# *The socioeconomic effects that are impacting on the development of solar energy in India.*

*By*

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# CHAPTER 1- Background

## 1.1 Introduction

This chapter will give an idea to the reader that what this research is all about. The chapter discusses the background of this research topic and gives an idea about the current energy problems in India. The aim and objectives are also discussed in this chapter with the scope and limitations. A short explanation of methodology is also given alongside structure of the dissertation.

## 1.2 Background

Fundamentally, solar energy is the energy that is reflected by the sun in the form of radiation. Nearly one billionth of total sunlight touched the surface of the earth and it's a major source of life. There is around 420 trillion kWh of sun energy is received by the earth. Solar energy is produced by catching sunlight through solar plates to produce the energy (BussinessDictionary, 2015).

According to the report of the International Energy Agency (IEA) that the demand for energy will increase by 1.5% per year from now and 2030. The developing Asian countries are considered as the drivers of the development. The below figure 1.1 will provide energy consumption at the global level.

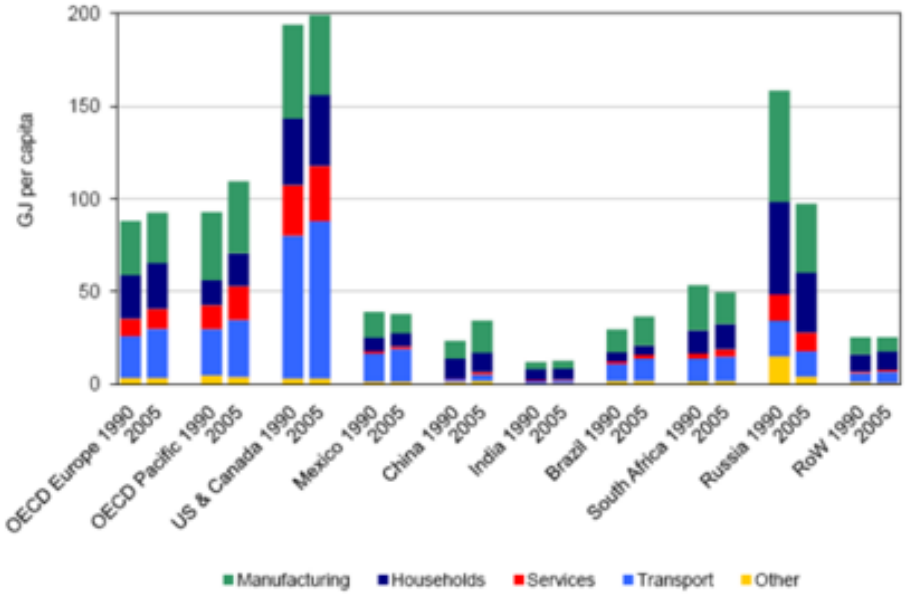


*Figure 1:1 provides the global per capita energy consumption statistics.*

***(Source:** Indian Renewable Energy Status Report, 2010)*

The massive demand of energy is increasing and concerns about the environment and economic consequences call for renewable energy technology in India. India is considered as one of the best recipients of solar energy because of the geographical condition in the solar belt that is 40°S to 40°N. India receives around 250-300 days and has a tremendous potential to produce clean solar energy and it's also the prime source of renewable energy which is available in India. India is a developing country and has a population of 1,21,01,93,422 by the census of India in 2011 (Censusindia, 2015), from this huge number we can easily identify that India needs greater power production to fulfil the requirements of 1.2 billion people but as per the census data of 2001, only 43.5% of Indian rural households have access to electricity. The remote villages are not connected with the electric grid because of the high installation cost of electric lines. In India, there are around 94,000 villages with no electricity and 25,000 villages have no access because of the maintenance. So India needs a great power production to fulfil the requirements of the people and developing the area of renewable energy production could be a great step in fulfilling this amount and can provide electricity to these isolated villages (Reddy and Reddy, 2014).

Many researchers argue that one of the most important factor in the development in solar energy is effective policies and according to Srivastava and Srivastava (2013), Indian government is promoting solar energy by different strategies and government announced the funding of ₹10 billion on Jawaharlal Nehru National Solar Mission to produce clean energy and he also add that government policies are also encouraging private solar companies to invest by reducing customs duty on solar panels by 5 percent and government believes that this reduction on duty is expected to reduce the rooftop solar panel installation by 15-20 percent, while the report of Sreenivas (2014), he suggests India still requires innovative policy formulation, efficient implementation and effective regulation, and this all can happen with a strong, capable and accountable government and but, unfortunately, India's record on governance and accountable institutional mechanisms is weak. This is a serious concern and there are some examples of this matter such as, the Bureau of Energy Efficiency (BEE) currently does not have a full-time head and the second, the Regulatory Board of Petroleum and Natural Gas has just three instead of five (Sreenivas, 2014). Looking at the current political scenario of India it's clear that India still requires more effective and impressive policies to encourage people to adopt this system. By the report of The Times of India (2015), the Ministry of New and Renewable Energy (MNRE) decided to reduce the subsidiary in solar rooftop panels from 30% to 15%. This is a very major decision by MNRE because this deduction in subsidiary can play a vital role in the development of solar energy, now it will cost more to people and creates a doubt that whether they will choose it or not (The Times of India, 2015).

So it's clear that there are many gaps that are barriers in the development of solar energy in India and there is a need to fulfil these gaps so that the vision of Indian Government to make India a global leader in solar energy production can be fulfilled. The purpose of this research is to identify such factors that are affecting the development of solar energy in India.

## 1.3 Statement of problem

India's main source in the production of electricity is coal and country are producing 80% of electricity from coal. India accounts a major 286 billion tonne of coal resources as of March 2011 and country is considered as the fifth largest coal reserves in the world. In the year 2006-07, India's coal production was approximately 431 MT but in the year 2011-12 it increases by 554 MT, this is a massive 28.5% increase and it is assumed that by 2016-17 the coal production can touch the 1000 MT mark.

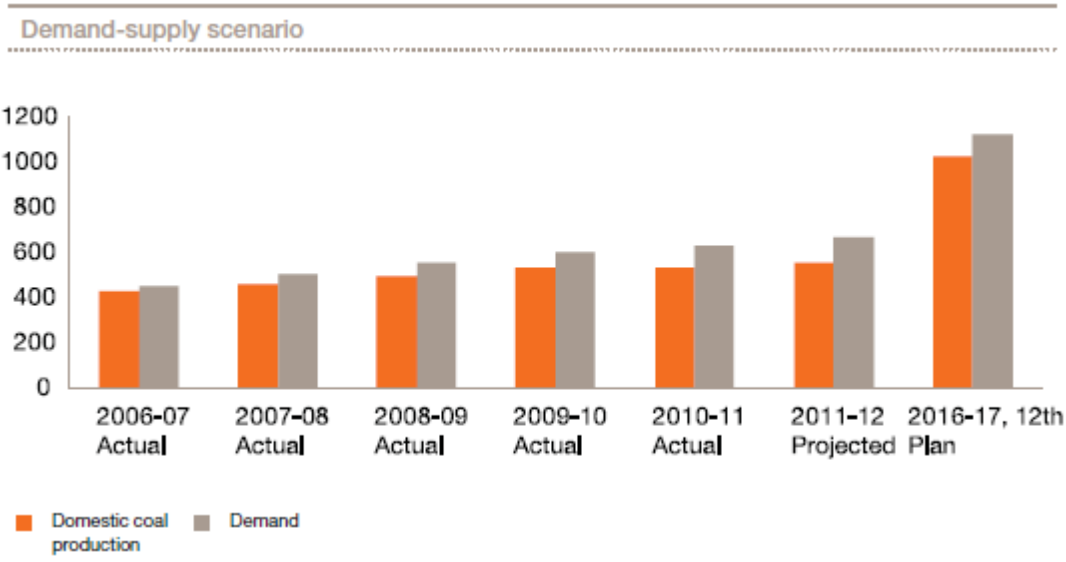


*Figure 1:2 Demand - Supply scenario*

(Source: Indian Renewable Energy Status Report, 2010)

India, with the fifth largest reserves of the coal in the world, but still country still not able to fulfil populations demand and due to this India starts importing more than 200MT of coal by 2012. By Mundhra (2015), recently India's 35 coal power plant were in shock because plant didn't have enough coal to generate electricity and only 7 days of coal stock left due to the following:

- Inadequate import of coal in five power plants.
- Inadequate and delayed receipt from Coal India in 20 power plants
- Running out of planned PLFs.

Looking at all above problems, it's clear that India is in great danger of fulfilling the requirements of the Indian people in the future. So one of the best solutions of this problem can be adopting the renewable sources and solar energy is one of the best options available in India for the production of electricity. Solar energy can fulfil the requirements of Indian people if the country takes right measures in the development of it.

## 1.4 Aim and Objectives

Aim – To investigate the socioeconomic effects that are impacting on the development of solar energy in India.

Objectives

1. To study current Renewable Energy policies in India
2. To find out the Pros and cons of these policies
3. To study the solar policies of other leading countries
4. To find out the barriers in development of solar energy
5. To find out the changes that are required in current policies
6. Future requirements

## 1.5 Scope and Limitations

Electricity is one of the most important things in this modern world. As India is a developing country and needs more power to maintain its development. The current coal generated energy is not beneficial for India because tonnes of coal is imported from foreign countries on higher prices. So that today India needs another energy source that help in fulfilling today's power needs and tomorrow can be India's main power generating source and looking at India's geographical conditions, the best would be solar energy. Many countries are investing heavily in their solar sector, just to make sure that in future they fulfil their people's demand. Indian government announces some amazing project but none of them is considered as successful, so there is a massive need of improvement in the solar sector. There are some limitations

for this research, as the researcher is doing this research from the UK, there are some barriers related to travelling to India. As travelling is very expensive from the UK to India, the researcher will not be able to do the questionnaire survey by himself now this questionnaire will be sent via email. One more problem is that politician/government officials don't have too much time to respond the surveys and this factor could play a vital role in the methodology.

## 1.6 Methodology

There are different types of methodology is available to achieve the aim but the most prominent one for this research is qualitative approach. As part of the qualitative methodology, a semi-structured questionnaire approach has been chosen. Altogether, 44 semi-structured questionnaire were carried out with people who are government official, researchers, construction builders and in agriculture. The questionnaire were carried out and then the questionnaire were analysed using a content analysis approach. Majority of respondents have an experience of 5-10 years.

## 1.7 Structure of the dissertation

This research is allocated into five chapters and the following are the content of these chapters:

Chapter 1 – with Introduction of the dissertation, this chapter will also discuss the aim, objectives and need of the study.

Chapter 2- will discuss the detailed literature review on the subject of solar energy in India. The current electricity needs and current generation, policies, subsidies etc. will be discussed.

Chapter 3 – will discuss in detail study of the methodology adopted for this research.

Chapter 4 – discuss the main findings through the semi-structured questionnaire obtained through the qualitative content analysis.

Chapter 5 – finally this chapter will summarise the research and provide the final conclusions and recommendations.

## 1.8 Summary

The chapter discussed the need of energy in India and how these needs can be fulfilled by the renewable energy. In future, renewable energy will play a vital role in any countries development and if we consider India, the solar energy is the best option that can help India in future. Indian government taking some serious steps in the development of solar energy but still there are some problems that are affecting the development, so a particular aim and objective were decided and the whole research will follow these objective and researcher will try to fulfil these aim and objectives. This research has certain scope and limitations that are discussed in this chapter.

