary chulha and other one is steel type chulha. As the beneficiary has to give extra amount for installing steel type chulha, nearly three-fourth of the household beneficiaries (72%) installed ordinary type of chulha and only one-fourth of the household beneficiaries (28%) installed steel type of chulha.

Most of the beneficiaries of steel type chulha (92%) belong to APL category. The household beneficiaries prefer steel type chulha as it is more convenient to clean and found more durable than ordinary chulha.

Two-third of the total household beneficiaries chose 1+1 model of chulha while 31 percent household beneficiaries opted for 2+1 model according to the availability of space for installing the chulha.

Picture 4.3.9 & 4.3.10: Ordinary Chulha and Steel Type Chulha

Status of Installation of Chulha

The proper installation of an equipment results in its efficient and effective functioning. Table 4.3.1 shows the status of installation of chulha.

Table 4.3.1
Status of Installation of Chulha

Type of Chulha	Percentage Installation	Proper Installation	Improper Installation (Cracks)
Ordinary	72	54	18
Steel	28	28	0

The efficiency of the chulha depends on the quality of materials used and the method of construction. Poor quality of chulhas results in developing cracks and release of smoke through these cracks. There were cracks formed in about one-fourth of the total ordinary chulhas due to poor quality. The steel type chulhas were found to be installed properly and working efficiently without any issues.

Picture 4.3.11 & 4.3.12: Chulhas which are Not Used by the Beneficiaries due to Cracks Developed

Place of Installation of Improved Chulha

One of the factors which affect the proper maintenance of Improved Chulha is its place of installation. Table 4.3.2 shows the relation with the place of installation of Improved Chulha and its functioning status.

Table 4.3.2
Place of Installation of Improved Chulha

Place of Installation of Chulha	Percentage households	Functioning	Abandoned
Inside	91%	90%	1%
Outside	9%	2%	7%

During the field visit, incidences of chulhas constructed outside the houses were found. There were a total of 9 percent chulhas which are constructed outside because of the space constraints inside the house.

All the chulhas constructed outside was of ordinary type. The steel type chulha was availed mostly by the beneficiaries who have pucca and semi pucca houses. As there was enough space to install the chulha in those houses, none of the steel type chulha was installed outside the house.

It is seen that more than three-fourth of the chulhas constructed outside the house were abandoned by the beneficiaries. The reasons attributable to this are the lack of proper roofing over the chulha and less care given by the beneficiaries. It is suggested that ANERT should discourage the installation of chulha outside the house.


Picture 4.3.13 & 4.3.14: Chulhas which are Constructed Outside the House that is in Abandoned Condition

Solar Lantern

Solar Lanterns are purchased by the beneficiaries mainly to cope up with the power failure and considers as a replacement to emergency lamp. It is of two types- LED and

CFL. Among the two types of lanterns, majority of the household beneficiaries (79%) uses CFL solar lantern whereas 21 percent uses LED type solar lantern.


Picture 4.3.15 & 4.3.16: LED Solar Lantern and CFL Solar Lantern

Functional Duration of Solar Lantern

The Functional duration in this context referred to time that a Lantern works after a recharge. It indicates the efficiency of the equipment. Normally Lantern works for 4-5 hours after recharging. The functional duration of Solar Lanterns purchased by the beneficiaries is presented in the table 4.3.3.

Table 4.3.3
Functioning Duration of Solar Lantern

Duration	Percent
1-2 hour	3
2-3 hour	11
3-4 hour	25
4-5 hour	28
More than 5 hour	33
Total	**100**

The Solar Lantern works for more than three hours after recharging in 86 percent households whereas in 14 percent cases, it works only less than 3 hours. Solar lantern is the one of the equipment which gets non-functional mostly. Continuous servicing is required for most of the lanterns as frequent occurrence of battery complaints is reported by the beneficiaries. More than one-third of the household beneficiaries (39%) of Solar Lantern reported such complaints which could be either due to improper maintenance of battery or due to the fault of the equipment. Though frequent battery complaints are reported, in majority cases it is found that the equipment works as usual after servicing.

Solar Water Heater (SWH)

Solar Water Heater is a cost effective way to generate hot water in a household as it harness thermal energy from sun to heat water. *It is of two types,* one based on *Flat Plate Collector (FPC) and other one Evacuated Tube Collector (ETC). FPC based SWH is more durable, but costlier than ETC based systems.*

The complaints related to SWH are relatively lesser when compared to other equipments. The equipment has aided beneficiaries in saving considerable amount of electricity usage.

Majority of the households (94%) have installed ETC type solar water heater. Few household beneficiaries (6%) installed FPC type of solar water heater. ETC solar water heater system was preferred because of the low cost compared to that of FPC solar water heater.

Picture 4.3.17 & 4.3.18: ETC Type SWH and FPC Type SWH

Capacity of Solar Water Heater

The capacity of Solar Water Heater system is defined in litre per day (LPD), which means that a 100 LPD system on an average would be able to deliver 100 litre of water on a given day. The capacity of solar water heater installed by the beneficiaries is presented in the table 4.3.4.

Table 4.3.4

Capacity of Solar Water Heater

Capacity (LPD)	Percent
100	59
125	8
150	7
200	25
250	0.8
300	0.2
Total	**100**

About 60 percent of the households have installed solar water heater of capacity 100 LPD. The beneficiaries of 100 LPD SWH is of the opinion that it is enough for a small family consisting of 4-5 members. About 25 percent of the household beneficiaries have solar water heater of capacity 200 LPD. The household beneficiaries of solar water heater of higher capacity are relatively less compared to lower capacity mainly due to the cost of equipment and the requirement of the family. The higher capacity SWH is installed mainly in joint families and institutions.

Rooftop Solar System

Rooftop solar system is a PhotoVoltaic (PV) plant that has its PV panels installed on the roof of a building, where PhotoVoltaic is the process by which the light energy is converted into electrical energy. On-Grid and Off-Grid Rooftop power plants are major schemes of ANERT under rooftop solar programme. On-grid solar systems are rooftop solar systems which are connected to the public electricity grid and therefore do not require battery storage. The generated power is exported directly on to the electricity grid. Off-grid solar systems are rooftop solar systems which are not connected to the public electricity grid and require battery to store the electricity produced by the solar system. Off-grid solar system includes schemes like 10,000 rooftop programme and Solar Smart whereas On-grid solar system includes the scheme Solar Connect.

Majority of the household beneficiaries (94%) installed Off-grid rooftop power plant and the rest has installed On-grid power plants. The number of household beneficiaries who installed On-grid solar system is very less as it is a new scheme compared to the Off-grid solar schemes. The long time duration for getting sanction and installation of On-grid power plants also makes the household beneficiaries to choose Off-grid over On-grid power plant.

Capacity of Solar Power Plant

The beneficiaries of ANERT have a variety of choices in selecting the capacity of a solar power plant. Under the scheme Solar Connect (On-grid), beneficiaries can choose capacity ranging from 2 KW to 100 KW and under the scheme Solar Smart (Off-grid), household beneficiaries can install solar system of capacity 1 KW to 3 KW. The capacity of the scheme 10,000 rooftop programme is 1 KW. The capacity of solar power plant is presented in the table 4.3.5.

Table 4.3.5

Capacity of Solar Power Plant

Capacity (KW)	Percent
1	87
2	7
3	3
4	1
5	1
More than 5	1
Total	**100**

The solar power plant of capacity 1 KW was installed by most of the household beneficiaries. The scheme 10,000 rooftop programme is the most installed rooftop solar scheme of ANERT. As capacity of solar power plant under the scheme 10,000 rooftop programme is 1 KW, the percentage of household beneficiaries who installed solar power plant of capacity 1 KW is also higher, i.e. 87 percent. Rest of the beneficiaries installed solar power plant of capacity 2 KW and above. The cost of the solar power panel depends on the capacity. As capacity increases, the cost also increases. Thus the solar power plant of higher capacity is not so popular among the public.

Functioning of Home Appliances after Installing Solar Power Plant

Except a few households, it is informed that all the home appliances connected are functioning well with solar power. Very few are reported that solar plant causes damage to electrical equipments due to voltage variation, sudden tripping of electric circuit, etc. The issues were yet to be resolved as the service providers also could not rectify this. This shows the significance of giving proper training to service providers on rectifying such problems.

Space for Installing Solar Panel

Installation of Solar Panel requires sufficient space at the terrace of the building. There is sufficient space to install solar panels in three-fourth of the households. In the remaining, separate structures are erected and the panels are installed above the structure. This practice shows the desire of the beneficiaries to go for renewable energy. However, this creates an issue for the proper maintenance and cleaning of the solar panel. In such cases, the proper maintenance of Solar Panel is not done by the beneficiaries, that results in the reduced efficiency of the solar power plant.

Maintenance of Solar Panel

The performance of the solar panel depends on proper cleaning of the panels. The accumulated dust on the surface of the photovoltaic solar panel reduces the system's efficiency by up to 10 to 50 percent. The frequency of cleaning solar panel by the beneficiaries is presented in the table 4.3.6.

Table 4.3.6

Frequency	Percent
Daily	1
Weekly	6
Monthly	54
No cleaning	26
Others	13
Total	**100**

The discussion with the beneficiaries had revealed that 61 percent of the household beneficiaries clean the solar panel regularly and the performance of the equipment in such cases is good. However there are households who do not clean the solar panels after installation. In such cases, the performance of the solar panel is adversely affected.


Picture 4.3.19 & 4.3.20: Solar Panel which is Well-maintained


Picture 4.3.21 & 4.3.22: Solar Panels which are Not Properly Maintained by the Beneficiaries

Maintenance of Battery

Battery is an essential component in Off-grid rooftop solar power plants and any failure of battery results in reduced performance of the system. Appropriate refilling of battery water is necessary in ensuring better performance of a solar system. The details on refilling battery water by the beneficiaries are presented in the table 4.3.7.

Table 4.3.7
Refilling of Battery Water of Solar Power Plant

Response	Percent
Yes	82
No	18
Total	**100**

Proper refilling of battery water is essential in maintaining the solar system properly. The schemes of ANERT like 10,000 rooftop programme, solar smart and home lighting system include battery and it has to be refilled properly. Majority of the household beneficiaries (82%) properly refills the battery water and 18 percent household beneficiaries did not refill the battery water properly as they were not interested in maintaining the equipment.

Picture 4.3.23 & 4.3.24: Batteries which are Properly and Not Properly Refilled with Battery Water

Beneficiaries Availing Generation Based Incentive (GBI)

Generation Based Incentive is an incentive given to the beneficiaries of Off-grid solar power plants to promote the use of renewable energy for power generation. The beneficiaries get an amount of one rupee per unit produced from the solar power plant. Majority of the household (99.5%) who are the beneficiaries of Off-Grid solar power plant, are not the beneficiary of GBI because of the lack of awareness regarding the incentive scheme. Only a very few beneficiaries of Off-Grid solar power plant are availing GBI. This has to be seriously looked into since it may defeat the very purpose.

Among those who have received the incentive, about 30 percent received Rs. 300/- per annum and another 45 percent have received Rs. 200/- to 250/- per annum. Rest of the beneficiaries has received less than Rs. 200/- per annum.

The beneficiaries are of the opinion that the KSEB meter shows faulty readings as the meter does not reads the exact units produced from the solar system.