# CHAPTER 2- Literature Review

## 2.1 Introduction:

This chapter discusses the studies or research that has been done by other researchers/scholars. The objective of this literature review is to find out the gaps that are restricting the development of solar energy. The purpose of this literature review is to investigate the factors of socioeconomic that are impacting on the new alternate source of energy that is solar energy in a developing country like India. The researcher will go through a lot of articles, credible journals and other relevant sources to investigate about solar energy in India (Smith et al., 2006). India is developing with a fast speed and energy requirement of such country is greatly increased. There are many socioeconomic factors like people priorities, people income, wealth, age differences etc. All of these factors have a great impact on the development of solar energy (Nayak, 2015). In developing countries all these factors effect greatly because these are the factors which have great value for the people of that area where any change is going occur. These factors and impact of these factors have been discussed a great detail through the eyes of credible sources.

At the end of this literature review, the researcher will go through the study of current renewable energy sources, pros and cons about the policies, policies of solar energy in the developed or leading countries, barriers in the development of renewable energy like solar energy. The Researcher will also study what changes are required in the current policies through journals or articles.

## 2.2 Current demand of energy in India

In 2008, India becomes the second leader in the population with 17.7% of total world population, but India's consumption of energy is fifth in the, accounting only 3.8% of total world consumption. The maximum contribution in the field of electricity is

provided by coal and imported oil and the contribution of renewable energy is less than 1%. The current power generating capability is not sufficient and it's not meeting the required demands, in 2009-10, there was a shortfall in power generation that was close to 10% that is 84 TWh. This energy shortage is affecting Indian economy by 6% of GDP in the year 2007-08. According to Arora et al. (2010), in their report of Indian Renewable Energy mentioned that India needs to double their energy output to over 300 GW by 2017 to fulfil the necessities of the population. (Arora et al., 2010)

## 2.3 Current Renewable Energy and Solar Energy Policies in India

India is a developing country and despite having old tradition India is becoming a country which is growing at very fast speed especially in the field of technology and IT. India is considered to be the world second most populated country after China. The population in the India is increasing at a much higher rate of birth than the rate of death. Soon India will become the world most populated country (Internetworldstats.com, 2015). In 2008, India population is around 17.7% of total world population, but India's consumption of energy is fifth in the world, accounting only 3.8% of total world consumption. The maximum contribution in the field of electricity is provided by coal and imported oil and the contribution of renewable energy is less than 1%. The current power generating capability is not sufficient and it's not meeting the required demands, in 2009-10, there was a shortfall in power generation that was close to 10% that is 84 TWh. This energy shortage is affecting Indian economy by 6% of GDP in the year 2007-08. According to Arora et al. (2010), in their report of Indian Renewable Energy mentioned that India needs to double their energy output to over 300 GW by 2017 to fulfil the necessities of the population (Arora et al., 2010).

To meet the demand and requirement of energy in India a lot of effort is going to take place which include the increase in the use of renewable energy. There are three most used renewable energy resources that are biomass, solar energy and energy through the wind (Lu, Sheng and Wei, 2012). These renewable energies are that energy that

are produced through some natural process and after some time it's replenished in a natural way and it again can be used. There are some more energy resources like the wind, thermal energy. In today's world, the most used renewable energy resource are the solar energy. According to Twidell (2006), there more than 10 renewable energy producing method. All have great impact and they can produce energy in a natural way. (Twidell and Weir, 2006). Twidell said that this energy should be used as early as possible otherwise coal, gas and water will be finished after some decades if it is used in the same proportion.

Out of more than ten renewable energy resources, the most used energy resource are the solar energy system. Solar energy uses sunlight into electricity and solar energy system is rapidly increasing throughout the world. Technology in the solar energy field is changing very rapidly. In old systems, a heavy plate was used to convert sunlight into energy but now due to latest innovation, only a portable sticker is enough to collect sunlight. The Sunlight is used in a lot of ways for the purpose of energy.

Due to a large number of people living below the poverty line, India cannot afford the expensive way of producing energy. People do not want to buy energy at the expensive rate. Due to the population, the per capita income is very low in India and because of this, people cannot afford expensive energy resources. Government have to face many challenges so government also want to spend the low amount in the energy sector. But if the low amount is invested then requirement and demand of energy cannot be met. To see this way the government of India has decided to spend more amount on renewable energy (Po and Subramanian, 2011).

Total consumption of energy in India is met by several ways including, thermal energy (coal), nuclear energy, LNG (Liquefied Natural Gas) and solar energy. India has strong policies to provide energy and electricity to all over the India, but due to poor structure and old machines, the current system is also not capable of providing electricity. The Government is trying to invest in solar energy system so that cheapest electricity can be provided to Indian people (Casten and Smith, 2009).

In India, there are hundreds of villages where people are living. There are currently many areas in India where there is no electricity and people are living without electricity. And the people living in the villages are the main victims of this problem because either they can't afford electricity or these villages are not connected to the grid yet. People of India who are living in the cities can afford the electricity, but due to the high inflation rate, the decrease in the per capita income and unemployment people in the cities are also looking for an alternate way of electricity. The only cheapest way of getting electricity in India is the solar system because of Indian geographical conditions. This system needs only one-time setup cost but this system can become cost effective after installation. After installation, only sunlight is needed to convert the sunlight into electricity. People in the city can afford the initial setup cost because people living in the city has much better per capita income than the people living in the old and too far villages (Solar Cells & Solar Energy Materials, 2005). The government is currently looking for the places where they can install the solar system plants in such a way that people of India can be benefited from such renewable energy source. This requires initial investment and later there is would be a small investment on certain occasions but it will help in India's development. This sources of energy are very environment-friendly and due to its natural process, environmentally friendly people are looking to install the solar system. Solar system supplier are also entering the Indian market to capture the potential customer.

The Indian government has a great plan for the solar system. In 2013 India set up its first solar plant of 5 MW but to expand such renewable energy resources government of India has set up a budget of 100 billion dollars to set up the 100 GW energy only from solar. This is the part of vision 2022 of India. The environment of India is very friendly. There are almost 250 - 300 sunny days and these days have enough energy to meet the whole year energy demand of the whole region. (Conser and Green, 1985)

Due to the recent development policies, the world is considering India as the new developing leader in solar energy sector. Recently announced mission like JNNSM, will make India the leader in solar energy development if the government will take right steps at the right time. India starts giving focus on solar at the start of 2003. People of

India living in cities and people of India living in villages see the same solar energy in a different angle, people of cities can afford the initial setup cost while people of the village cannot afford that (Kaur and Jain, 2011).

According to Indian Renewable Energy Status Report (2010), these are some positive sides of developing the sector of renewable energy.

- More the renewable energy sector grow, the fewer imports of fossil fuels from other countries will be there.
- There is a big competition for fossil fuels in the current market and the prices of these fuels are going higher and higher, as technology is improving day by day and renewable technology is going cheaper, so it's the best time for India to develop its renewable market.
- The renewable energy technologies can suit India perfectly to meet the need of energy in villages and rural towns that are not connected to the grid and road.
- Renewable energy technologies offering the possibility of cheaper electricity services as India has to look its greenhouse gas concerns and goals.

There is a driving investment by government in renewable energy technologies because of India's recent policies and desire to become the world leader in solar energy.

## 2.4 Climate Change

In India, every energy planning take place is the context of climate change. In recent meetings during the international climate negation, India has promised to minimize the greenhouse gas (GHG) amount and also pledged that counties per capita emissions will not go higher than the other developed countries. The government of India implemented on this issue and started a mission named National Action Plan on Climate Change (NAPCC), which make sure that by 2020 India will generate at least 15% of their energy from renewable sources. To make sure that will reach to their identified goals, the government started the mission called Jawaharlal Nehru National Solar Mission (JNNSM). (Emerging Markets, 2015)

But till today, there is no official end for controlling the GHG emissions has been set. The primary method for accomplishing the goal is can be achieved by enhancing fossil fuel energy production via new and improved technologies. For example, supercritical and ultra-supercritical coal plants, enhancing public transport, gasification combined cycle and end-user efficiency can help Indian government in reaching their specified goal. It will take very high start-up investment and much lower return if India wants to move to low-carbon technologies (Country Study India, 2012).

In 2008, India released the NAPCC to promote the development objectives while tending climate change adoption and Indian government launches eight national missions with NAPCC and JNNSM was especially concentrated on solar energy and it's a part to reduce the emissions in future while increasing development opportunities with the whole nation. The other seven national missions were based on the other global issues like water, Himalayan ecosystem, agriculture and climate change (Arora et al., 2010).

## 2.5 Overview of energy sector in India

According to Indiacore, the electricity intensity tumbled from more or less 3.14% in the 1950's but in 2007, it was 0.73% (Indiacore, 2015). The major factor behind this reduction is that Indian growth until now was majorly based on service area and then on the industrial sector (Environment and Energy Sustainability, 2009). In today's time, for every economic development up to 1%, India requires an additional energy of approximately 0.75%. Indian long-term policies which are coordinated by the Planning commission of India, analyses that this additional value could fall to 0.67% during 2021 to 2031 (Integrated Energy Policy – Report of the Expert Committee, 2015).

McKinsey, a Managing Consultancy made a report "Powering India: The road to 2017", the report has a study of goals/objectives of India government and it shows that the goals have been set too low. The study calculated that India is going to need 3015 to 335 GW of energy by 2017 rather than just 213 GW assessed by Central Electricity

Authority (CEA) in 2007. The Figure 2.1 is showing the situation for the development of peak load capacities.

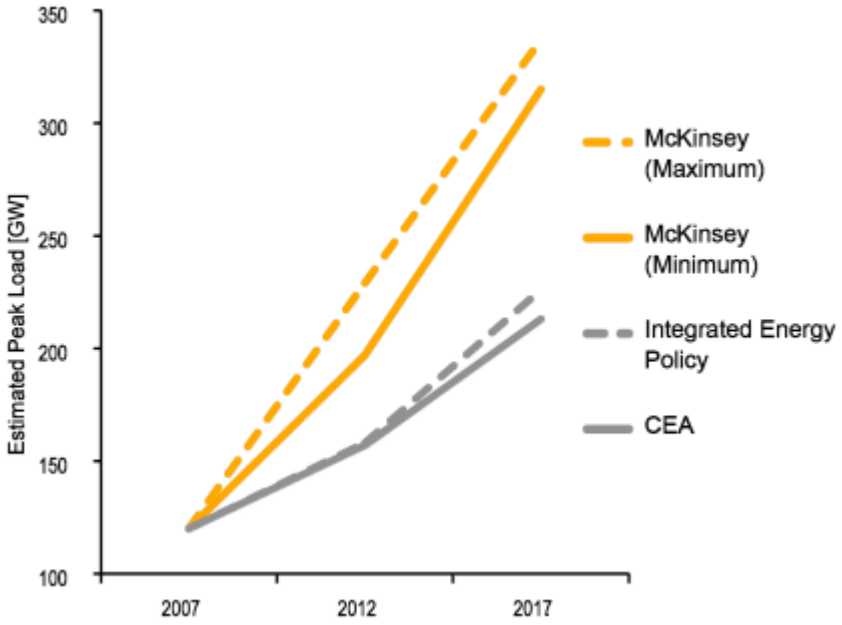


*Figure 2:1 Scenario for the development of necessary peak load capacities*

*(Source: Indian Renewable Energy Status Report, 2010)*

## 2.6 The Energy sector and the Renewable energy in India –

India is a developing country and slowly country has been gaining ground in various infrastructural ranges, for example, developing roads and extension of telecommunication sector but the energy sector is still not getting that pace which is required. India's energy business is defined with significant difficulties seeing the amount and the nature of the power supply. By 2017, the base load capacity should exceed to 400 GW in order to fulfil the requirements and India's current installed capacity by April 2015 is 272.69 GW (CEA, 2015) and in March 2010 it was 159 GW, so in the last 5 years India only installed around 123 GW and to fulfil the country's requirement they need around 125 GW of more capacity in the upcoming 2 years. India's energy market must guarantee a steady and cheap energy so that it attract

more new clients and help the country in different development purposes but with minimizing the emissions. The quality of energy supply must be improved because the country is facing high voltage fluctuations and blackouts for days in every major part of the country. By the "Global Competitiveness Report 2010-2011", among the 139 countries, India ranked 110 in the category of "Quality of Electricity Supply" (Klaus Schwab, 2010).

Recent new and improved policies and long-term goals make local investors confident to investing in the power sector but on the other hand, the foreign investors are still hesitating because of the low energy prices and no steady and beneficial returns. The government is giving cheap or free energy in many parts just as to secure their votes for the future (Lal, 2006).

## 2.7 Power consumption

By the report of World Bank, average power consumption by a person in India is 684 kWh in 2011 (World Bank, 2015). The most power is used by industrial sector followed by households and agriculture. The following figure 2:2, is showing the different sectors with their power/electricity consumption.

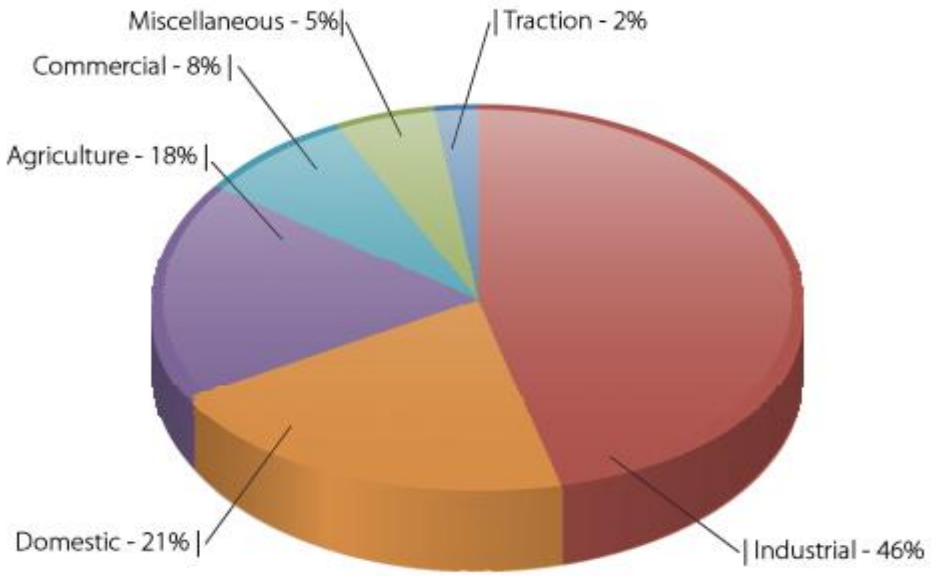


*Figure 2:2India electricity consumption sector-wise*

*(Source: Indian Renewable Energy Status Report, 2010)*

The utilization of energy is expanded around seven times since 1980 to 2009 from 85,334 GWh to 5966,943 GWh, this shows a yearly development rate of almost 7%. The most increment in demand of energy came from private households, which expanded around 14 times since 1980 (Arora et al., 2010).

## 2.8 Capacity of Power Generation

India's current installed capacity by April 2015 is 272.69 GW (CEA, 2015). From this total installed capacity, fossil fuels power plants have a contribution of 64.3% which includes coal diesel and gas, 2.9% nuclear power, 9.7% renewable energy and 23.1% hydro-power.

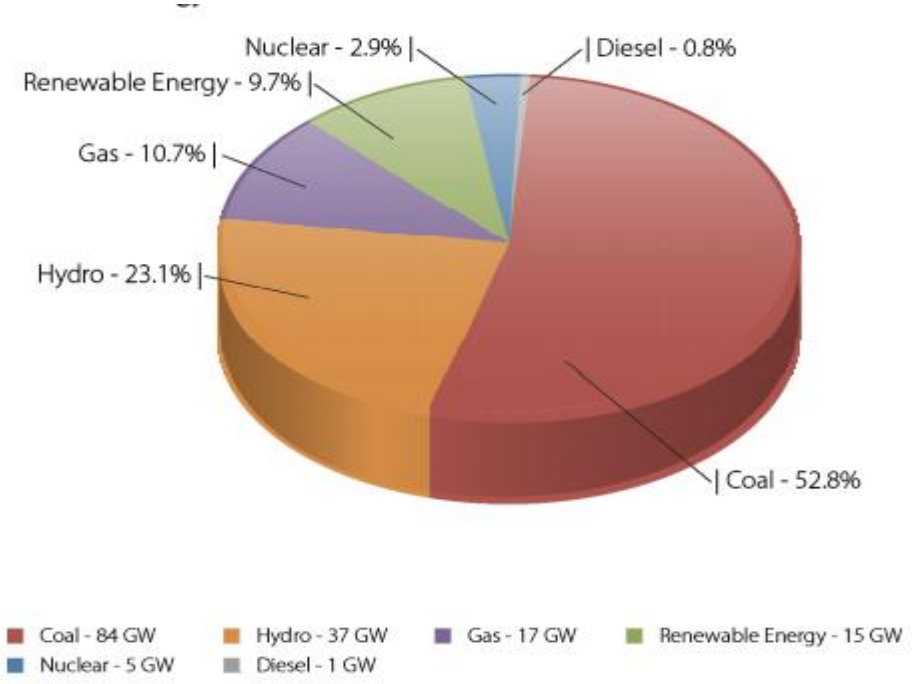


*Figure 2:3Installed capacities for power generation in India according to energy sources*

*(Source: Indian Renewable Energy Status Report, 2010)*

The central government controlled around 32% of total energy generation, which was 12% during 1980's. But the energy generation controlled by states tumbled from 83% to 50%. Now the private energy generation controlled around 18% from 5%. These new private energy owners are investing more in renewable energy sector.

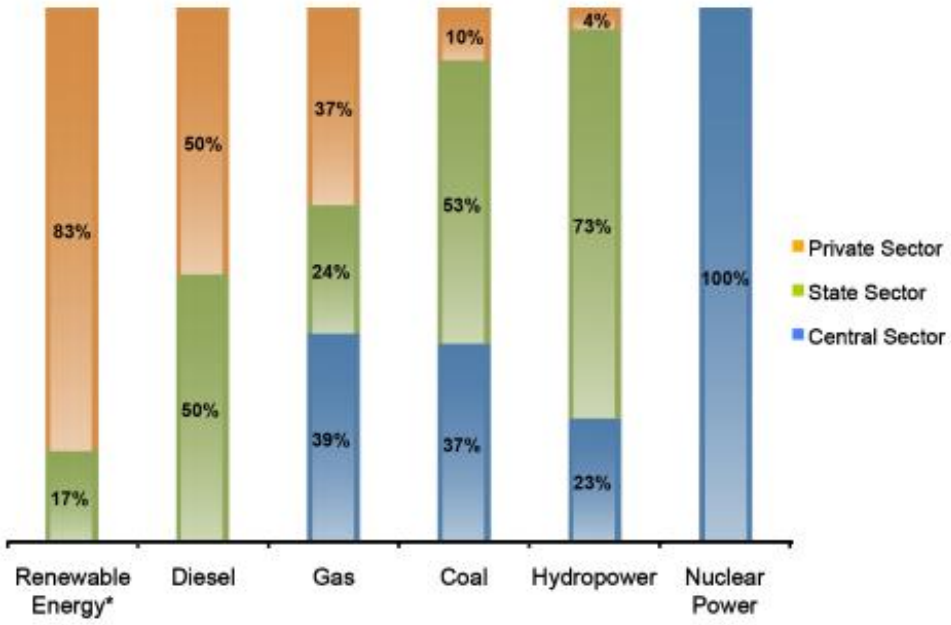


*Figure 2:4 Percentage of private and public sector power generation capacity by energy source.*

*(Source: Indian Renewable Energy Status Report, 2010)*

India's main power generation is from thermal power and this conventional method has three main challenges, that are –

1. Plant average efficiency of conversion is low.
2. The country is exporting low quality of goal because of competition in the market and this coal has high ash content and has less calorific value i.e. 3,500-4000 kcal/kg.
3. No efficiency gains as electricity's off-take price are fixed.

There are around 25%-30% of power plants is old and these plants have low efficiency and require more heat rates to generate sufficient energy.

## 2.9 Technical and Commercial Loss during the Transmission and Distribution

India is at number one spot for the loss of electricity. But slowly this number is going down, in 2000 the average loss was 40% to total, in 2005 it was 30% and in 2009, it

was 27%. The Indian government plans to minimize this number to 20% by 2012 but still it's not achieved yet whereas the worldwide average is only 10%. One of the major reason behind this loss is the old traditional grid, country needs more investment in this sector. Another reasons are lack of consumption monitoring and massive power theft. A large portion of power is given to farmers for free of cost, these losses and free distribution effects the financial status of the State Electricity Boards (SEB's), which effect their investment in grid infrastructure.

As India's large population is not connected to the grids, there is a golden opportunity for India to start generating more eco-friendly and cheap electricity. These change can be a big step and can put India ahead of developed countries and all this can be achieved by developing the renewable energy sector. The challenge is to develop new working plans and develop new policy framework which invite more investment.

## 2.10 The current status of renewable energy in India

By 2010, India had the capacity of generation 17 GW from the renewable sources and in this 17 GW, a large contribution was by installed wind energy systems of 12 GW, from hydro, country only produce 2.8 GW of energy. But the contribution of solar is only 15 MW. The country which is has a great geographical to produce solar energy but only producing 15 MW. The mission JNNSM has a target of 20 GW to expand solar energy contribution to the grid by 2022. The renewable is very important to support and provide additional energy to the grids and around 75% of wind, instalments are being used for supporting purpose.

India's Ministry of New and Renewable Energy (MNRE) is the department which take care of policy actions, the capacity of projects and all further developments while the Indian Renewable Energy Development Agency (IREDA) helps in the monetary assist. The IREDA is also responsible for implementing the policies that are proposed by the Indian government.

## 2.11 Renewable Energy Share of Electricity

In June 2010, with the capacity of 17,594 MW, India become one of the leaders in installed renewable energy and this is almost 10% of total power generating capacity installed in India. The wind energy has achieved a great success with the capacity of 12 GW in 2010. Whereas the main area to concern was the development of solar energy because only 3MW of solar PV plants were installed (Arora et al., 2010).

Indian government launched solar mission JNNSM hoping to develop countries solar resource potential. India reached a generation of around 15.2 MW energy by solar PV plants and this only .07% of JNNSM target 22GW which need to be achieved by 2022 (MNRE, 2011). As CSP stated that "the new solar mission of India is a very ambitious solar energy project and if country achieved its aim target of 22 GW, it will make India the producer of almost 75% of the world's total solar energy output" (CSP today, 2011).