Performance

Status of the Equipments Installed

Majority of the renewable energy equipment installed (97%) in the households are functioning well. The equipment was not functioning properly in 3 percent households due to the low quality of equipment, poor maintenance of the equipment by the beneficiaries and poor service by the agencies.

Performance of the Renewable Energy Equipment

The performance of the renewable energy equipment from the beneficiaries' perspective in terms of quantity and duration of energy obtained, financial benefit and maintenance of the equipment is presented in the table 4.4.1.

Table 4.4.1

Performance of the Renewable Energy Equipment

Performance	Percent
Very Good	11
Good	69
Average	13
Poor	6
Very Poor	1
Total	**100**

About 80 percent of the household rated the performance of renewable energy equipment as very good to good. Only less than 10 percent of the households considered that the performance as poor to very poor. This could be due to the technical problems of the equipment faced by the beneficiaries. Proper training on maintenance by the agency at the time of installation and following the maintenance schedule properly by the household can solve the performance issues to a great extent.

Satisfaction with the Renewable Energy Equipment

Satisfaction of a beneficiary with the renewable energy equipment is mainly coupled with its performance. Majority of the beneficiaries (86%) are satisfied with the equipment. The prompt service rendered by the agency also adds to the satisfaction. Meanwhile 14 percent household beneficiaries were not satisfied with the equipment as they opined that the quality of installed equipment is very poor which leading to the wastage of money and effort. The service provide by the agency in terms of installation, training and after sales service was also not up to the work.

Performance of the Agency

The opinion of the beneficiaries regarding the performance of the agency like installation and prompt after sales service is presented in the table 4.4.2.

Table 4.4.2

Performance of the Agency

Performance	Percent
Very Good	9
Good	58
Average	15
Poor	16
Very Poor	2
Total	**100**

About 67 percent of the beneficiaries rated the performance of the agencies as good to very good. The equipment provided by the agency is working well in those cases and the agency is providing proper after sales service to these beneficiaries. However 18 percent were not satisfied with the performance of the agencies. Those beneficiaries revealed that the agency did not attend to the queries and problems on time and proper servicing was also not provided. Instances of distributing low quality materials by the agency were also reported by the beneficiaries during the study.

Picture 4.25: Shows the Low Quality Earth Wire Distributed by the Agency

The Process Involved in Availing the Scheme

The process involved in availing the scheme include selection of the scheme based on the available information and knowledge, submitting the application at ANERT, contacting the supplier, installation and proper maintenance of the equipment.

Reason to Use Renewable Energy Equipment

As discussed in the previous section, the use of R.E.E. serves various purposes. The beneficiaries select a scheme which is most suited to the household. The decision to install/ purchase renewable energy equipment is influenced by various factors. This includes the concern for environment to savings. The reason for selecting a renewable energy equipment as revealed by the beneficiaries is presented in the chart 4.5.1.

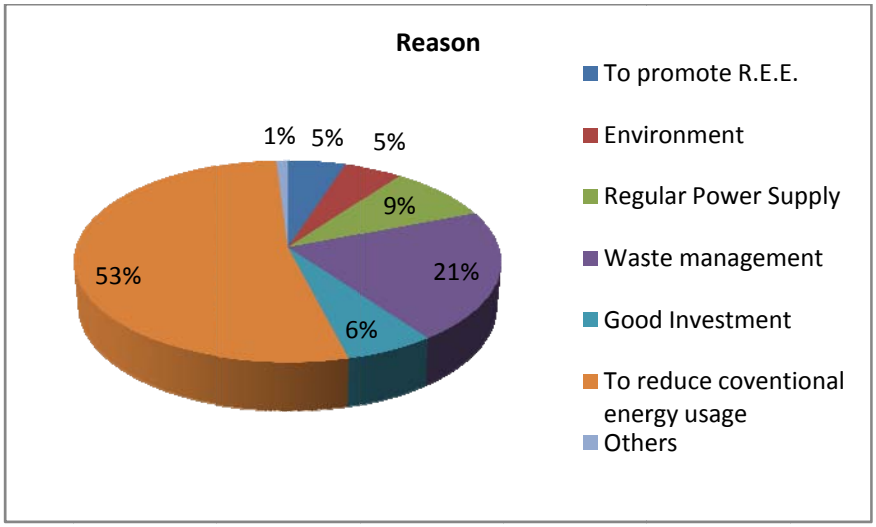


Chart 4.5.1
Reason to use R.E.E.

Above 50 percent of the household beneficiaries preferred renewable energy equipment to reduce the usage of conventional energy. Nearly one-fourth choose the equipment for managing the bio-degradable household waste. Schemes like biogas were installed by the beneficiaries to deal with the issues of waste. Less than 10 percent household beneficiaries consider it as regular source of power supply. The household beneficiaries who consider installing renewable energy equipments as a good investment are 6 percent. They consider it will help in reducing amount spent on conventional sources of energy. There are also beneficiaries who installed the equipments to promote renewable energy sector. There are around 5 percent of beneficiaries who switched to renewable source of energy considering its environmental advantages and 1 percent due to other reasons like self sufficiency and experimenting new technology.

Factors Influencing the Choice of Renewable Energy Equipment

After deciding to purchase a renewable energy equipment, the factors looked in to by the beneficiaries in purchase is presented in the table 4.5.1.

Table 4.5.1
Factors Influencing the Choice of Renewable Energy Equipment

Factors	Percent
Initial Cost	32
Finding a Trustworthy Agency	13
Choosing the Suitable Technology	23
Good Return on Investment	13
Impact on Environment	17
Others	2
Total	**100**

Majority of the household beneficiaries (32%) stated that they consider initial cost of the equipment as the most influencing factor for choosing renewable energy equipments. The subsidy component for the equipment is also considered by the beneficiaries. They prefer the schemes and type of equipments according to the cost. About one-fifth of the household beneficiaries looked into a suitable technology as their priority while 17 percent household beneficiaries considered impact on environment as a factor. They are concerned with the impact of non-conventional energy on environment. According to 13 percent of household beneficiaries, good return on investment is the main factor for choosing the equipment. Finding a trustworthy agency is considered as the main factor by 13 percent household beneficiaries and 2 percent stated that they considered other factors in choosing equipment like trustworthiness of the brand of equipments.

Thus in the process of scheme implementation, the decision making by the beneficiaries is an important activity. The beneficiaries consider this as a means of energy saving by preserving the environment. Before installing the equipment they will consider the initial cost, reliability of the supplier and the technology. By considering all these factors and the concern of the people for environment, ANERT can design suitable promotional activities.

Number of Schemes Availed by the Beneficiary

The number of schemes availed by the beneficiaries is presented in the table 4.5.2.

Table 4.5.2
Number of Schemes Availed by the Beneficiary

Number of Schemes	Percent
1	97
2	2.8
3	0.1
4	0.1
Total	**100**

Most of the household beneficiaries (97%) installed only single renewable energy equipment in their household. The household beneficiaries who installed more than one renewable energy equipment are only few in numbers (3%). The high cost of equipments is one of the reasons for not purchasing more than one equipment. The beneficiaries who installed more than one renewable energy equipment revealed that good performance of the equipment and proper servicing by the agency has made them avail more number of equipments from ANERT. The focus Group Discussion revealed the need for enhancing subsidy component to the existing beneficiaries of ANERT for availing the facilities under another scheme.

Source of Funding

The amount for installing the R.E.E. is mobilized through various sources. The different sources adopted by the beneficiaries are presented in the table 4.5.3.

Table 4.5.3

Source of Funding

Source	Percent
Own Fund	89
Loan	10
Free of cost	1
Total	**100**

Majority of the beneficiaries (88.9%) utilised their own fund in purchasing the renewable energy equipments and about 10 percent of the household beneficiaries took loan or borrowed money to avail the equipment as they are very much interested in installing renewable energy equipment. Some schemes were given free of cost for the people belonging to certain categories.

As the availability of sufficient fund restricts many interested beneficiaries from installing R.E.E., ANERT can negotiate with national banks for providing loan with a nominal interest for promoting this noble cause that protects our environment.

As the initial cost of installation cannot be afforded by many household, a system of providing bank loan with a nominal interest may be introduced considering the relevance of promoting renewable energy.

Place of Submission of Application

The beneficiaries can submit the application for availing the equipment either in ANERT office directly or through various mediums like agency, LSGI's or ward members. The place of submission of application by beneficiaries is presented in the table 4.5.4.

Table 4.5.4

Place of submission of application

Place	Percent
ANERT office directly	57
LSGI's	2
Ward Member	1
Agency	38
Others	2
Total	**100**

Mainly household beneficiaries preferred ANERT offices or agency for the submission of the application. More than half of the beneficiaries (57%) submitted the application for availing the renewable energy equipment directly in ANERT office. About 38 percent of household beneficiaries submitted their application through agencies. The beneficiaries received information of the agency and the scheme through awareness programmes organized by agencies to promote their equipments by conducting exhibitions, advertisements in print and electronic media, distribution of pamphlets and door to door campaigns. The submission of application in other places is relatively low. The number of household beneficiaries who submitted the application through LSGIs and ward members is very low (3%). Those applications are mainly for the scheme Improved Chulha. The household beneficiaries who submitted the application through other mediums like SHG is only 2 percent.

Time Taken for Sanctioning

The application for installing the renewable energy equipment is sanctioned with a unique registration number after scrutinizing the applications and verifying the feasible study. The time taken for sanctioning equipment is presented in the table 4.5.5.

Table 4.5.5

Time Taken for Sanctioning

Time	Percent
Within 1 week	21
2 - 5 week	40
6 - 10weeks	20
11 - 15 weeks	5
16 - 20 weeks	5.5
21 - 25 weeks	0.5
More than 26 weeks	2
Installation first	4
Don't know	2
Total	**100**

Most of the beneficiaries (61%) got sanction for installing the renewable energy equipment from ANERT within one month of submission of application of which 21 percent of the household beneficiaries got sanction within a week's time. As the schemes Solar Lantern and Home Lighting System are purchased by the beneficiaries directly from ANERT offices, the time for sanctioning for these schemes is less.

In a few cases, the household beneficiaries had to wait for more than 26 weeks to get sanction. In the case of 4 percent household beneficiaries, the beneficiary installed the

equipment even before sanction was accorded by ANERT. The officials of ANERT opined that the shortage of staff is a reason for the delay in many of the cases. Beneficiaries also pointed out the same opinion as they have to call several times to get the call attended.

The procedure for getting sanction for the scheme Solar Connect involves approval from the office of the chief electrical inspectorate. This process also consumes more time.

Time Taken for Installation

Once the scheme is approved, installation is the responsibility of agency selected by the beneficiary. The time for installation varies according to equipments. Among the schemes, Rooftop Solar schemes take more time for installation.

As Solar Lantern is directly distributed from ANERT office, it is excluded here. The time taken for installing the equipment by agency is presented in the table 4.5.6.

Table 4.5.6

Time Taken for Installation

Time	Percent
Within 1 week	48
2 - 5 weeks	42
6 - 10 weeks	5
11 - 15 weeks	1
16 - 20 weeks	1
21 - 25 weeks	0.5
More than 26 weeks	0.5
Don't know	2
Total	**100**

In most of the cases (90%), the agency installed the equipment within a month after getting the sanction from ANERT. However in many cases, the equipment was installed within a week. In a few cases (10%) it took six weeks and above to get the equipment installed. Beneficiaries pointed out that the delay from the part of agency mainly due to shortage of manpower is the main reason for the setback in the installation of renewable energy equipment.

Inspection of Equipment

For the purpose of releasing the subsidy and to verify whether the installed equipment is of ANERT specification, officials of ANERT has to inspect each and every site of installations. Details of inspection of the equipment by ANERT officials are presented in the table 4.5.7.

Table 4.5.7
Inspection of Equipment

Monitoring	Percent
Yes	61
No	21
NA	15
Don't know	3
Total	**100**

According to the beneficiaries, majority (61%) of the installations were monitored by the ANERT officials after installation. But in the case of nearly one-fourth (21%) installations, officials did not monitor the equipment and 15 percent of the total schemes were solar lantern that does not require inspection as the equipment are distributed from the ANERT office directly.

After Sales Service

After sales service refers to various processes which ensures better performance of the equipment and beneficiaries' satisfaction. Rendering proper after sales service is inevitable in proper functioning of the equipment. The details of after sales service by agency is presented in the chart 4.5.2.

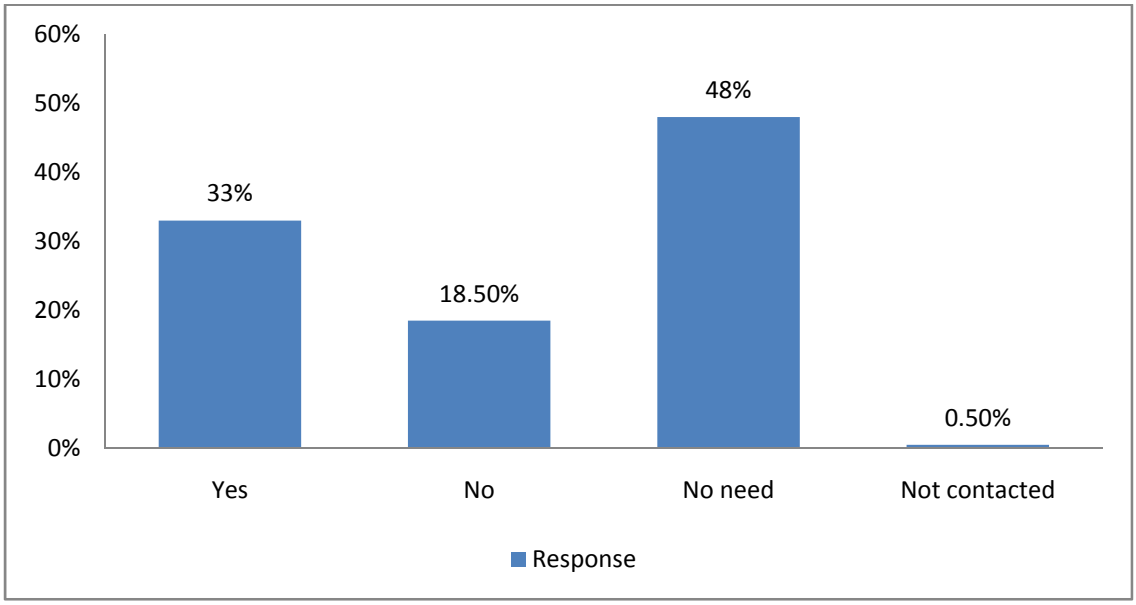


Chart 4.5.2
After Sale Service

About half of the total installations (48%) are working properly without any problems since its installation and there was no necessity of contacting the agency. Among the beneficiaries, one-third has informed that they are receiving satisfactory after sales

service. In such cases, the agency members attend and rectify the problems within one week. However some of the beneficiaries (20%) informed that they have not received proper after sales service. They have to contact agency several times for even registering the problem and to wait for a longer period to get their equipment repaired.

The agency members serviced the equipment within one month of registering complaint in most of the cases. In the case of 10 percent, it was reported that agency members did not bother to service the equipment even after registering complaints several times.

The beneficiaries reiterated the need for a regular monitoring by the agency members and officials of ANERT for ensuring proper quality and performance of the equipment.

Training by Agency

Providing necessary information for properly maintaining the renewable energy equipment is vital as it has an effect in the performance of the equipment. Majority of the household beneficiaries (87%) stated that the agency who installed the equipment provided necessary information and training on how to use the renewable energy equipment. Around 13 percent household beneficiaries stated that the agency did not provide any type of training or necessary information regarding this.

Benefits

"The nation that leads in Renewable Energy will be the nation that leads the world"

– James Cameron

Other than savings on power, the beneficiaries who have availed the schemes enjoy various other benefits.

Health

About three-fourth (74%) of the household beneficiaries who installed Improved chulha, who were more prone to chest related diseases, stated that they are relieved from chest related diseases like asthma and allergies after replacing traditional chulha with Improved chulha. While constructing the chulha, it is to be ensured that the smoke flows outside the kitchen and does not remain stagnant inside the kitchen. About 25 percent of the beneficiaries had revealed that due to construction issues, they are not getting relief from smoke.

Studies

According to 94 percent beneficiaries, schemes of ANERT for lighting have helped children in their studies. The schemes from solar lantern to Off-grid roof top solar power plant provide uninterrupted power supply and that enables the children in their studies. But in the case of 6 percent household beneficiaries, the schemes did not have any impact in the studies of their children as the equipment installed were not functioning properly and not receiving proper servicing from the agency.

Savings

More than 50 percent of the household beneficiaries have of the opinion that the renewable energy equipment could save the power bill and the money so saved could be utilised for other household needs, whereas 48 percent respondents stated that there is not much savings from renewable energy equipment. There are also households, who do not maintain a proper record of the savings.

The money saved from the utilization of the schemes like Solar Lantern and Improved Chulha is comparatively not significant. The major savings is from the schemes like rooftop solar system, solar water heater and biogas. As discussed, the quality of the equipment provided and proper servicing by agency are also factors that contribute to the performance of the equipment that leads to savings.

Annual Savings from the Scheme

Most of the beneficiaries (72%) of the renewable energy equipment could save an amount more than Rs. 1200 rupees per annum whereas about one-fourth of the beneficiaries could only save a mere amount.

Annual savings depends on the type of renewable energy equipment installed. Savings from the schemes which needs higher investment is more than those need low investment. Among the schemes, Rooftop Solar schemes enables beneficiaries to save more compared to other schemes. In 84 percent households who installed rooftop solar systems, beneficiaries could earn an annual savings of more than Rs. 5,800.

Annual savings below Rs. 1200 are generally from the schemes Improved Chulha and Solar Lantern. Below 1 percent of household who are the beneficiaries of Improved Chulha stated that they were in loss by using the equipment as the Chulha needs more firewood than conventional Chulha.

Employment Generation

Sales and service of renewable energy equipment is a major source of income. The MNRE guidelines envisage generation of employment through this. However, during the field visit it is observed that members from a very few households (1%) are engaged in the sales and service of renewable energy equipment. Awareness of employment opportunities in this sector may be created by ANERT.

Contribution to Carbon Credit

Solar energy production by a PV module is numerically equal to the product of cell area, cell efficiency, light intensity and sunshine hours. In India, the intensity of solar energy varies from 4 to 7 kWh/m^2/day, considering the 10-hr duration of sunshine in a day and

always more than the threshold level of 1.50 kWh/day. Carbon credits earned is proportional to the power output and is directly deductible from the cost of electricity produced. As such CC is important in estimating return on capital cost and also estimating the cost of electricity production. CC in this study has been calculated from 2012-2017 and estimated as 9880.36 tonnes of carbon from solar panel programmes, solar water heating systems and wind mills which could be traded and the revenue which could be generated will be 1,96,06,589.24 INR from these years (for detailed contribution to carbon credit, refer Annexure 3).

CC study of wind mills is taken into account according to the carbon emitted during generation of electric power by using thermal power plants only, the production of wind turbines, transporting and commissioning is not taken into account. From the above study, it can be inferred that by promoting new and improvised versions of renewable energy resources ANERT can make significant contributions to the carbon credits and also it can reduce the carbon footprints, moreover by promoting these methods it can generate revenue as well. It is highly recommended that more of these type of projects should occur in future because most of the countries has realized that renewable energy resources is the future and in coming years there would be an increasing demand for these projects.

i. Institution

The guideline of ANERT not only allows household beneficiaries to avail the scheme, but institutions also have the same facility. Various government institutions, private institutions, NGOs and trusts have installed various equipments of ANERT. The process of availing the scheme is same as that of household beneficiaries.

Biogas (fixed) is the most popular schemes among the institutions which constitute more than half of the total installations (51%). The schemes like 10,000 rooftop solar system, solar water heater accounts to nearly half of the total installations. These schemes are installed by private institutions, trusts and NGOs. The schemes availed by government institutions mainly include Community Chulha in schools and street light system by various LSGIs. The schemes installed by the institutional beneficiaries are of higher capacity compared to household beneficiaries.

Status of the Equipment

The functioning status of the renewable energy equipment installed in institution is given in the table 4.7.1.

Table 4.7.1

Functioning Status of the Renewable Energy Equipment Installed in Institutions

Status / Type of Institution	Functioning	Not Functioning	Total
Government Institution	21	11	32
Private Institution	72	6	78
NGO	1	0	1
Others	28	6	34
Total	122	23	**145**

In majority of the institutions (84%), the installed equipment is functioning well. It was observed that, there is a responsible staff in majority of the non-government institutions who manage the equipment. This results in proper maintenance and thereby getting better performance of the equipment.

It is seen that the renewable energy equipment is maximum utilised by the institutional beneficiaries than household beneficiaries. However, the low quality of equipment, low level of maintenance by the beneficiaries and poor services by the agencies made some of the equipment non-functional.

Several complaints related to efficiency, brightness of light and instances of stealing of battery are raised in the street light scheme in the state. Both the LSGIs and the public are highly not satisfied with the efficiency of street light system. Absence of proper servicing is the main reason pointed out by the beneficiaries for low efficiency of street light system. This condition of street lights installed should be brought to light by the authority.

Community chulhas are constructed mainly in schools, anganwadis and in other private institutions. It was found that community chulhas were functioning effectively. However, it was reported that Directorate of Public Instruction (DPI) has issued an order to use LPG for the purpose of preparing mid-day meal. Thus community chulhas are not used in about three-fourth (76%) of the schools.

Satisfaction with the Equipment

Nearly two-third of the institutional beneficiaries (74%) are satisfied with the installed equipment. The equipments of ANERT have aided the beneficiaries to save a considerable amount of money. One-third of the institutions save amount of more than Rs. 600/- per month. The usage of conventional energy also considerably reduced after installing the equipment. Meanwhile, 26 percent stated that they are not satisfied with the equipment due to the low quality and inefficiency of the equipment. Lack of proper servicing is indicated as one of the reasons for inefficient functioning of the equipment.

After Sales Service

Rendering proper after sales service is inevitable in proper functioning of the equipment. The details of after sales service by agency is presented in the table 4.9.1.

Table 4.9.1

After Sales Service

Receiving Proper after Sales Service / Type of Institution	Yes	No	No need	Total
Government Institution	5	10	17	32
private Institution	66	4	8	78
NGO	0	0	1	1
Others	18	7	9	34
Total	89	21	35	**145**

One-fourth of the installations are functioning efficiently and thus the beneficiaries did not have to contact the agency for this purpose. Nearly two-third of the beneficiaries receives proper after sales service from the agency. As most of the non-government institutions have a responsible staff to deal with the maintenance of the equipment, they frequently contact the agency and thereby proper after sales service is ensured. Mean while 15 percent beneficiaries did not receive proper after sales services. The agency members did not attend to the complaints of the beneficiaries and rectified the problems of the equipment in those institutions properly.