Initiatives/plans by government to develop solar energy in India

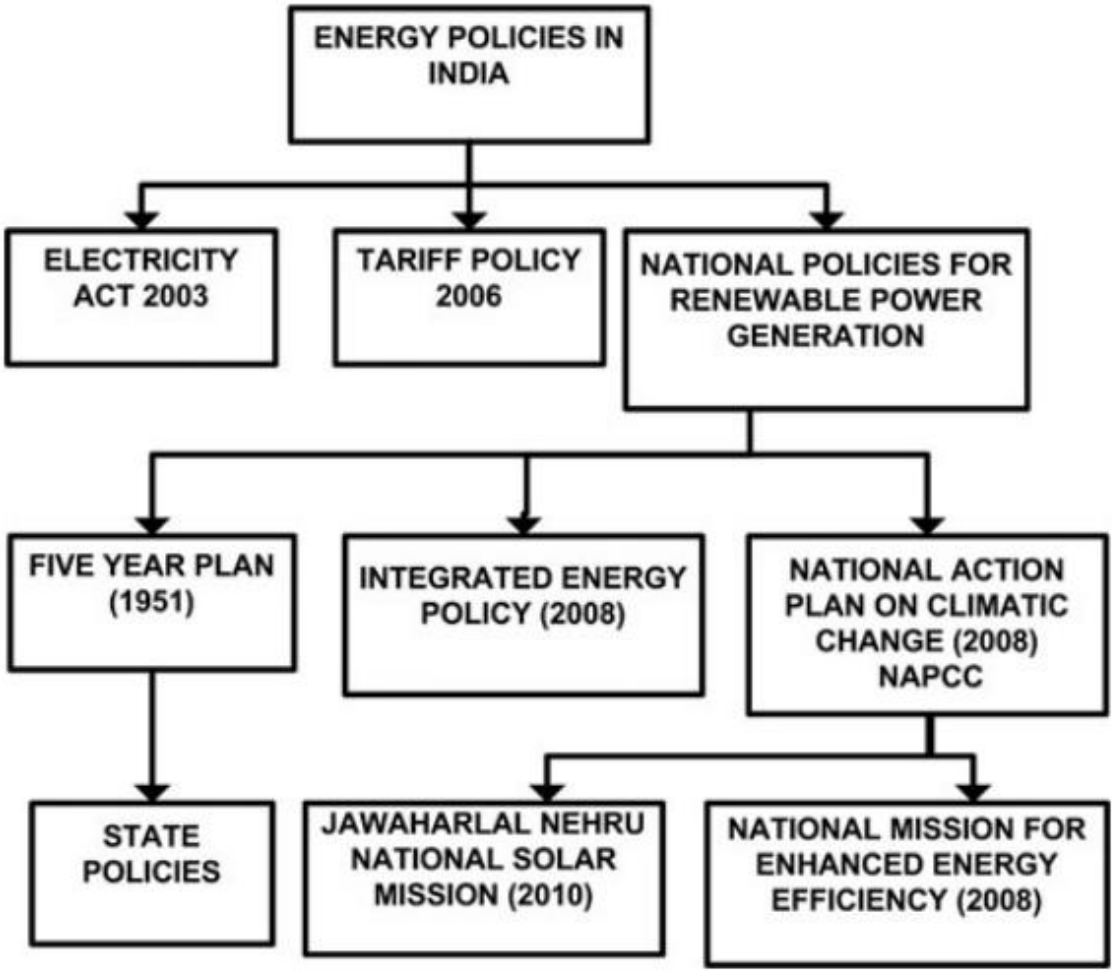


*Figure 2:5Energy plans by the government*

*(Source: Nagamani et al., 2015)*

A. Electricity Act 2003 – this act provides that the production of renewable energy would be promoted the State Electricity Regulatory Commission (SERC). The SERC will provide essential measures for the grid connectivity and electricity sale to any Individual. The act also focuses on the continuous development of solar energy and this should be done by the state government. The state government can buy electricity from any individual/companies and this purchasing will be done by a competitive bidding process. As renewable energy is a developing sector, the government promise to provide appropriate differential prices (Ministry of Law and Justice, 2003).

With this law government become little lenient and give permission to the state government to make changes in their power plans/sector and the state can set renewable portfolio (RPO). This renewable energy strategy gives an outline for the pricing and sustainability of renewable energy.

- Section 86(1) (e) – this section provides necessary measures to promote the generation and co-generation of electricity from renewable energy sources. The section also provides measures for the grid connectivity and electricity sale to any individual.
- Section 61 (h) – this section specifies that each term and conditions for any tariff will be guided as the promotion of generation and co-generation of power from renewable energy sources.
- The Electric Act 2003 also determine the guidelines for production, transmission and distribution of energy for the promotion of renewable energy.
- There is no need of a license for any power generation company under this act. Furthermore, if a person generating energy from renewable sources, he has the right to carry it from their plant to the destination of their own use (Ministry of Law and Justice, 2003)
- SERC has the right to set tariff for the development of renewable energy under the Electricity Act of 2003. By Singh and Sood (2011), SERC will also clear the following functions –
    1. Promotion of generation and co-generation of power and provide the appropriate methods for the connectivity with the grid and sale of power to any individual.
    2. A total percentage of power consumption in the area, from co-production and production and purchased power from the companies, must be specified by SERC.

B. The National Tariff Policy 2006 – this policy guide SERC to require RE Purchase Obligation (RPS/RPO) in a time-bound manner from distribution licensees (Kumar et al., 2015).

C. National Rural Electrification Policy (NREP), 2006 – the main goal of NREP was to provide power in each and every house by 2009. The power should be cheaper, reliable with quality (Singh et al., 2013).

## 2.12 Policy Structure for Development of Renewables in India –

The framework of policies plays a vital role in the development of renewable energy in any country. Policies are important because it aim at overall development and promotion of renewable energy technologies. Policies also encourage the private sector to invest in renewable energy business. In India, policies empower household private investment with a procurement of fiscal and financial incentives, for example, tax holidays, duty rebates and accelerated depreciation. The Ministry of New and Renewable Energy Sources (MNRES) administrate all the policies measures at the central level. The state level, state government provide their support by making available infrastructure for power development and buying the power from renewable units. The followings are some policies and incentives provided by Indian government for further development of renewable energy.

1. Foreign Investment Policy – now every foreign investor has right to invest in a joint venture with Indian partner on any renewable energy based power production projects. The Foreign Investment Promotion Board (FIPB) can permit the investor for the 100% foreign investment as equity. This policy is encouraging for foreign investors to invest in renewable energy projects (Kumar et al., 2015).
2. Foreign Investment Implementation Authority (FIIA) – this Authority is for the approvals and implementations of FDI. The FIIA provides step by step guidance to the foreign investor on critical issues like approvals, clearance, and other important factors. The FIIA is a department which forward investors problem to government and government plans to the investors. The FIIA deals with many government agencies and hence it FIIA is indirectly linked with the development of renewable energy (Kumar et al., 2015).

3. Industrial Policy – the MNRE's is the department which plays a vital role in development in renewable energy. Recently MNRE's is promoting enterprises which are small, for the production of renewable energy systems and devices. The MNRE also make sure that these enterprises don't need any industrial clearance for energy production projects which is required for every industry according to CEA (ProjectsNRI, 2015).
4. Joint Ventures Policies – these are the collaboration of technical as well as financial and there are important for the development of any sector in the country. Any investor can enter the market by setting renewable source-based power plant and by making systems and products.
5. Feed-in tariff policy – these policies designed differently for each and every country. These policies thought to build up diverse tariff for different technologies, typically identified with the expense of production. A few policies help individuals who are involved with renewable energy, like reduction in tax etc.

## 2.13 Solar Energy in India

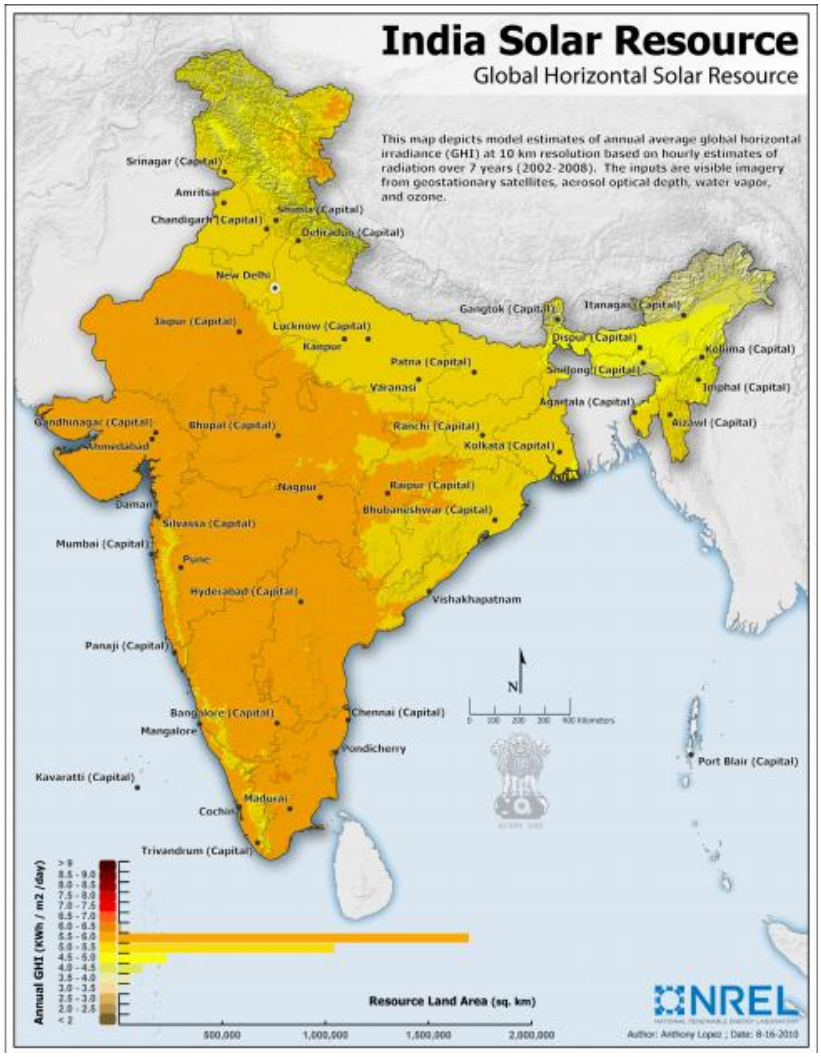


*Figure 2:6 India's Global Horizontal Irradiance (GHI) resource at 10km resolution*

*(Source: NREL, 2015)*

The figure 2:6 is showing the Global Horizontal Irradiance across India, it's clear that almost every part of India have higher or equal to5.5 kWh/m²/day of Global Horizontal Irradiance (NREL, 2015).

## 2.14 Current Solar Capacity

By the survey of 2010, India has grid-tied photovoltaic solar power of 12.2 MW to the total 17.1 MW of grid-connected renewable energy (Arora et al., 2010).

2.14.1 Policies –

From 2000 to 2010, the Indian government and state government launched various solar power programs, although none of them quite consider as a successful one. During the tenth 5 year plan, only 1 MW of solar PV were installed but the target was 5MW (Yumpa, 2015).

*2.14.1.1 Jawaharlal Nehru National Solar Mission (JNNSM)*

In November 2009, the Indian government announced the mission of JNNSM, it was a biggest solar plan launched in India. The goal of this mission was to generate 22,000 MW of solar energy from both CSP and PV tech by the year 2022. The plan was among other eight national mission launched by India's NAPCC. This mission was divided into three phases (MNRE, 2015).

Phase I: 2010-2013

This phase was focused to make a market for solar energy and to invite more investors, equipment manufacturers, engineers, and contractors. During this phase, government's focus was to generate around 500MW for grid and around 200MW for off-grid. This 500MW project was allocated in two batches, first was from 2010-11 and second in 2011-12.

If any company wants to apply for the phase 1 JNNSM then the company needs to have a value of 30 million rupees per MW of the project. From the above report it is easy to see the future and development of solar energy but according to the report of "Renewables 2014 Global status report", the target which is set by the Indian government is not completed and the country is short of its target 4,325MW in 2013-14 (Ren21, 2014). So this creates a doubt in people's mind that country is unable to generate its targeted energy in early years of the mission, so how they are going to generate such big amount of energy by 2022.

Phase II: 2013-17

In this phase, the goal was to learn from the phase 1 and increase the capacity. Another important mission was to cut down the cost of per kW-hour and install the further system to reach the set target of 10,000MW of combined CSP and PV. In phase 2 the government has realized the importance of international support with both financially and technically to achieve the higher goals. So the government decided to give a comfortable environment to the manufacturers, so a complete development can take place. The goal in this phase is to install thermal collector in the area of around 15million mt. sq. by 2017 (MNRE, 2015).

PHASE III: 2017-22

JNNSM mission is to produce 22,000MW of solar energy in which 20,000MW will be the on-grid capacity and 2000MW will be off-grid capacity. The thermal collector will be installed in the area of 20million mt. sq. and around 20million solar lighting systems will be installed in villages (Arora et al., 2010).

By the report of Economic Times, the JNNSM is on its second phase and still the price of energy that generate by solar is still high. Today thermal energy cost is 3.5-3.6 rupee per unit while solar is costing around 6-8 per unit (Economic Times).

Specific Issues relating JNNSM –

1. Selection Criteria – in between the developers the opinion regarding the selection criteria of the JNNSM draft was different. Only 28% of developers satisfied with the selection criteria. Around 22% of the developers thinks that the selection criteria was harsh, they also mentioned that the financial measure of worth wasn't necessary. Around half of the developers who were sure that the criteria were casual called attention to that the experience in the foreign country, successful projects etc. are those tech which have a historical background (ESMAP, 2015).
2. Timelines – the timeline that were set for the projects were unrealistic and around 90% of the developers were agreed with that. The rest 10% mentioned

that they have started development early and they are ahead of the timeline and it will help them to reach their goals.

3. Domestic content criteria – the most developers mentioned that the government should not include domestic content. They also mentioned that government should more focus on quality equipment's to install successfully to achieve the target of 1000MW. Around 75% developers said that domestic content is a barrier in development.

## 2.15 Policy and regulatory constraints in renewable energy sector development –

1. Policy framework for Renewable energy – in India, there is no availability of one single complete policy explanation for renewable energy. The government announced strategies when it's important to encourage the development of particular renewable energy tech but there weren't any further arrangements has been done for the development of renewable energy and the development don't match up with the policies. The following table will show the targets of JNNSM and how much it achieved its objectives.

*Table 2-1 Targets of JNNSM*

| | 2009-10 | 2010-11 | 2011-12 | 2016-17 |
|---|---|---|---|---|
| Energy requirement | 820920 | 891203 | 968659 | 1392066 |
| Share of RE as mandated under NAPCC (in %) | 5% | 6% | 7% | 12% |
| Quantum of RE required | 41046 | 53472 | 67806 | 167048 |
| RE capacity targeted by MNRE (in MW) | 15542 | 20376 | 25211 | 57000 |
| Solar capacity targeted under JNNSM (in MW) | | | 1000 | 10000 |
| Quantum of RE available | 29952 | 39269 | 50514 | 129122 |
| Additional RE required to meet RE share mandated under NAPCC | 11094 | 14230 | 17292 | 37926 |

(Source – Arora et al., 2010)

The state policies are also can't be consider as effective because many state policies have created just to get more investment in renewable energy sector. One of the very good examples of this is that the state Madhya Pradesh, the strategy which state government made had crossed the appropriation charge for renewable energy and it was too expensive.

2. Act of depreciation to wind developers – around 80% of tax depreciation has been provided by the Indian government and wind energy sector relied on it. Because of this many companies set up the plant in bulk to save the income tax and most of these project are located in areas where the speed of wind is low.
3. Subsidy support for fossil fuels amounted to ₹81,094 crores in 2010-2011, covering their real generation and utilization cost
4. Authorizes if there should arise an occurrence of resistance with renewable energy policies are not surely known by a huge number of shareholders.

5. The usage of the single window clearances framework for little scale entrepreneurs of renewable energy projects is time-consuming and can't consider as efficient.
6. The area securing procedure for renewable energy installations, which for the most part require big areas, is both time consuming and complex.

## 2.16 Solar Polices of other leading countries

Solar energy is becoming the hottest topic because of this reason that all other and traditional sourced of energy is becoming old and they are also finishing. Coal, gas and petrol are disappearing from the earth due to excessive use of these resources. All the countries have started to preserve such resources for future. This time, all these resources are used only for energy production. Soon after some decades, there will be a time when none of these resources will be available then how energy will be produced energy production by means of gasification process of residuals sourced in Extremadura (Spain), (2006).

Currently, in almost all countries there are some policies regarding renewable energy especially solar energy. In other countries, they made a lot of policies some are good and some are poor policies. China has made a name in this field regarding making a great policy regarding renewable energy especially solar energy policy. In another country, a policy has been introduced that is called feed-in tariff policy. This policy in the other countries is very successful due to its result. Feed in the tariff is the name of the policy that provide a guarantee and gives benefit to the producer of solar energy. Producer of solar electricity companies can sell their electricity at that price that is set in advance with the government of that country. This policy has become so successful that their energy issues have been solved.

This policy has one thing that this policy has brought a huge value of investment in the country because the producer of such electricity faced reliable guarantee. China is one

the example who apply this policy (Grau, 2014). On the other hand due to this policy the government has to bear losses also which was a burden on the government.

Other countries like the USA also have a policy of giving a tax credit to an energy producer. This relief is only available when there is a producer who produces energy from renewable resources. France is also the country who developed country is but the policy of renewable energy is that they are giving tax credit as well as green loans to the producer of electricity. France is also giving same feed in tariff policy to the producer of energy. Feed-in tariff policy is the most adopt policy in solar or renewable energy production sector (Khan and Latif, 2010). Despite tax losses and burden on the government, this policy was successful.

Australia who is considered to be developed country also using feed-in tariff policy. But on the other side, Australia is giving subsidies to the producer of such energy. While in Malaysia who is also very conscious about future energy plans have some policies. In Malaysia government is approving grants and relief for energy producer. The government is providing an incentive for all renewable energy producer in Malaysia. These are the policies which major countries are following regarding solar energy and all other renewable energy production. It seems that people and whole world countries are looking for renewable energy production. All countries are looking for energy replacement things that are environmentally friendly (Energy Charter Treaty: implications for Australia, 2002)

For the first in the year 2014, the energy demand was full filled by solar energy is measured at 1 percent of global demand. This shows that other countries have too much concern over the renewable energy. All developed or under developed countries have made remarkable policies to increase the solar energy. But the focus of all countries is only on one source of energy. All other sources of energy are ignored. All USA, France, Malaysia made policies like the most popular policy of feed-in tariff policy and Tax credit. Relief to the producer of renewable energy especially in the field of solar energy. Due to this major changes in policies, people start using solar energy and production of energy from such sources start increasing (Maïzi and Assoumou, 2014).

All developed countries apply almost similar policies, but they faced a lot of criticism also. There is climate change law in almost every country, the most used policy which support climate change law are feed in tariff, net metering, and high use of public tenders, rebate on the purchase of solar parts, the incentive in the shape of tax relief or tax credit and providing the relief and subsidy over investment. In the list of developed country the country which is leading in solar energy is Germany. Germany is leading 35.5 GW solar energy production. Germany is at the top, but they still have to fight with the energy crisis (Lin, 2014).

Studies also showing that whenever the country reduced the level of policy in favour of solar energy then there is a reduction in the level of production of electricity. Germany is an example. In 2013 Germany was at the top for producing the energy from solar when they change the reduced feed-in tariff policy then the production of electricity also decreased. Many underdeveloped countries are also fighting with the energy crisis. Italy also has the great favorable terms for producer of solar energy. In this energy war china is not too behind. China is making more flexible policies to attract the investor as well as the people to produce the solar energy (Nordensvärd and Urban, 2015).

## 2.17 Barriers In development of solar energy

There are many barriers in the development of solar energy in India the below table is showing the important barriers that need to be solved.

Table 2-2 Barriers in development of solar energy

| Barriers | Variables | Reason |
|---|---|---|
| **Policy** | Issues regarding the clarity of policy (ESMAP, 2015). | The stakeholders are uncertain about the policies.<br><br>Policy issues with installation plan. |

| | | |
|---|---|---|
| | Insufficient certain policy and lack of legal structure for the betterment of the technology.<br><br>The absence of financial incentives. | Lack of –<br><br>• Strategies regarding assistance.<br>• Support mechanism<br>• monetary intermediaries & inducements<br>• small scale circulation of energy services |
| | Policy for market generation, monetary grants<br><br>The scarcity of sufficient financial incentive mechanism.<br><br>No strong implementation of policies.<br><br>Land and water allocation issues (ESMAP, 2015). | Proper means of entry to funds & subsidies by the government |
| **Regulatory** | Utility interconnection issues<br><br>The absence of effective laws and governance for power generation.<br><br>Capital cost benchmarking by the regulator (ESMAP, 2015).<br><br>supervision for the effective implementation of guidelines | Issue in integrated power sector reforms.<br><br>sufficient legal protocols for private power producers |

| | | |
|---|---|---|
| **Financing** | Restricted permission to cost-effective credit (Oliver and Jackson, 1999).<br><br>Difficulty in project finance (Ghosh et al., 2002).<br><br>Difficulty in bankability of the project (India environment portal, 2015)<br><br>Weak industry networks<br><br>High transaction cost for technology commercialization (Ghosh et al., 2002).<br><br>High initial cost (Packer, 1979). | Difficulty in the applicability of buyer's credit<br><br>Higher interest rate on project finance.<br><br>The long payback period of the project.<br><br>The dependency of the national budget and limited financial incentives.<br><br>It raises the market insecurity. |
| **Market** | Existence of informal & unqualified PV manufacturers & operators<br><br>Difficulties in the supply of silicon (Timilsina, et al., 2012)<br><br>Challenges in technology circulation because of insufficient business sector infrastructure, deals and benefits systems (Ghosh et al., 2002).<br><br>Lack of community involvement | Cause of less in a number of local manufacturers.<br><br>Most of the countries are reliant on the imported silicon.<br><br>Which is a cause of weak industry networks<br><br>Stealing of equipment, as well as vandalism, can be one of the |

| | | |
|---|---|---|
| | | results of it. |
| **Acceptability and awareness** | Political instability<br><br>Less responsiveness by the policy makers<br><br>Lack of interest by Power utilities to accept innovative concepts.<br><br>Lack of technology awareness and its benefits among different stakeholder<br><br>Pricing of storage is very high. | A collision between various political views and priorities can be one of the reasons of it.<br><br>Lack of vision among the politicians & their advisors<br><br>unawareness towards the impact on environment & society by the conventional source of energy<br><br>Biases towards conventional energy |
| **Cost** | Exclusion of environment externalities in the cost of generation of electricity from the fossil fuel and risk related to pre-investment cost (Ghosh et al., 2002).<br><br>Preference towards the centralized source of energy generation and import tariff (Ghosh et al., 2002).<br><br>The cost of the balance of system [BoS] are somewhat saturated (Timilsina, et al., 2012). | Lack of fuel risk assessment by the respective agencies<br><br>Comparison of cheap fossil fuel to free renewable fuel on the base of technology cost (Ghosh et al., 2002).<br><br>Trade barriers impose high import duties. |

| | | |
|---|---|---|
| **Land** | Lack of land availability<br><br>No availability of land data.<br><br>Inadequate installation space & service infrastructure | Unending land for large solar projects.<br><br>Lack of data on land/ property registry |

From table 2.3, it clear that these factors still need to be solved for the development of solar energy. For the government, the policies should be the priority because better policies encourage people to use the solar systems. The government should have a clear and visible laws which don't create a negative impact on people's mind. Government strategies are not sufficiently satisfactory to solar power installations. By Ghosh et al. (2002), difficulty in project financing is another point that caused because of the higher interest rate on project finance. The political barriers are also one important factor, the big companies and contractors don't want to take a risk in this market because of unstable government. They think the new government always come with new plans and could impact the current ongoing project and this may cause a massive loss. According to Timilsina et al. (2012), the total payback time to solar energy is high due to the high initial set up cost, but from last few years, the prices of solar energy tech are coming down but still it is way too much in comparison of the other power generation conventional technologies.