The renewable energy equipment is functioning properly in about 50 percent government institution and thus they do not have to contact the agency. About 30 percent government institutions are not receiving proper after sales service from the agency. Absence of a responsible staff to deal with the maintenance of the equipment may be the reason for this. The agency members attend and rectify the problems of the installation within a time period of 2-5 week in nearly three-fourth cases. One-fourth of the beneficiaries received service within one week of registering the complaints to the agency. Few beneficiaries (4%) waited up to 6-10 weeks to get their equipment serviced.

Maintenance of the Renewable Energy Equipment

The maintenance of renewable energy equipment is vested with responsible hands in most of the institutions. A staff is given responsibility to maintain the equipment. Therefore, in most institutions, the renewable energy equipments are properly maintained.

Majority of the beneficiaries (88%) properly refills the battery water of solar power plant. In 12 percent of the institutions, the beneficiaries did not refill the battery water properly as the entrusted staffs are not concerned about the equipment.

More than half of the institutions (56%) properly maintain the solar panel by cleaning it on monthly basis and 2 percent on weekly basis. One-fourth (24%) cleans once in 6 months and 7 percent beneficiaries did not clean at all the solar panels after installation. The lack of awareness among the beneficiaries in properly maintaining the solar panel affects the efficiency of the solar system.

In connecting Biogas to stove, more than 90 percent of the beneficiaries are aware of the issue of sagged pipeline and therefore they did not allow the pipeline to sag.

Performance of the Equipment

Nearly two-third of the beneficiaries are satisfied with the performance of the equipment, where majority of the beneficiaries (61%) rated the performance of the equipment as a good and very good. Nearly 10 percent of the total beneficiaries are not satisfied with the equipment. They rated the equipment as poor and very poor.

Performance of the Agency

Proper training to the beneficiaries on maintenance of the equipment is to be ensured by the agency. Even though the institutional beneficiaries properly maintain the equipment, lack of training and information in some areas are found during the study especially in the case of cleaning of solar panel. Nearly two-third of the beneficiaries are satisfied with the performance of the agency and they rated the performance as good to very good. The proper response of the agency made them highly satisfactory with their performance. One-fourth of the beneficiaries are not satisfied with the performance of the agency and to them the agency did not attend to their queries and issues of the equipment.

i. Demonstration, Deposit and Consultancy Work

During the study, improper maintenance of the equipments of ANERT installed as part of Demonstration, Deposit and Consultancy work is noticed in many of the government institutions. There is no regular utilization of the renewable source of energy. It is rather used only as an alternative when there is power failure. So if there is any problem with the equipment, it is only noticed belatedly by the beneficiaries. Responsibilities of maintaining the equipment and switching over to solar power in the case of solar power plant are not vested with any staff. The staffs are not aware of any information regarding the equipment. Being unused, most of the renewable energy equipment is now in an abandoned condition. As the installed capacity of the panel in these institution is considerable compared to household installations, there is a huge wastage in terms of energy and money. The poor condition of these equipments creates indifferent attitude in the minds of the prospective consumers. Immediate attention of the authorities in this regard is required.

More than half of the installed schemes (53%) are not functioning in the institutions. Proper utilisation of the renewable energy equipment was found in only 13 percent of the institutions. Most of them (87%) use the solar system only when there is a power failure. The maintenance of the equipments is also poor. In more than three-fourth cases (92%), the solar panel is not cleaned since the installation. Only 8 percent of the beneficiaries clean the solar panel monthly. Among the beneficiaries who installed off- grid rooftop solar system, 66 percent respondents did not refill battery water properly.

Picture 4.26, 4.27 & 4.28: Solar Panels of Solar Power Plants in Government Institution which are Not Used Efficiently

CHAPTER 5
CASE STUDIES

Case Study 1: Status of Maintenance of Renewable Energy Equipment in Attingal Municipality

During the visits to various public offices, it was noticed that no proper attention is paid to the maintenance of the renewable energy equipment in most of the public offices. Even the employees fail to remember that they have a renewable energy system in their office. The equipment is used only when there is a power failure. Being unused, most of the renewable energy equipment is now in an abandoned condition. But there is an exception to this general practise.

Attingal municipality is one such model office where solar system is utilized to the maximum extent. The municipality installed the renewable energy equipment as the municipal council meeting decided to make use of the energy from renewable sources. The solar system was installed under Consultancy work of ANERT. Consultancy work means, if 6 percent of the estimate amount is paid, ANERT prepares and submit technical specification and tender document. Then further tender evaluation and work supervision are also done. Here the tender process was carried out by the municipality itself. The tender submitted by the agency IGA- tech was approved by the council and the agency installed the equipment in 2016. The installed capacity of the solar power plant was 3 KW. The system provides power to the new block of municipality.

The electricity requirement of the new block of municipality building is met from renewable energy source, except in the case of extreme weather condition. The maintenance of the solar system including proper cleaning of solar power panel and refilling of battery water is being properly carried out by the municipality. The overseer of the municipality is responsible to the maintenance of the renewable energy equipment. Under the overseer, electrician in the municipality refills the battery water and cleans the equipment. The agency which installed the equipment is also co-operating with the municipality in providing proper maintenance work whenever it is required.

This shows that through proper maintenance and commitment, the public offices can use renewable energy sources to meet their power requirement, thereby saving power and the environment.

Case Study 2: Installation of more Number of Renewable Energy Equipments as a Result of Good Performance of Equipment and Agency

Usually, as most of the equipment of ANERT is costlier, most of the beneficiaries only install single renewable energy equipment only. However, the benefits derived from the renewable energy equipment, better performance of the equipments and proper service rendered by the agency have induced some beneficiaries to install more number of ANERT equipments for different purposes.

Mr. Jayakrishnan is a doctor who owns a clinic and his family comprises of four members. In 2012-13 he installed biogas plant (fixed) to deal with the issue of biodegradable waste in his house. The name of the Turn Key agent who installed the equipment is Mr. K. Balachandran Nair. The efficient working of the biogas plant and the responsible servicing from the agent made him to buy more renewable energy equipments of ANERT. After that he bought three equipments from ANERT namely Solar Water Heater in 2013-14, Solar lantern in 2014-15 and Home Lighting System in 2015-16. All the equipment purchased by Mr. Jayakrishnan from ANERT is performing well. The case of Mr. Jayakrishnan reflects that if efficient equipment and proper servicing are provided, more people will install renewable energy equipment.

Picture 5.1 to 5.4: Solar Water Heater, Solar Lantern, Biogas (fixed) and Home Lighting System Purchased by Mr. Jayakrishnan

Case Study 3: Status of Maintenance of Renewable Energy Equipment in Women and Child Hospital, Thycaud

Improper maintenance of solar panel is noticed in many government offices/institution during the study. The situation in the Women and Child Hospital, Thycaud is not different. The rooftop solar power plant in the hospital is installed as part of the demonstration work of ANERT. Demonstration works is done to make a new scheme popular and it is installed free of cost. The installed capacity of the solar power plant in the hospital was 40 KW. It was installed in the year 2014 by the agency Aditi solar Pvt. Ltd.

The hospital has not utilised renewable source of energy on regular basis. It is rather used only as an alternative at the time of power failure. Responsibilities of maintaining

the equipment and switching over to solar power are not vested with any staff by the hospital authorities. None of the responsible staff in the hospital are aware of the maintenance of the power plant like refilling of battery water, cleaning of the solar panel, etc. At the time of our field visit, solar power plant was seen in an abandoned condition. This is the result of not entrusting the charge of rooftop solar power plant to a responsible staff in the institution. This has reduced efficiency of the equipment installed.

Picture 5.5: Solar Power Plant and Solar Panels in Women and Child Hospital, Thycaud

Immediate attention of the authorities is required in this regard to put in proper condition. As the installed capacity of the solar power plant in the institution is considerable compared to other installations, the attitudes of concerned officials towards this equipment leads to huge wastage in terms of energy and money.

Even though this equipment was installed as a demonstration work, due to the irresponsible attitude of concerned authorities towards this installation, the demonstration work could not show the benefits for attracting other institutions. This indicates that this installation failed in achieving its objective.

Case Study 4: Emerging Concern for Environment

During the field visit, the team could feel the concern of many beneficiaries on the issues related to environment. Such concern for nature has influenced some of the beneficiaries in installing the renewable energy equipment. During the study 16.30 percent respondents stated that they consider impact on environment as the most influencing factor for choosing renewable energy equipments and 66 percent respondents stated that they prefer more eco-friendly renewable energy equipment irrespective of the cost. In spite of the higher cost involved in purchasing the renewable energy equipment and lack of adequate space for installation, beneficiaries with the concern to nature has invested on erecting separate structures for installing the equipment.

Mr. Jeevan David is such one person who has concern about the environmental issues caused by conventional energy sources. He is a government employee lives in Thiruvananthapuram district. As his strong wish for using renewable energy equipment, in spite of the lack of sufficient space for installing the renewable energy equipment, he

erected separate structures for installing rooftop solar power plant and solar water heater. He paid more than Rs. 30,000 for constructing the structures. Those structures are shown below.

Picture 5.6 & 5.7 Additional Structures for Solar Panels and Solar Water Heater Erected by Mr. Jeevan

This indicates the awareness among the beneficiaries on non-conventional energy and this may be properly utilized by the implementing agencies and suitable campaign may be organized to attract more households to resort to the use of Renewable Energy Equipment.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

Agency for Non-conventional Energy and Rural Technology (ANERT) is the State Nodal Agency for the Ministry of New and Renewable Energy (MNRE), Government of India, to carry out the Centrally Assisted Programmes in Kerala. ANERT involved in the implementation of wide range of renewable energy programmes which include Solar Photovoltaic programme, Solar Thermal programme, Biogas programme, Wind Energy programme and Improved Chulha programme. The major schemes implemented by ANERT under various programmes are 10,000 Rooftop Programme, Solar Smart, Solar Connect, Solar Lantern, Solar Home Lighting System, Solar Water Heater, Biogas (portable and fixed), Wind Energy Programme and Improved Chulha. ANERT also undertakes Consultancy Work, Deposit Work and Demonstration Work for institutions. The beneficiary gets the equipment of ANERT by submitting an application when a scheme is announced and installed by an agency selected by the beneficiary from the empanelled agencies of ANERT.

While analysing the financial statements of ANERT it was found that the State funds were almost utilized and MNRE funds remained under-utilized. Interestingly, it was found that there was an increasing trend in the amount of state funds utilized. In the year 2014-2015, there were no funds allotted to ANERT by the State government so it incurred an amount of Rs. 12 lakh. Those funds were allotted only in the successive year. Resource assessment of Renewable energy sources was found to be the least utilized except for the financial year 2012-2013. Renewable energy programme of ANERT was found to be the most utilized among the all programmes of ANERT.