## 2.18 Changes required in current policies

There are a lot of policies in current time that needs to change. If the policy of country regarding solar energy will be good then there will be more energy through renewable sources. In the long term, there will be more reserve and cheap electricity. If policies of renewable resources will be bad then there will be no good energy production. In the

current policies, there are a lot of changes are required that needs to change for better energy production (Williams, 2011).

There needs to be more relaxation as current relaxation is not enough. If this traditional system carries on in future then there will be a time when there will be no such reserve left. To save the coal and another reserve it is better to change policy now, but country still have to face a lot of criticism due to relaxed policies.

Current policy regarding renewable energy is only allowing the small companies to come and invest while on the other large companies are hesitating to come in this field. Companies who are small in nature cannot produce enough energy. To meet the current energy demand, it is strong need of the time that large companies should come in the market to produce energy. The government should pay attention on this matter especially (Baltas and Dervos, 2012). The government due to the instability of internal environment is not paying enough attention to it.

There is another thing that needs to change that the government should pay attention to the financial institutions because these institutions are not paying loans and small companies are facing difficulty to find the fund from banks. This is because of the high cost of banking and a lot of time wasted. If the government gave fund instead of banks then such type of policy will help a lot to the current producer of energy. It is the government's inefficiency that government has a good future vision but not giving relaxation to companies.

There a policy need that there should a high level of security against investment to ensure funds are safe. This should be done through different long term or short term prices control. Along with this type of change in policy, there is another that needs to be addressed in the policy. There should be compatibility between market and trading requirement and the policymaker needs to pay more attention.

All policy maker needs to pay more attention in favour of green energy or renewable energy rather than old traditional energy resources.as all wholesale market are only made and these market are only designed to give favour of old energy products and

old energy way of production. There is no spot in the wholesale market for any renewable energy resources. The government has not given any focus to this factor.

There is another drawback in such wholesale market regarding energy that market treats all goods and things in the same way. Market do not provide any favour. The market does not give any favour in financial terms beside the benefits of renewable energy. The market does not care how much good is this product (Stodola and Modi, 2009). This the inefficiency of rule and law making authorizes of the market.

In all other countries, all policy maker tries that they create a hybrid version of the new policy. It is also need of time that there should be a proper mix of hybrid policy in such way that renewable energy should be treated fairly. This policy should be made in such a way that renewable energy becomes a great option for the economy of the country.

There is also changes required in the policy. If compare both policies traditional and new there is a clear line in between them it will never be advisable for anyone and from anyone that there should rely on one policy that is too old. There are a lot of factors that contribute while making the policies like these factors are a decrease in the cost of renewable energy especially solar energy.

There should be climate change policy. As climate is changing with a fast speed. To enhance the green environment, there should be a change in climate change policy to save the climate as well as all other resources that vanishing at very fast speed like coal. Policymaker should play an important role in making these type of policies.

All these above-mentioned changes are hard to implement because there will be less benefit to the government in financial terms at the start due to huge outflow and reliefs, but these changes are essential as these change if not done at the right time then it will be too late. Policymaker should pay high preference so that requirement of energy can be full filled. (Lin, 2014)

The tax credit should be given more to the taxpayer to both individual and small as well as large companies. Such type of change in policies is essential today. Policymaker

makes cash grant system to other companies in such a way that it will attract solar energy production companies. The most expensive thing in solar energy that is photovoltaic cell should be taken into consideration while giving cash grant. Government has given too much relaxation due to which company has to face a huge burden on its shoulder.

## 2.19 Key Findings

In a nutshell, renewable energy is the future for any country which wants to be the leader in future. India has started renewable energy mission 30 years ago but due to lack vision and policies these missions were not successful but now is the right time when globalizations is at its peak. The Indian government has initiated some good plans for the development of solar energy, but still government needs some vital and effective plans that change people's mind-set and encourage them to use the solar energy without any doubts. Indian increasing population is a major problem in front of government and as these numbers are increasing, the demand for energy is increasing too. Indian cannot rely on coal for a long time because its prices are increasing day by day and it's one of the resources that soon will not be available, so India needs a solid development of renewable energy especially solar energy because of India's geographical condition it is the most suitable one. The JNNSM is one of a kind solar mission and can create a massive difference by providing additional energy to the grids. The whole world's eye is on India because this mission can make India a global leader in solar energy sector. This mission is in its second phase and the government should learn from the phase one. It is a very big project and expectations are high, but the phase one leaves some question mark on this. In phase I, the JNNSM could not able to meet its target and leave a doubt on everyone's mind, as this was phase one and target was also not that high but insufficient policies, less time period for target achievement, cost and land problems are some issues of many that create problems in achieving the targets. India's energy demands are increasing rapidly and the country still needs a strong power sector to fulfil this requirement. Furthermore, Indian

government still need to focus on these following sectors for the better development if solar energy:

- As renewable energy is expensive but it can be utilized as the part of the generation and local distribution systems to balance the transmission and distribution losses.
- The energy sector regulatory framework should include renewable energy strategy.
- A complete modification of public-private role in renewable energy.

Many research shows that India is in a desperate need of strong and effective energy sector otherwise the country will not have sufficient energy to satisfy the country's requirement by 2020, so government should start taking some serious steps towards the development of solar energy.

## 2.20 Summary

This chapter discussed the current energy generation and the current energy needs of India. A role of renewable energy is also described in this chapter and how much renewable energy is contributing in current energy grids. The chapter also discussed the policies of renewable energy and then a deep analysis on current solar energy status was also given by the researcher. The JNNSM is the biggest solar mission of India and if the government take right steps and follow the goals of the mission then India can be a world leader in solar energy. An analysis on JNNSM is also done and all three phases of this mission are also analysed.

# CHAPTER 3- Methodology

## 3.1 Research Methodology

The chapter will discuss the methodology that has been adopted for this dissertation. After considering all vital areas of methodologies and also considering all objectives of the study, this research is based solely on qualitative research methods. The qualitative methodology was carried out by using closed-ended questions. This chapter also discusses the justification behind the choice of qualitative methodology and the way these closed-ended questionnaires were carried out.

## 3.2 Qualitative Method

This approach is used in the major field of academic research study like dissertations and theses in the UK and worldwide. Sometimes this method is also used in market research by the business sector. This study involved in any imaginable phenomenon and the study requires human approvals. According to Denzin and Lincoln (2005), qualitative research is an activity that mainly analyses the observer's point of view. This methodology comprises of some arrangement of interpretive, material practices that helps the world to understand the concept. Taking interviews, discussions, photos, recordings, and notices are the part of the techniques that provides a platform for a worldwide opinion on any particular topic. Qualitative research includes an interpretive, naturalistic way to deal with the world. This implies qualitative specialists likes to study things in their natural habitats, endeavouring to understand, or to translate, spectacles regarding the implications various individuals bring to them (Denzin & Lincoln, 2015).

The qualitative analysis can portray or give further comprehension of a subject and its logical setting, give clarification of reasons and affiliations, assess the adequacy and help the development of hypotheses or systems. Qualitative research is further useful to represent the development of quantitative examination by advising study content and scope, creating topics and typologies on which a questionnaire or survey modules

can be planned, and in testing the inquiries. Furthermore, it provides the opportunity for the detailed survey inquiry to ensure the result is not biased (ONS, 2015).

There were many reasons behind choosing the qualitative approach for this research. This research help in providing information on individual's opinion and also providing an in-depth examination of the research topic. This approach also helps researchers in generating a new tentative but explanatory theory about the phenomenon which is based on previous theories. The qualitative approach helps in exploring new areas of research. The data received from this approach is more powerful than data gathered through a quantitative approach (Occupy Theory, 2014).

## 3.3 Data Collection Method

It is one of the most important stages of any research if doesn't matter if someone has designed the world's best research and the most important thing is how someone collect the data and find the result of the research. This technique of data collection is required planning, patience, determination, hard work and more to finish research successfully. Information accumulation begins with figuring out what kind of information required took after by the determination of an example from a specific populace. After that, the researcher need to use a specific instrument to accumulate the data obtained from the research (Vbtutor, 2015).

For this research, a questionnaire survey approach was taken. These questionnaires were conducted/delivered by email. The questionnaire was sent to the people who have experience of at least 5-10 years in the field of solar energy and people who are using or have used solar energy in their workplace but not satisfied with the current policies, technology, subsidies and many more. Mail or internet survey costs effective and requires less time.

## 3.4 Population and sampling

There are a number of projects going on in solar energy and since 2000, the Indian government is focusing on the renewable energy a lot. The government started major

projects like JNNSM, which can make India a global leader in solar energy generation. But there are some barriers in the development of solar energy in India. To find out these barriers from people's point of view, a purposive sampling has been taken for this research. According to Teddlie and Yu (2007, p.80) mentioned that "purposive sampling techniques are primarily used in qualitative studies and also defined as selecting units". According to Teddlie and Tashakori (2009), "the purposive sampling is an intentional selection of important settings, events and persons for the collection of vital data that can't be gathered from other methods". A total of 60 questions were sent to three different categories of people which included Public official, independent researchers in the field of solar energy and people from the agricultural background, private builders/contractors etc.

## 3.5 Data Analysis

The data analysis is a method which convert a raw data gathered from the questionnaire, interview etc. into a professional and visible result. There was 60 questionnaires that were sent and researcher got 44 responses back. These questionnaires were sent to four different categories as follows:

*Table 3-1 Responses in each categories*

| Role | Questionnaires sent | Responses |
|---|---|---|
| **Government officials** | 20 | 15 |
| **Researchers** | 20 | 18 |
| **Agricultural background** | 10 | 5 |
| **Construction field** | 10 | 6 |

Through data analysis, the researcher will be able to find out the barriers that are impacting the development of solar energy. From the analysis, a clear picture and the opinion of people towards solar energy will come out. The questionnaire is an easier and faster method for the respondents to reply. A purposive sampling is used which means the study would pick from the participants regarding the criteria that was placed and this sampling also deduct the time which is a need to collect the feedback. The results obtain from the questionnaire will be analysed in the form of the graph to show the responses more clearly.

# CHAPTER 4- ANALYSIS AND INVESTIGATION

## 4.1 Introduction

This chapter will discuss the main findings that are collected from the questionnaire. The data gathered from questionnaires are expert opinion and these experts have an average experience of 5-10 years in their field. The main findings are divided into three sections. Section one discusses the general details of the participants. The 2nd sections discuss the findings of the questionnaire and the 3rd section presents the data synthesis to bring main findings of the literature and the empirical findings together.

## 4.2 Details of the respondents

A total of 60 respondents has participated in the research. These 60 people belong from three different category and researcher selected 20 for each category. First 20 people are the government official and their opinion is very important because they provide the clear picture of what government is doing and how each step can change the outcome of the solar sector in India. Another 20 people are selected for the second category who are independent researchers and they have a good experience and knowledge in solar energy sector. Some of them also act as consultants and they provide their experience to the private projects. They have the knowledge of current scenario, so they guide the project in such a way that no trouble occurs during the project. The third category is to know the opinion of the people and for this 10 persons from agriculture and 10 persons from construction and from these people a clear picture of current scenario and problems occurs in using solar in residential or office buildings.

## 4.3 Experience level of the respondents

The table 4.1, shows respondents average years of experience and their type of job role.

*Table 4-1 Experience of respondents*

| Job Role | Number of Responses | Avg. years of Experiences |
|---|---|---|
| **Government officials** | 15 (75%) | 5 |
| **Researchers** | 18 (90%) | 8 |
| **Construction Firm** | 6 (60)% | 4 |
| **Agriculture** | 5 (50%) | 12 |
| | | |

## 4.4 Findings of the survey results

### 4.4.1 Education Level of Respondents

Respondents were asked to select an appropriate option that describe/represent their education level. Out of 44 respondents, 7 (15.9%) has been selected the 'school level' while 13 (29.5%) respondents chose 'bachelor degree' as their education level but on the other hand about, 24 (54.5%) respondents has selected 'master's degree' as their education level.

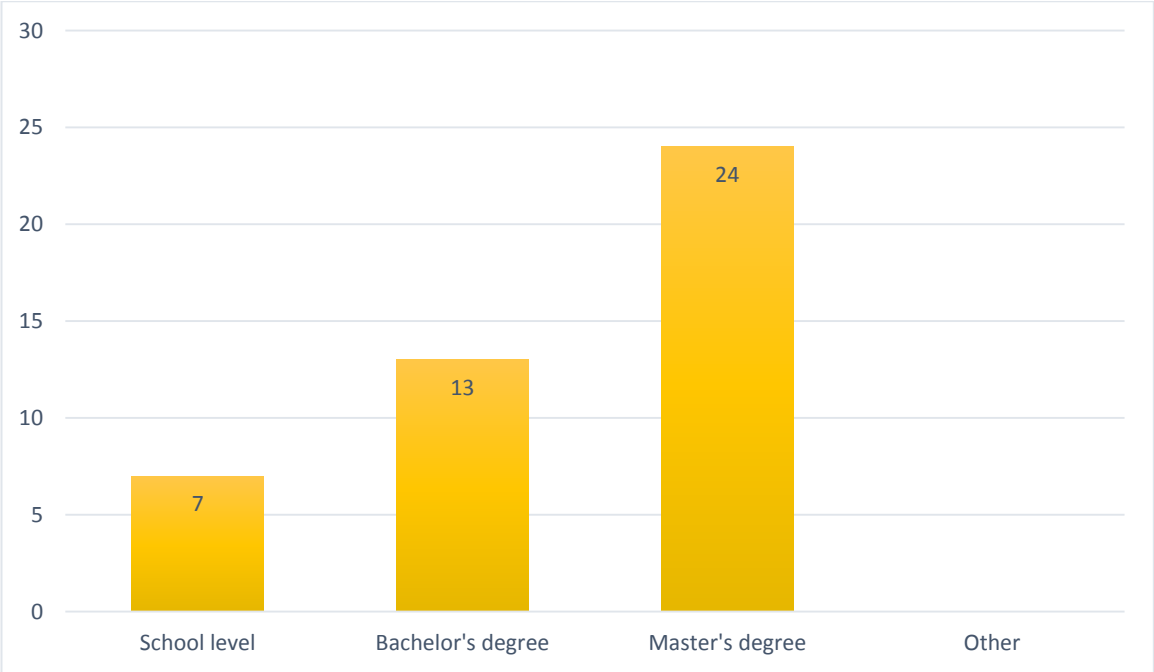


*Figure 4:1 Education Level of Respondents*

### 4.4.2 Respondent's occupation

Researchers asked respondents about their current job occupation and 15 (34.1%) of them are working as a government employee. There are 18 (40.9%) respondents from consulting firm/researchers who took part in this research. There were only 5 (11.4%) people from agriculture field and 6 from the construction firm.

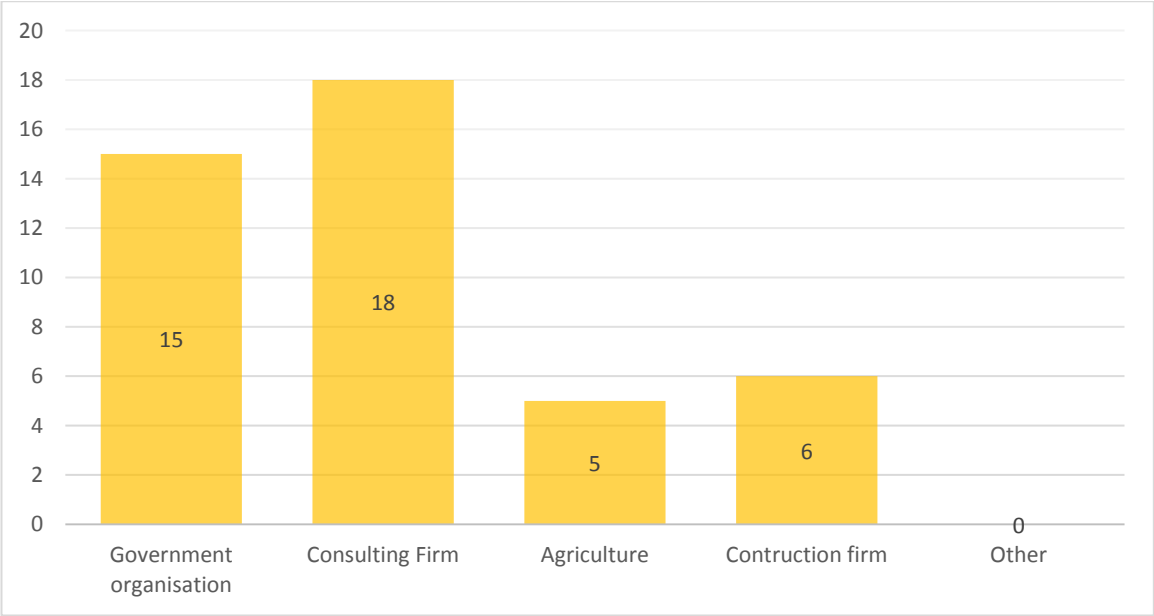


*Figure 4:2 Respondent's occupation*

### 4.4.3 Coal as primary source of generating energy

Respondents were asked that what they think about how long coal will be India's primary energy generation method. Most of the respondents (35 or 79.5%) thinks that coal will last more than 20 years while 7 (15.9%) respondents selected the option 'more than 10 years and less than 20 years' but only 2 (4.54%) respondents have the option 'more than 5 years and less than 10 years.

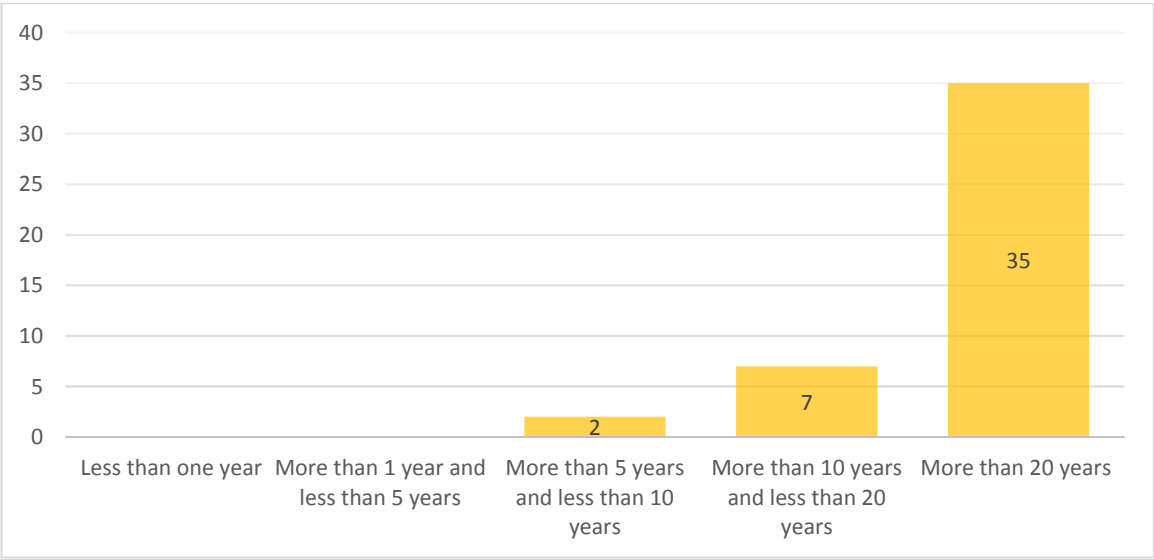


*Figure 4:3 Coal as primary source of generating energy*

### 4.4.4 Substitute of Coal in India for power generation.

The respondents were asked to rate the other power generation options which consider as a substitute of coal like hydropower, solar power etc. For this question the 5 point Likert scale was used as: 5 = strongly agree, 4 = agree, 3 = no opinion, 2 = disagree and 1 = strongly disagree. The following result has been presented through the gathered data from the survey. The figure below shows that 10 (22.7%) respondents were 'strongly agreed' and 25 (56.8%) were 'agreed' with hydropower as a substitute. Whereas in wind energy these number was raised from 10 to 12 and 25 to 27 respectively and only 3 (6.9%) respondents were 'strongly disagree' with wind power. But most respondents selected solar power as the best substitute of coal and 26 (59.1%) were 'strongly agreed' with this and 12 (27.2%) were 'agreed'. The reason of choosing solar power could be India's geographical condition and also that India receives around 250-300 days sunlight and the respondents may think that solar power can fulfil the requirements of the country. And when we talk about the geothermal power and biofuels, most of the respondents have chosen 'no opinion or neutral' and more than 10 (22.7%) respondents in both geothermal and bio-fuel were 'disagreed'.

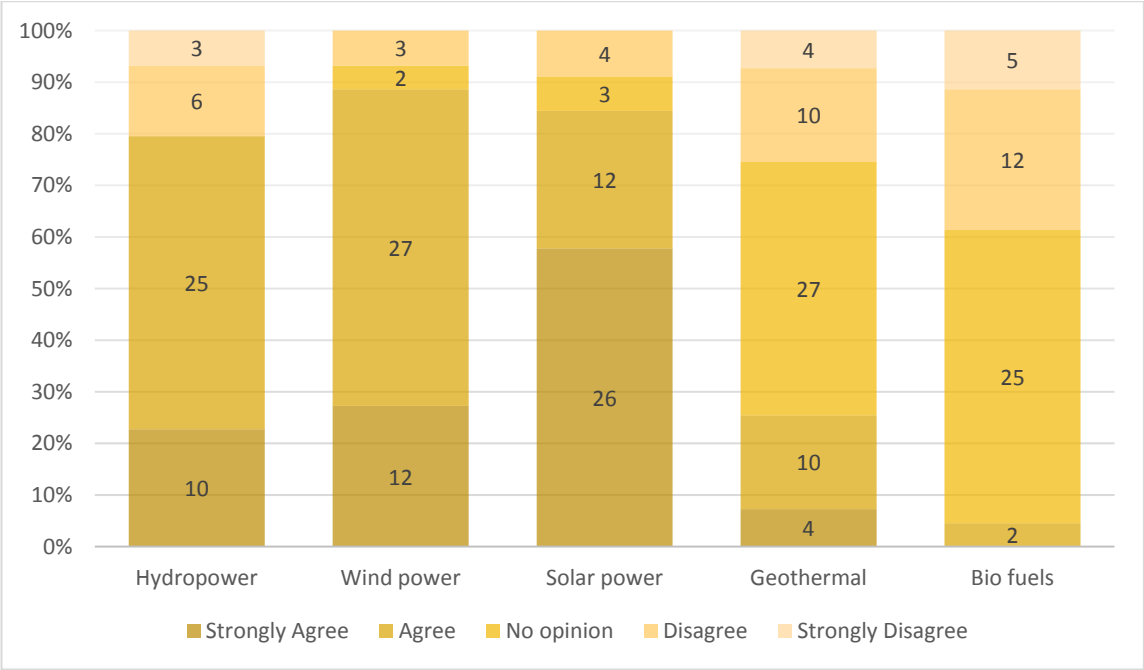


*Figure 4:4 Respondents view on other power generation options.*

### 4.4.5 Satisfaction with the current solar energy production

Respondents were asked that 'how satisfied they are with current solar electricity generation', most of the respondents thinks that the solar electricity generation is 'poor' and 27 (61.3%) respondents have selected this option while 3 (6.8%) respondents have chosen 'very poor'. But looking at the positive side, about 12 (27.3%) respondent are satisfied with the current solar energy generation and 2 (4.5%) have selected the option 'good'.