The study revealed that the schemes of ANERT are popular in both the rural and urban areas of the state. The schemes are less popular in tribal and coastal areas due to lack of knowledge about the schemes in those areas. The majority of the beneficiaries (61%) who availed the schemes belong to general category. The beneficiaries belonging to SC/ST category is comparatively low. The high cost of the equipments of the ANERT repels SC/ST category from purchasing the equipment. The schemes are more popular among APL beneficiaries. The beneficiaries belongs to BPL category (6%) are less and they mainly availed the equipments like Improved Chulha and Solar Lantern, which need only less investment. In most of the cases, the schemes are installed in the house where there are four and more than four members (47%). The equipment is found to be more beneficial to the households where there are more members as the consumption of energy is high. The schemes of ANERT were availed mostly by the beneficiaries who have a good educational background. Most of them have an education of degree and above. It is also seen that the schemes of ANERT are mostly availed by the people who are in middle age. The contribution of young people is less.

The main source of information about the scheme is through newspaper (51%). Agency also plays a major role in creating awareness among public. It was also observed that many beneficiaries did not maintain proper documents of the equipment and thus do not know about the scheme specifications as given in the document. Nearly 50 percent of the total beneficiaries were not aware on the subsidy component of the equipment. Majority of the household beneficiaries (80%) who are the beneficiaries of Off-Grid solar power plant, were not aware of the incentive scheme Generation Based Incentive. Neither the agency members nor the officials of ANERT made the beneficiaries aware of the incentive scheme.

Most of the household beneficiaries (97%) installed only single renewable energy equipment in their household. The high cost of equipments made the beneficiaries to limit their purchase to one equipment only. Majority of the beneficiaries preferred renewable energy equipment to reduce the usage of conventional energy, thereby reducing the amount spend for conventional energy. The beneficiaries purchased the renewable energy equipments from their own savings in most of the cases. There are cases where beneficiaries availing loan and borrowing money to install the renewable energy equipment showing their interest towards renewable energy equipment. Majority of the renewable energy equipment installed (97%) in the households are functioning and more than three-fourth of the beneficiaries are satisfied with the equipment. More than half of the beneficiaries submitted the application in ANERT office and through agency for the renewable energy equipment. In most of the cases, it took about 1 month to get sanction for installing the equipments from ANERT. According to ANERT officials, shortage of staff in ANERT affects the sanctioning of the equipment in time. After getting sanction, the agency installed the equipment within a month for majority beneficiaries. It was found that nearly one-fourth (21%) installations, ANERT officials did not inspect the equipment before releasing the subsidy due to shortage of manpower, as pointed out by the officials of ANERT.

About half of the total installations are working properly without any problems since its installation. The agency members serviced the equipment within one month of registering complaint in most of the cases. In the case of 10 percent of the household beneficiaries, agency members did not service the equipment even after registering complaints several times. Around three-fourth of the household beneficiaries rated the performance of the agencies as good to very good, whereas one-fourth of the household beneficiaries are not satisfied with the performance of the agencies. In majority of the households, agency who installed the equipment provided necessary information and training on how to use the renewable energy equipment. In the case of 28 percent of biogas beneficiaries, the pipeline is found sagged. The discussion with those beneficiary revealed that the lack of proper training by the agency. Nearly two-third percent of the household beneficiaries clean the solar panels regularly. It was understood that that beneficiaries who clean the solar panel get more performance from the solar power plant than the one that are not

properly cleaned. It was also seen that one-fourth of the household beneficiaries are not refilling the battery water properly as they were not interested in maintaining the equipment.

Portable biogas plant is more popular than fixed biogas plant due to its ease of installation and less cost. The biogas plant of size 1 cubic metre is popular among the beneficiaries as it is found to be the most convenient size. Even though most of the beneficiaries installed biogas to deal with the bio-degradable waste issues in households, it also helped them in reducing the usage of LPG considerably. It is observed that due to improper waste dumping, 5 percent of the biogas plants are abandoned. Lack of Knowledge regarding the usage is reported as the main reason. One of the benefits accruing from the biogas plant is the reduction of mosquito growth. However, water stagnated around the water jacket in the portable biogas plant and less awareness regarding the maintenance of biogas plants in some cases induces mosquito growth. Most of the APL beneficiaries installed steel type chulha and BPL beneficiaries installed ordinary type of chulha. Improved chulha aided the beneficiary to cook in a smoke free atmosphere in majority of cases. Poor quality of chulhas results in developing cracks and release of smoke. In about one-fourth of the total chulhas, cracks were formed as a result of poor quality. More than three-fourth chulhas were found abandoned by the beneficiaries that are constructed outside the house. The Solar Lantern works efficiently for more than five hours after recharging in one-third of the households. However, frequent occurrence of battery complaints is also reported by more than one-third of the household beneficiaries. Complaints related to SWH are relatively few when compared to other equipments. ETC type solar water heater is found to be more acceptable than FPC type. The solar water heater of capacity more than 100 LPD is not generally preferred as it is more costly than 100 LPD. The long time duration for getting sanction and installation of on-grid power plants also makes the beneficiaries to choose off-grid over on-grid power plant. As the solar power plant of higher capacity costs higher, the public is not going for such plants. Except a few households, it is informed that all the home appliances connected are functioning well with solar power. Some people indicated that solar plant causes damage to electrical equipments due to voltage variation, sudden tripping of electric circuit, etc. Due to non-availability of adequate space, one-fourth of the beneficiaries installed solar panel above additional structure constructed for the purpose. In such cases proper maintenance of solar panel is an issue. It was found that most of the beneficiaries are satisfied with the performance of the equipment.

Three-fourth of the household beneficiaries who installed Improved chulha who were more prone to chest related diseases are relieved from chest related diseases like asthma and allergies after replacing traditional chulha with Improved chulha. Majority of the beneficiaries have the opinion that the schemes of ANERT for lighting have helped their children in studies. More than half of the household beneficiaries could save the power bill and the money could be utilised for household needs. In more than three-fourth of

households who installed rooftop solar systems, beneficiaries could earn a monthly savings of more than Rs. 900 per month. It was observed during the study that very few households are engaged in the sales and service of renewable energy equipment.

Directorate of Public Instruction (DPI) has issued an order to use LPG only for the purpose of preparing mid-day meal. Thus community chulhas are not used in about three-fourth (76%) of the schools. In the government institutions, there were no responsible staffs to undertake maintenance of the equipment.

In considerable number of institutions, where deposit, demonstration and consultancy works are installed, uses the solar system only when there is a power failure. In more than three-fourth of the institution, the solar panel is not cleaned since the installation and 66 percent institutions did not refill battery water properly. Most of the installations in government institutions, the solar system were seen in abandoned condition.

It was found while analysing the carbon footprints from solar panels, solar water heating systems and Wind power plants, it was clear that renewable energy has lot of scope for the purpose of energy conservation. During the evaluation of number of installations it was found that in the successive years since 2012 there was an increasing trend in the number of installations as well as the number of programmes implemented by ANERT. Moreover, it was estimated that 9880.36 tonnes of carbon credits could be earned from solar panel programmes, solar water heating systems, and windmills which could be traded and the revenue which could be generated will be accounted as 1,96,06589.24 INR from 2012-2017.

Recommendations

Based on the discussions with beneficiaries, ANERT officials, ERRC and other stake holders the following recommendations are made.

- Awareness- It is worthwhile to initiate continual promotional activities to increase awareness among potential customers. The study found that more awareness activities in the tribal and coastal areas are essential to popularise the schemes. Spreading awareness through Self Help Groups can help in increased awareness of renewable energy equipment among women. Creating awareness through schools and colleges will help more young people to install renewable energy equipments in future. Using social media as a platform to popularise schemes of ANERT will have a positive result among young people. The benefits of renewable energy should be made aware to the public which in turn helps in installing more number of equipments. Making public aware on various incentive schemes for renewable energy equipment will result in more number of installations of the equipment. The awareness of the customers should be in the perspective of Buying as well as in usage. Conduct Workshop for promotion of renewable sources of energy can be considered.

- There is a need for a regular monitoring by the agency members and officials of ANERT for ensuring proper quality and performance of the equipment.
- Linkage of ANERT with bank to get loan for Renewable Energy Equipment will be useful.
- Proper training to the beneficiaries on the usage of renewable energy equipments must be ensured. There is need to develop mechanisms to ensure quality of equipment and servicing.
- Setting up of a healthy Consortium of ANERT, Agency and KSEB will aid in more installation of On-grid rooftop solar power plants. The maintenance of the equipment in Government office has to be ensured.
- Grading of agencies may be implemented on a regular basis according to quality of equipments supplied and the after sales services provided by the agencies.
- Making the solar panels and other devices such as the inverters branded and BIS certifications will enhance the promotions. It will aid in reduction in service related problems and problems related to genuinely.
- Enabling Eco system needs to be created.
- Initiative like 'Buy My Sun' an E- Governance platform by ANERT for buying solar panels, SWHS and Biogas plants towards transparent and easy buying platform without much government procedures is appreciable and should be promoted.
- Authorized installer for solar panels should be encouraged in order to avoid possible accidents during the time of installation.
- Geo-tagging inspection shall be incorporated in order to ensure that the inspection is done in the proper place.
- Innovative schemes could be promoted by integrating different agencies and departments for giving training as well as for developing innovative products powered by renewable energy sources.
- Selection of ANERT head should be based on his/her expertise in the sector and a person with vision about the renewable energy sources and is capable to promote innovative ideas for the sustainability of ANERT integrating various other Departments/Agencies.
- Frequent changing of officials should be minimized since this technology is still not in a mature stage and needs continual training. Recruitment of competent engineers in ANERT should be done to ensure smooth functioning of ANERT. There shall a recruitment policy developed for ANERT for hiring qualified personnel.
- E-Office and Paperless communication shall be encouraged in order to avoid the tedious government procedures and create a positive image about ANERT.

- Annual Maintenance Contract (AMC) shall be maintained for solar lanterns with the service providers.
- ANERT shall make proposals to the government to promote green energy in schools and other institutions.
- ANERT can form programmes taking into considerations the socio-economic conditions, resource potential and institutional arrangements. Context specific local solutions must adapt to maximize outcomes. One template for all will not be suitable to all conditions.
- Capacity Building Training and Technology related training should be given for the employees of ANERT. The discussion with ANERT officially clearly suggests that availability of appropriately skilled workforce is essential for an effective delivery of renewable energy projects in the state. The skill set shall be beyond technical aspects and should include regulatory, policy formulation, business development, finance-related skills at various levels project implementation and project management capacity.
- Eco-system for renewable energy solutions: In order to ensure sustainability of renewable energy solutions in the long-term, an entire system has to be developed and properly supported. A local eco-system has to be developed for renewable energy activities, including local service, an ancillary after-sales service system, a pool of trained technicians, and demand creating services.
- The incentive element of the 10000 rooftop solar programme of the ANERT may be reinstated.
- The study suggests that renewable energy shall be included in the rural and urban development programmes of the state.

Road Map for Implementation

In addition to the recommendations made above, following suggestions are made for effective implementation.

- Human resource capacity in ANERT shall be assessed for efficient functioning on the basis of work-study.
- District level offices shall be strengthened.
- Local self government institutions may be made an active partner in implementation of schemes of ANERT.
- The present practice of giving subsidy immediately after installation leads to complaints from the beneficiaries regarding the service received during the warranty period. The eligible subsidy component for the implementing agency shall be disbursed in installments covering the period of warranty.

- The existing beneficiaries of off grid solar equipment may be given preference for switching over to grid connected solar system if they are interested.
- Large installations need to be maintained by adhering to the maintenance schedule.
- ANERT shall prepare a vision document on the switching over to renewable energy sources in the state by 2025.

ANNEXURE 1

STATE PLANNING BOARD, KERALA

CENTRE FOR MANAGEMENT DEVELOPMENT

EVALUATION STUDY ON VARIOUS RENEWABLE ENERGY PROGRAMMES IMPLEMENTED BY ANERT

SCHEDULE FOR COLLECTING INFORMATION FROM INDIVIDUAL HOUSEHOLD BENEFICIARIES

PROFILE OF THE BENEFICIARY

Name of the beneficiary	

Address with Telephone number	

Name of the respondent and relation with the beneficiary	

Location (Tick mark)	Rural	Urban	Rural Tribal Area	Urban Tribal Area	Rural Coastal Area	Urban Coastal Area

Household Details

1. Category (Use tick mark):

SC	ST	OBC	OEC	GENERAL	OTHERS

   i) If others, Specify: _____

2. Colour of ration card: Yellow ☐ Rose ☐ Blue ☐ White ☐

3. Type of house: (use tick mark)

Kutcha	Semi pucca	Pucca

4. Is the house electrified: Yes ☐ No ☐

5. Details of Family Members

Adult Male (Age 18 and above)	**Adult Female**	**Children Male (Age below 18)**	**Children Female**

6. Sources of Household Income

Sl. No:	Family Members	Age	Education	Occupation	Annual Income(Rs)
1	**Beneficiary**				
2	**Spouse**				
3	**Children**				
4	**Other dependants**				
				Total Annual Family Income (Rs.)	

****

7. Number of Schemes availed by the beneficiary:_____

   i) Specify:_____

8. Why did you choose to use the Renewable Energy Equipment: _____

9. Do you know the difference between renewable and non-renewable energy:

   Yes ☐ NO ☐

   i) If yes , How: _____

10. Factors influencing your choice for a Renewable Energy System:

    Initial cost ☐ Find a trustworthy agency ☐ Choosing the suitable technology ☐

    Good return on investment ☐ Impact on environment ☐ Others ☐

    i) If others, Specify: _____

11. Source of finance for installing Renewable Energy System:

    Own fund ☐ Loan ☐ Others ☐

    i) If others, Specify: _____

SCHEME PARTICULARS

12. Details of Benefit Availed by the Beneficiary

Type of Renewable Energy Equipment	Availed (Y/N)	Nos.	State/MNRE Scheme	Functioning Y/N	If no, reason?

13. Source of Information about Scheme

Source	Yes/No
LSG's	
Newspaper (News given by ANERT)	
Cooperative Society/SHG	
Local Politicians (members)	
Agency	
Other (Specify)	

Process Involved in Availing the Benefit

14. Date/Month and year of getting the renewable energy equipment: _____/ can't remember

15. Did you submit an application to avail the benefit? Yes ☐ No ☐

i) If Yes, application was submitted to (Put Tick Mark)

ANERT office Directly	
LSG's	
Ward Member	
Agency	
Other (Specify)	

ii) If No, How did you get the scheme benefit? _____

16. Time Duration for sanctioning the benefit

Renewable Energy Equipment	Time Taken for Sanctioning (Days)	Time Taken for Installation /Availing after sanctioning (days)

17. Did you get the subsidy for the renewable equipment purchased: Yes ☐ No ☐

i) If no, Why: _____

18. Installation of Equipment, Performance and after Sales Service

Renewable Energy Equipment	Name of Supplier	Did they Install the Equipment in Time (Yes/No)	Are You Satisfied with the Performance of the Equipment (Yes/No)	Do You Get Prompt After Sales Service (Yes/No)	Within How Many Days You Get the Service from the Agency

19. Details of Amount Paid:

Renewable Energy Equipment	Actual Amount	Amount Paid by Beneficiary (Rs.)	Subsidy Amount (Rs.)	Awareness of beneficiary about Subsidy amount

20. Initially did you pay the full amount (Actual Amount): Yes ☐ No ☐

i) If Yes, How many days it took to get the subsidy amount? _____

ii) Subsidy received through : Bank Account ☐ Cheque ☐ Others ☐

a) If others, Specify: _____

21. Are you in receipt of any other subsidy: YES ☐ NO ☐

i) If yes, Specify: _____

Fuels Used

22. Any bio fuels/electrically operated vehicle is owned: Yes ☐ No ☐

23. Details of vehicles owned by the beneficiary

Type of Vehicle	Number	Fuel Used

24. Type of fuels used for cooking

Type of Fuel for Cooking/Equipment	Yes/No	Monthly Consumption (Quantity)		Expense per Month (Rs.)	
		Before Scheme	After Scheme	Before Scheme	After Scheme
LPG					
Kerosene					
Fire wood					
Electric appliance					
Coal					
Total					

(In case the beneficiary has not purchased any equipment for cooking, the columns "after scheme" to be marked as "not applicable")

****

DETAILS OF SCHEME PARTICULARS

SOLAR LANTERN	HOME LIGHTING SYSTEM	SOLAR WATER HEATER	ROOFTOP SOLAR

CHULHA	BIOGAS	LED STREET LIGHT

DEPOSIT WORK	DEMONSTRATION WORK	CONSULTANCY WORK

Biogas

25. Biogas Type: Fixed ☐ Portable ☐

i) If Fixed, Model of Biogas Plant: Deenbandhu ☐ KVIC ☐ Janatha ☐ Others ☐

ii) If others, Specify: _____

26. Size of Biogas Plant (m^3):_____

27. Whether the Biogas Plant is connected with toilet: YES ☐ NO ☐

28. Incidence of mosquito/flies induced diseases before and after biogas plant installation:_____

29. Whether the gas pipeline is sagged: YES ☐ NO ☐

Chulha

30. Type of Chulha: Ordinary ☐ Cement ☐ Steel ☐ Others ☐

i) If others, Specify: _____

31. Model: 1+1 ☐ 2+1 ☐ Others ☐

i) If others, Specify: _____

32. Whether Air hole is present: YES ☐ NO ☐

33. Lighting/Solar Water Heater

Type of Lighting	**Yes/No**	**Numbers**	**Power Consumption (units)**		**Electricity Expense per month (Rs.)**	
			Before scheme	**After Scheme**	**Before scheme**	**After Scheme**
Solar Lantern						
Rooftop Solar						
Solar Water Heater						
H.L.S						
Total						

i) In case the beneficiary has not purchased the items, the actual power consumption and electricity expense per month may be collected

Actual power consumption: _____Electricity expense per month: _____

Solar Lantern

34. Type of solar lantern: LED ☐ CFL ☐

35. Duration of fully charged lantern: _____

Home Lighting System

36. Components in Home lighting system: _____

Solar Water Heater

37. Type of Solar Water Heater: ETC ☐ FPC ☐

i) If ETC, whether it is copper tube ☐ glass tube ☐

ii) Capacity: _____

iii) Whether the Pipe line is insulated : Yes ☐ No ☐

a) If no, why: _____

iv) Duration of getting hot water: _____

Roof Top Solar Panel

38. Is your solar panel is Grid Connected: Yes ☐ No ☐

i) If yes do you sell power? Yes ☐ No ☐

a) If yes, the unit of power sold per month: _____ units

b) Specify the monthly saving accrued by sale of power (beneficiary may specify either as units of power or in money terms): units/ Rs. Per month: _____

39. Do you refill water in battery at the appropriate time: YES ☐ NO ☐ NA ☐

i) If no, why: _____'

40. Capacity of the solar power plant :_____

41. Are you aware of the Generation based Incentive offered to off grid solar energy system

Yes ☐ No ☐

i) Are you a beneficiary of the scheme: Yes ☐ No ☐

a) If yes, total amount received as incentive: _____

42 Have you experienced any problems to the home appliances after the installation of the solar power plant?

Yes ☐ No ☐

i) If yes, Specify: _____

43. How often the solar panel is cleaned: Daily ☐ Weekly ☐ Monthly ☐ Others ☐

i) If others, Specify: _____

44. Material used for cleaning the solar panel: _____

45. Whether the solar panel is installed at an accessible place: YES ☐ NO ☐

****

46. Give your opinion on

a. Performance of the renewable energy equipment :

Very good	Good	Average	Poor	Very poor

ii) Service provided by the supplier (At the time of installation and after sales service):

Very good	Good	Average	Poor	Very poor

47. Additional expenditure, if any, incurred: Below 5000 ☐ 5000-10,000 ☐

Above 10,000 ☐ No additional expenditure ☐

48. Have you been properly trained by the agency to handle the renewable energy equipment:

YES ☐ NO ☐

49. Would you prefer for a more costly Eco-friendly supplier if available:

YES ☐ NO ☐

50. Have the authorities of ANERT monitored the installation process: YES ☐ NO ☐ NA ☐

51. Impact of the Scheme on Health, Studies, Productivity, Livelihood

Criteria	Yes/No/Not Applicable. (Any other points)
After replacing the cooking fuel with renewable source, do you feel any relief from chest related diseases	
Do you feel any relief from diseases other than chest diseases	
Does the lighting helpful in studies of children	
Does the savings through the renewable sources can be utilised for other household needs	
Is any of the household member is engaged in sales and service of renewable energy equipment?	

52. Monthly savings from the scheme: _____

53. Constraints faced (if any) in each stage of availing the benefit and during the usage of the equipment

54. Your suggestions to improve the implementation of the scheme.

ANNEXURE 2

STATE PLANNING BOARD, KERALA

CENTRE FOR MANAGEMENT DEVELOPMENT

EVALUATION STUDY ON VARIOUS RENEWABLE ENERGY PROGRAMMES IMPLEMENTED BY ANERT

SCHEDULE FOR COLLECTING INFORMATION FROM INSTITUTION/INDUSTRIAL BENEFICIARIES

INDUSTRY	INSTITUTION

Profile of the Beneficiary

Name of the Institution/Industry	
Address with Telephone number	
Name of the respondent and designation	

Industrial Details

1. Type of industry: Small manufacturing unit ☐ Medium manufacturing unit ☐

Large manufacturing unit ☐ Cooperative ☐ Others ☐

i) If others, Specify: _____

Institutional Details

2. Type of Institution: Government Institutions ☐ Private institutions ☐

NGO ☐ Others ☐

i) If others, Specify: _____

Location (Tick mark)	Rural	Urban	Rural Tribal Area	Urban Tribal Area	Rural Coastal Area	Urban Coastal Area

3. How many people are employed in your organisation?

Less than 20 ☐ 20-100 ☐ 101-500 ☐ More than 500 ☐

4. Turnover of the previous year: _____

5. National Industrial Classification (NIC) code:_____

****

6. Number of schemes availed by the beneficiary:_____

   i) Specify:_____

7. Who manages the Renewable Energy Equipment: _____

8. Why did you choose to use the Renewable Energy Equipment: _____

9. What is the use of the obtained energy?

   Heating ☐ Cooling ☐ Electricity ☐ Transport ☐ Others ☐

   i) If others, specify:_____

10. Do you know the difference between renewable and non-renewable energy:

    Yes ☐ NO ☐

    i) If yes, how: _____

11. Factors influencing your choice for a Renewable Energy System:

    Initial cost ☐ Find a trustworthy agency ☐ Choosing the suitable technology ☐

    Good return on investment ☐ Impact on environment ☐ Others ☐

    i) If others, Specify: _____

12. Source of finance for installing Renewable Energy System:

    Own fund ☐ Loan ☐ Others ☐

    i) If others, Specify: _____

SCHEME PARTICULARS

13. Details of Benefits Availed by the Industry

Type of Renewable Energy Equipment	Availed (Y/N)	Nos	State/MNRE Scheme	Functioning Y/N

14. Source of Information About scheme

Source	Yes/No
LSG's	
Newspaper (News given by ANERT)	
Cooperative Society/SHG	
Local Politicians (members)	
Other (Specify)	

Process Involved in Availing the Benefit

15. Date/Month and year of getting the renewable energy equipment: _____/ can't remember

16. Did you submit an application to avail the benefit? Yes ☐ No ☐

i) If Yes, application was submitted to (Put Tick Mark)

ANERT office Directly	
LSG's	
Ward Member	
Agency	
Other (Specify)	

ii) If No, How did you get the scheme benefit? _____

17. Time duration for Sanctioning the Benefit

Renewable Energy Equipment	Time taken for Sanctioning (Days)	Time taken for Installation after Sanctioning (days)

18. Did you get the subsidy for the renewable equipment purchased: Yes ☐ No ☐

i) If no, Why: _____

19. Installation of Equipment, Performance and After Sales Service

Renewable Energy Equipment	Name of Supplier	Did they Install the Equipment in Time (Yes/No)	Are You Satisfied with the Performance of the Equipment (Yes/No)	Do You Get Prompt After Sales Service (Yes/No)	Within How Many Days You Get the Service from the Agency

20. Details of Amount Paid

Renewable Energy Equipment	Actual Amount	Amount paid by Beneficiary (Rs.)	Subsidy Amount (Rs.)	Awareness of Beneficiary about Subsidy Amount

21. Initially did you pay the full amount (Actual Amount): Yes ☐ No ☐

    i) If Yes, How many days it took to get the subsidy amount? _____

    ii) Subsidy received through : Bank Account ☐ Cheque ☐ Others ☐

        a) If others, Specify: _____

22. Are you in receipt of any other subsidy: YES ☐ NO ☐

    i) If yes, Specify: _____

Fuels Used by the Industry

23. Any bio fuels/electrically operated vehicle is owned: Yes ☐ No ☐

24. Details of Vehicles owned by the Industry

Type of Vehicle	Number	Fuel Used

25. Type of fuels used for processing/manufacturing (Put Tick Mark)

Type of Fuel for Processing/ Manufacturing	Yes/No	Monthly Consumption (Quantity)		Expense per month (Rs.)	
		Before Scheme	After Scheme	Before scheme	After Scheme
LPG					
Kerosene					
Fire wood					
Coal					
Furnace oil					
Electric appliance					
Total					

(In case the industry has not purchased any equipment for processing/manufacturing, the columns "after scheme" to be marked as "not applicable")

DETAILS OF SCHEME PARTICULARS

SOLAR LANTERN	HOME LIGHTING SYSTEM	SOLAR WATER HEATER	ROOFTOP SOLAR

CHULHA	BIOGAS	LED STREET LIGHT

DEPOSIT WORK	DEMONSTRATION WORK	CONSULTANCY WORK

Biogas

26. Biogas Type: Fixed ☐ Portable ☐

    i) If Fixed, Model of Biogas Plant: Deenbandhu ☐ KVIC ☐ Janatha ☐

    Others ☐

    ii) If others, Specify: _____

27. Size of Biogas Plant (m^3):_____

28. Whether the Biogas Plant is connected with toilet: YES ☐ NO ☐

29. Whether the gas pipeline is sagged: YES ☐ NO ☐

Chulha

30. Type of Chulha: Ordinary ☐ Cement ☐ Steel ☐ Others ☐

    i) If others, Specify: _____

31. Model: 1+1 ☐ 2+1 ☐ Others ☐

    i) If others, Specify: _____

32. Whether Air hole is present: YES ☐ NO ☐

33. Lighting/ Solar Water Heater

Type of Lighting	Yes/No	Numbers	Power Consumption (units)		Electricity Expense per month (Rs.)	
			Before scheme	After Scheme	Before scheme	After Scheme
Solar Lantern						
Rooftop Solar						
Solar Water Heater						
H.L.S						
Total						

(In case the industry has not purchased the items, the actual power consumption and electricity expense per month may be collected)

*Actual power consumption:*_____ *Electricity expense per month:*_____

Solar Lantern

34. Type of solar lantern: LED ☐ CFL ☐

35. Duration of fully charged lantern: _____

Home Lighting System

36. Components in Home lighting system: _____

Solar Water Heater

37. Type of Solar Water Heater: ETC ☐ FPC ☐

    i) If ETC, whether it is copper tube ☐ glass tube ☐

    ii) Capacity: _____

38. Whether the Pipe line is insulated : Yes ☐ No ☐

    a) If no, why: _____

39. Duration of getting hot water: _____

40. In case of industry, the savings of other fuel used for steam generation/boiling water

    i) Monthly saving in the quantity of other fuel: _____kg/Ltr
    ii) Monthly amount saved: Rs. _____

LED Street Light

41. Total number of street light installed:_____

42. Number of locations:_____

43. Is it working efficiently: : Yes ☐ No ☐

    i) If no, why:_____

44. Number of working street lights:_____

i) Reason for not working, if any:_____

45. Any instances of missing of battery: Yes ☐ No ☐

    i) If yes, numbers:_____

46. Energy saving per month:_____

47. Locations in which the street lights are installed:

    Public places ☐ Habitations ☐ Institutions ☐ Others ☐

    i) If others, specify:_____

Roof Top Solar Panel

48. Is your solar panel is Grid Connected: Yes ☐ No ☐

    i) If yes do you sell power? Yes ☐ No ☐

    a) If yes, the unit of power sold per month: _____ units

    b) Specify the monthly saving accrued by sale of power (beneficiary may specify either as units of power or in money terms): units/ Rs. Per month: _____

49. Capacity of the Solar power plant:_____

50. Do you refill water in battery at the appropriate time: YES ☐ NO ☐ NA ☐

    i) If no, why: _____'

51. Are you aware of the Generation Based Incentive offered to off grid solar energy system

    YES ☐ NO ☐

    i) Are you a beneficiary of the scheme: Yes ☐ No ☐

    a) If yes, total amount received as incentive: _____

52. Have you experienced any problems to the home appliances after the installation of the solar power plant?

    YES ☐ NO ☐ NA ☐

    i) If yes, Specify: _____

53. How often the solar panel is cleaned: Daily ☐ Weekly ☐ Monthly ☐ Others ☐

    i) If others, Specify: _____

54. Material used for cleaning the solar panel: _____

55. Whether the solar panel is installed at an accessible place: Yes ☐ NO ☐

****

56. Give your opinion on

    i) Performance of the renewable energy equipment :

Very good	Good	Average	Poor	Very poor

    ii) Service provided by the supplier (At the time of installation and after sales service):

Very good	Good	Average	Poor	Very poor

57. Additional expenditure, if any, incurred: Below Rs. 5000 ☐ Rs. 5000- Rs.10,000 ☐

    Above Rs.10,000 ☐ No additional expenditure ☐

58. Have you been properly trained by the agency to handle the renewable energy equipment:

    YES ☐ NO ☐

59. Would you prefer for a more costly and Eco-friendly supplier if available:

    YES ☐ NO ☐

60. Have the authorities of ANERT monitored the installation process: YES ☐ NO ☐ NA ☐

Pollution

61. After installing renewable energy equipment, the status of emission from the factory (Tick Mark)

Reduced	Remains Same

(*Obtain a copy of certificate issued by the pollution control board before and after the scheme*)

62. Total energy saving per month:_____

63. Monthly savings from the scheme: _____

64. Constraints faced (if any) in each stage of availing the benefit and during the usage of the equipment

65. Your suggestions to improve the implementation of the scheme

ANNEXURE 3

Contribution to Carbon Credit

The development of a carbon project that provides a reduction in Greenhouse Gas emissions is a way by which participating entities may generate tradable carbon credits. Carbon credits (CC) are a tradable permit scheme. A credit gives the owner the right to emit one ton of carbon dioxide. International treaties such as the Kyoto Protocol set quotas on the amount of greenhouse gases which a country can produce. Countries, in turn, set quotas on the emissions of businesses. Businesses that are over their quotas must buy carbon credits for their excess emissions, while businesses that are below their quota can sell their remaining credits. The sale and purchase of credits empowers a business for which reduction of emissions would be expensive or prohibitive to pay another business to continue operations.

Carbon Credit Trading (Emission Trading) is an administrative approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. There are currently two exchanges for carbon credits: (i) the Chicago Climate Exchange and (ii) the European Climate Exchange(ECE) currently offers derivatives contracts on four types of carbon units: EU Allowances (EUAs), EU Aviation Allowances (EUAAs), Certified Emission Reductions (CERs) and Emissions Reductions Units (ERUs)[7].

The amount of CC earned is obviously associated with the amount of solar electricity produced, which usually depends on climatic conditions of the area and also the efficiency of the cells along with other prevailing conditions. Hence, there are large variations on the extent of solar energy production using Photo Voltaic (PV) cells and, consequently, on the CC earned as well as on the contribution of CO_2 emission.

India, being a developing country, is exempted from the requirement of adherence to the Protocol. However, it can sell the Carbon Credits to the developed countries. Companies investing in windmills, Bio-Diesel, Co-Generation, Bio-Gas are the ones that will generate Carbon Credits for selling to the developed nations.

The Estimation of Carbon Credits Earned while Generating Electric Power through Solar Panels

The calculation of carbon credits is done here in accordance with the different schemes of ANERT which are:

1. 10,000 Rooftop programme with (1 KW each)
2. Deposit work scheme for off-grid solar power plants
3. Deposit work scheme for on-grid solar power plants
4. Consultancy work for off- grid solar power plants

5. Solar connect Distributed generation through solar grid connected power plant programme
6. Solar smart programme

Some assumptions are made such as efficiency of the solar panels will be 13%, average life span of solar panels as 25 years, Average solar radiation in Kerala as 5.13 KWh/m^2/day and 300 clear days in a year. The amount of carbon dioxide released into the atmosphere while generating 1 MWh of energy by thermal power plants fired with coal is approximated as 0.932 tonnes. Carbon credits can be traded as 27.5 US dollar/tonne.

Power Output = Efficiency × rate of solar intensity
= 0.13×5.13×1 KWh/day
=0.6669 KWh/day
Assuming 300 clear days = 0.6669×300 KWh/year = 200.07 KWh/year
During 25 years, power output = 200.07×25 = 5001.75 KWh = 5.001 MWh
Carbon credits earned in 1 year = 0.2×0.932=0.1864 tonnes
If this is traded = 0.1864×27.5 = 5.126 USD in INR 5.126×72.03 = 369.225

Carbon Credits estimation of Demonstration scheme of Solar power plants in 2012-2013 is presented in table 1.

Table 1

Carbon Credits Estimation of Demonstration Scheme of Solar Power Plants in 2012-2013

Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
73.359	22.0077	20.5111764	40702.3784

Carbon credits estimation of 10,000 Rooftop Programme (1 KW each) in 2013-2014 is presented table 2.

Table 2

Carbon Credits Estimation of 10,000 Rooftop Programme in 2013-2014

Number of solar roof top installations	Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
1871	1247.77	374.33097	348.8765	692310.5

Carbon credits estimation for Deposit Work Scheme for off-grid solar power plants in 2013-2014 is presented in table 3.

Table 3
Carbon Credits Estimation for Deposit Work Scheme for Off-grid Solar Power Plants 2013-2014

Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
45.3492	13.60476	12.67964	25161.47

Carbon credits estimation for Consultancy work for off-grid solar power plants in 2014-2015 is presented in table 4.

Table 4
Carbon Credits Estimation for Consultancy Work for Off-grid Solar Power Plants in 2014-2015

Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
2.0007	0.60021	0.559396	1110.065

Carbon credits estimation for 10000 Roof top Programme (1 KW each) in 2015-2016 is presented in table 5.

Table 5
Carbon Credits Estimation for 10,000 Rooftop Programme in 2015-2016

Number of solar roof top installations	Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
3163	2109.405	632.82141	589.7896	1170378.39

Carbon credits estimation for Deposit work scheme for off-grid solar power plants in 2015-2016 is presented in table 6.

Table 6
Carbon Credits Estimation for Deposit Work Scheme for Off-grid Solar Power Plants in 2015-2016

Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
68.0238	20.40714	19.01945	37742.2055

Carbon credits estimation for Deposit work scheme for on-grid solar power plants in 2015-2016 is presented in table 7.

Table 7
Carbon Credits Estimation for Deposit Work Scheme for On-grid Solar Power Plants in 2015-2016

Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
66.69	20.007	18.64652	37002.1622

Carbon credits estimation for Consultancy work for off-grid solar power plants in 2015-2016 presented in table 8.

Table 8
Carbon Credits Estimation for Consultancy Work for Off-grid Solar Power Plants in 2015-2016

Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
4.6683	1.40049	1.305257	2590.15136

Carbon credits estimation for 10,000 Roof top Programme (1 KW each) in 2016-2017 is presented in table 9.

Table 9

Carbon Credits Estimation for 10,000 Rooftop Programme in 2016-2017

Number of solar roof top installations	Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
2877	1918.671	575.60139	536.4605	1064552

Carbon credits estimation for 'Solar Connect' Distributed Generation through Solar Grid connected power plant programme is presented in table 10.

Table 10

Carbon Credits Estimation for 'Solar Connect'

Power output in KWh/day	power output in 1 year in MWh/year	carbon credits earned in tonnes	Revenue which can be earned by trading in INR
1107.054	332.1162	309.5323	614235.893

Estimation of carbon credits for 'Solar smart' programme is presented in table 11.

Table 11

Estimation of Carbon Credits for 'Solar Smart'

Power output in KWh/day	Power output in 1 year in MWh/year	Carbon credits earned in tonnes	Revenue which can be earned by trading in INR
962.3367	288.701	269.0693	533941.2

From these analysis it is clear that the total carbon credits earned from all these schemes in tonnes would be 2485.58 and while trading this, a revenue of 49,32,388.05 INR could be earned which is an additional benefit which the state could earn other than the benefits like less pollution and eco-friendly from green energy sources.

The Estimation of Carbon Credits Earned while using Solar Water Heating Systems (SWHS) through ANERT

The heat supplied while using SWHS is calculated by taking into consideration the following assumptions. Maximum achievable temperature is 60°C. Feed water temperature is 26°C. Enthalpy of Outlet water is 259.8 KJ/Kg. Enthalpy of Inlet water is 118.0 KJ/Kg. Here Carbon credits has been calculated in accordance with these perspectives. Considering NG gasket fired Boiler, Efficiency of NG gasket fired boiler is 85%, Emission factor of NG gasket boiler is 56.1 tonne CO_2/TJ [6].

Total heat supplied = (Enthalpy of outlet – Enthalpy of inlet) × Capacity of SWHS

= (259.8-118)×100 = 14180 KJ/Kg

Total heat energy supplied annually = 14180 × 365 = 5175700 KJ

Total heat energy supplied annually in Tera Joules = 0.005175700 TJ

Input energy required by NG gasket boiler = $\frac{\text{Total heat energy supplied annually}}{\text{Efficiency}}$

$= \frac{5175700}{85\%}$ = 6089058.824 KJ

= 0.00608906 TJ

Emission reduction achieved by SWHS

= Input energy required by NG gasket boiler × Emission factor of NG gasket

= 6089058.824 TJ×59.1 tonne CO_2/TJ = 0.3415962 tonne CO_2 annually

= 341.5962 Kg CO_2 annually

Estimation of Carbon Credits for SWHS in 2012-2013 is presented in table 12.

Table 12
Estimation of Carbon Credits for SWHS in 2012-2013

Total number of SWHS	Daily consumption of heated water in kg	Total Heat supplied in KJ	Total heat energy supplied annually in KJ	Total heat energy supplied annually in TJ	Input energy required by NG gasket boiler in KJ	Input energy required by NG gasket boiler in TJ	Emission reduction achieved by SWH in TCO_2	CO_2 footprint in kg	Total carbon credits in tonnes
3696	100	14180	5175700	0.0051757	6089058.824	0.00608906	0.3415962	341.5962	1262.54
773	200	28360	10351400	0.0103514	12178117.65	0.01217812	0.6831924	683.1924	528.1077
20	300	42540	15527100	0.0155271	18267176.47	0.01826718	1.0247886	1024.7886	20.49577
3	400	56720	20702800	0.0207028	24356235.29	0.02435624	1.3663848	1366.3848	4.099154
19	500	70900	25878500	0.0258785	30445294.12	0.03044529	1.707981	1707.981	32.45164

Estimation of Carbon Credits for SWHS in 2013-2014 is presented in table 13.

Table 13

Estimation of Carbon Credits for SWHS in 2013-2014

Total number of SWHS	Daily consumption of heated water in kg	Total Heat supplied in KJ	Total heat energy supplied annually in KJ	Total heat energy supplied annually in TJ	Input energy required by NG gasket boiler in KJ	Input energy required by NG gasket boiler in TJ	Emission reduction achieved by SWH in TCO_2	CO_2 Carbon credits in kg	Total carbon credits in tonnes
1442	100	14180	5175700	0.0051757	6089058.824	0.00608906	0.3415962	341.5962	492.58172
589	200	28360	10351400	0.0103514	12178117.65	0.01217812	0.6831924	683.1924	402.400324

Estimation of carbon credits for SWHS for Deposit work in 2013-2014 is presented in table 14.

Table 14

Estimation of Carbon Credits for SWHS in 2013-2014

Total number of SWHS systems	Daily consumption of heated water in kg	Total Heat supplied in KJ	Total heat energy supplied annually in KJ	Total heat energy supplied annually in TJ	Input energy required by coal boiler in KJ	Input energy required by coal boiler in TJ	Emission reduction achieved by SWH in TCO_2	CO_2 carbon credits in kg	Total carbon credits in tonnes
2	500	70900	25878500	0.0258785	30445294.12	0.03044529	1.707981	1707.981	3.415962

Estimation of carbon credits for SWHS for demonstration work in 2013-2014 is presented in table 15.

Table 15

Estimation of carbon credits for SWHS for demonstration work in 2013-2014

Total number of SWHS systems	Daily consumption of heated water in kg	Total Heat supplied in KJ	Total heat energy supplied annually in KJ	Total heat energy supplied annually in TJ	Input energy required by coal boiler in KJ	Input energy required by coal boiler in TJ	Emission reduction achieved by SWH in TCO_2	CO_2 Carbon Credits in kg	Total carbon credits in tonnes
1	500	70900	25878500	0.0258785	30445294.12	0.03044529	1.707981	1707.981	1.707981

Estimation of Carbon Credits for SWHS in 2014-2015 is presented in table 16.

Table 16

Estimation of Carbon Credits for SWHS in 2014-2015

Total number of SWHS	Daily consumption of heated water in kg	Total Heat supplied in KJ	Total heat energy supplied annually in KJ	Total heat energy supplied annually in TJ	Input energy required by NG gasket boiler in KJ	Input energy required by NG gasket boiler in TJ	Emission reduction achieved by SWH in TCO_2	CO_2 Carbon credits in kg	Total carbon credits in tonnes
1202	100	14180	5175700	0.005176	6089059	0.006089	0.341596	341.5962	410.5986

Estimation of Carbon Credits for SWHS in 2015-2016 is presented in table 17.

Table 17

Estimation of Carbon Credits for SWHS in 2015-2016

Total number of SWHS	Daily consumption of heated water in kg	Total Heat supplied in KJ	Total heat energy supplied annually in KJ	Total heat energy supplied annually in TJ	Input energy required by NG gasket boiler in KJ	Input energy required by NG gasket boiler in TJ	Emission reduction achieved by SWH in TCO_2	CO_2 Carbon credits in kg	Total carbon credits in tonnes
5941	100	14180	5175700	0.0051757	6089059	0.006089	0.341596	341.5962	2029.423

Estimation of Carbon Credits for SWHS in 2016-2017 is presented in table 18.

Table 18

Estimation of Carbon Credits for SWHS in 2016-2017

Total number of SWHS	Daily consumption of heated water in kg	Total Heat supplied in KJ	Total heat energy supplied annually in KJ	Total heat energy supplied annually in TJ	Input energy required by NG gasket boiler in KJ	Input energy required by NG gasket boiler in TJ	Emission reduction achieved by SWH in TCO_2	CO_2 Carbon credits in kg	Total carbon credits in tonnes
6299	100	14180	5175700	0.005176	6089059	0.006089	0.341596	341.5962	2151.714

From these analysis it is clear that 7339.53 tonnes of carbon credits can be earned, and by trading these, a revenue of 1,45,64,574.41 INR could be earned from using SWHS over these years.

Estimation of Carbon Credits while Generating Power through Wind Mills

Wind generated electricity is inherently variable, providing unique challenges to the electricity generating industry for provision of a supply to meet consumer demand. When calculating the time required for a wind farm development to pay back the Carbon emissions associated with its construction, operation and dismantling, it is important that the appropriate level of CO_2 saving be assigned to the electricity generated by wind energy. This depends on the type of energy generation displaced by wind energy. It can be argued that increased energy generation from renewable energy sources in the India represents a displacement of energy produced by coal-fired plants alone.

List of wind mills which were installed and with their capacity is presented in table 19.

Table 19

List of Wind Mills their Capacity

Sl. no.	District	Name of the firm	Capacity of tech machine	Number of machines	Total installed capacity (MW)
1	Palakkad	KSEB	225 KW	9	2.025
2	Palakkad	Suzlon	600 KW (15) 2.1 MW (4)	19	17.4
3	Palakkad	Sarjan Realities	600 KW	16	9.6
4	Idukki	Vestas	750 KW	19	14.25
5	Palakkad	Inox	2 MW	8	16.00

(Source: ANERT)

Total capacity of wind mills is 59.275 MW while calculating the carbon credits associated with this we take into account the amount CO_2 released into the atmosphere while generating 1 MW electric power through thermal plants that is approximated as 0.932 tonnes. So, 59.275 MW corresponds to $59.275 \times 0.932 = 55.2443$ tonnes of CO_2 is being saved.

Revenue which can be earned by trading these carbon credits in rupees will be $55.2443 \times 27.5 \times 72.16 = 109626.78$ INR.

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