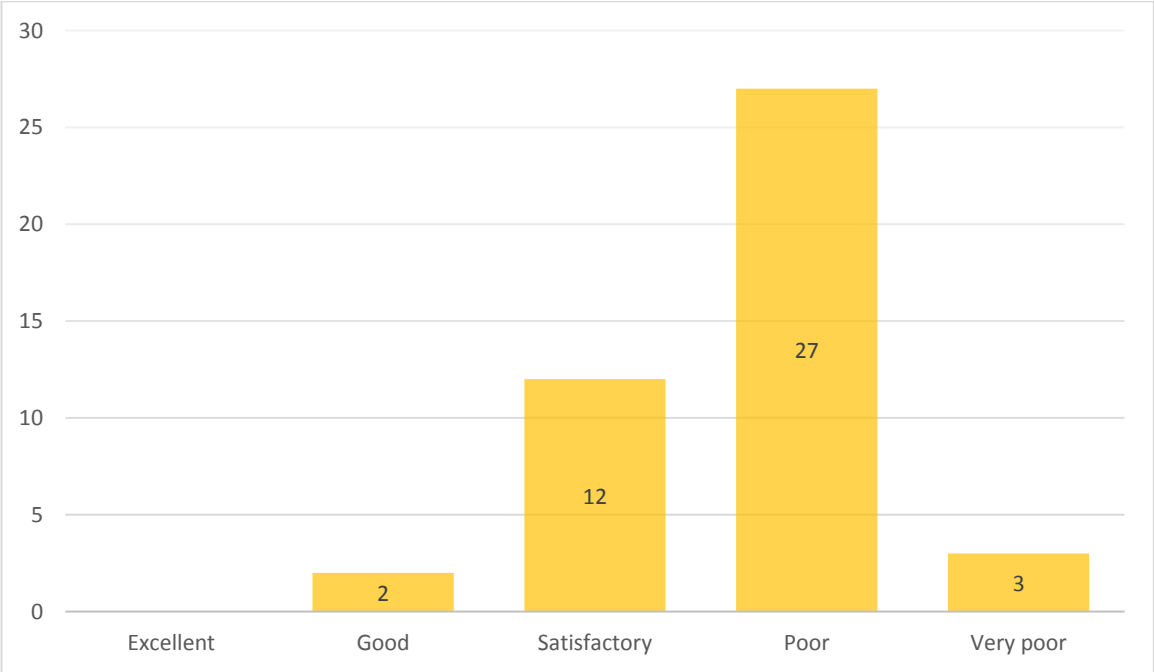


*Figure 4:5 Satisfaction with the current solar energy production*

### 4.4.6 Respondent's opinion on electricity generated by solar energy

Researcher asked respondents that far they agreed with the statement 'solar energy is far better than energy generated by coal' and 23 (52.3%) respondents were 'strongly agreed' with this statement while 12 (27.3%) respondents were 'agreed'. But 3 (6.8%) respondents have stayed neutral and 3 chose 'disagree'.

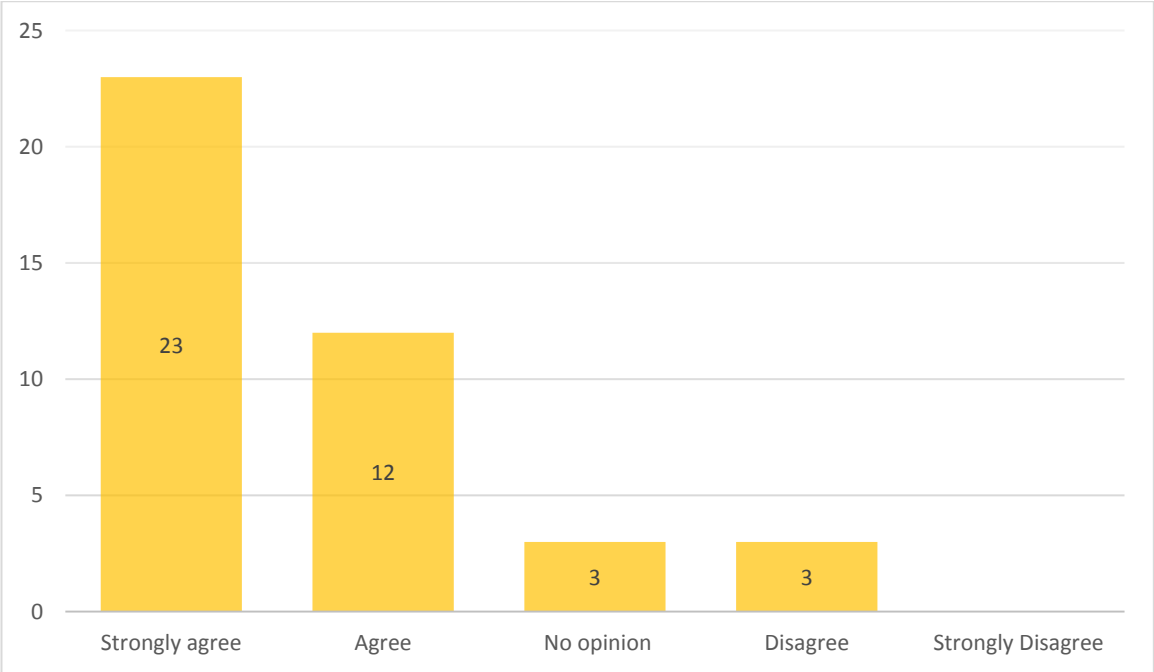


*Figure 4:6 Respondent's opinion on electricity generated by solar energy*

### 4.4.7 Effectiveness of incoming solar radiations

Respondents were asked that whether the incoming solar radiations are sufficient to generate electricity to fulfil the requirements of the country or not. About 29 (65.9%) respondents were 'strongly agree' and 12 (27.3%) were 'agree' with the statement. Only 2 (4.5%) respondents have chosen 'no opinion'.

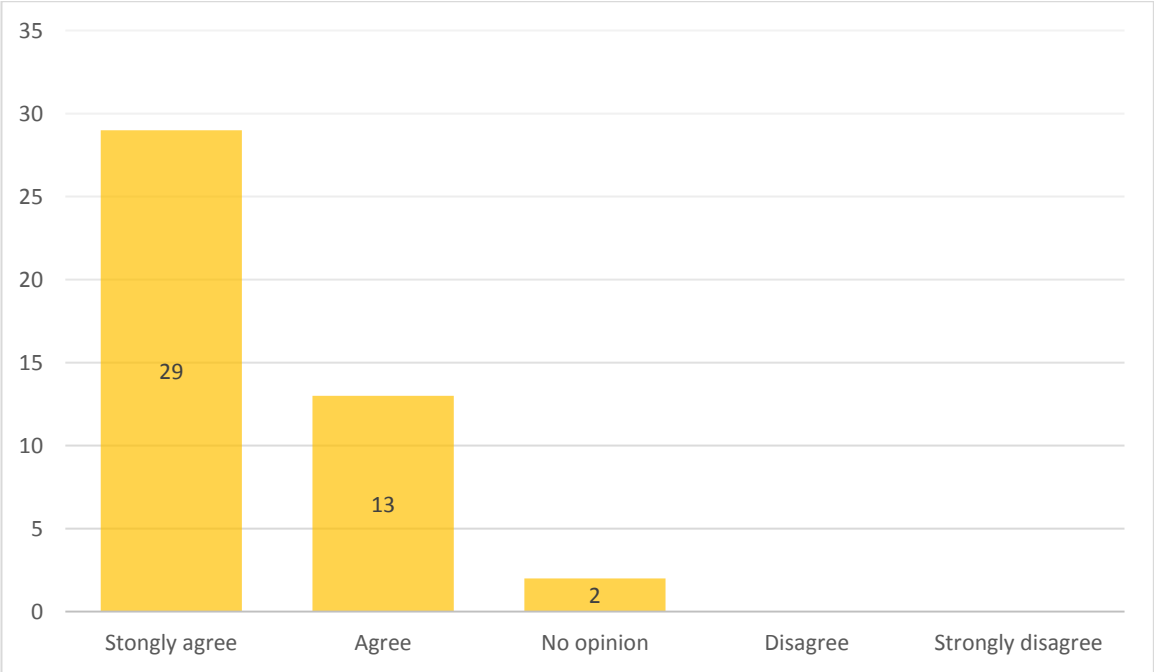


*Figure 4:7 Effectiveness of incoming solar radiations*

### 4.4.8 Cost of solar energy generation

In this question respondents were asked if they have to pay more for the solar energy, are they going to willing to pay. The responses were not that positive and 19 (43.2%) respondents were 'disagreed' and 3 (6.8%) were 'strongly disagreed' while 11 (25%) respondents chose the option 'no opinion'. But 8 (18.2%) individuals were 'agreed' and 3 (6.8%) were 'strongly agreed' to pay more.

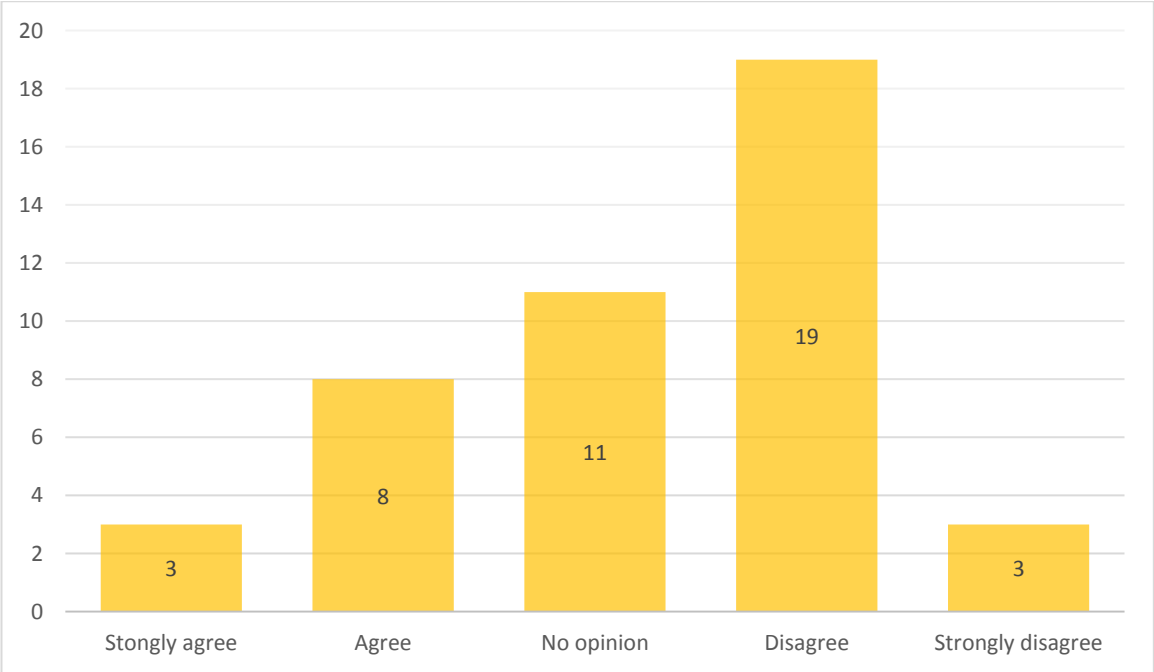


*Figure 4:8 Cost of solar energy generation*

### 4.4.9 Willingness to pay

A Likert scale has been used for this question. When researcher asked that how much respondents are willing to pay for the solar energy, there were 5 respondents who were willing to pay 6-10% more while 3 respondents were willing to pay 11-15% and only 1 respondent chose the option of 'more than 15%'.

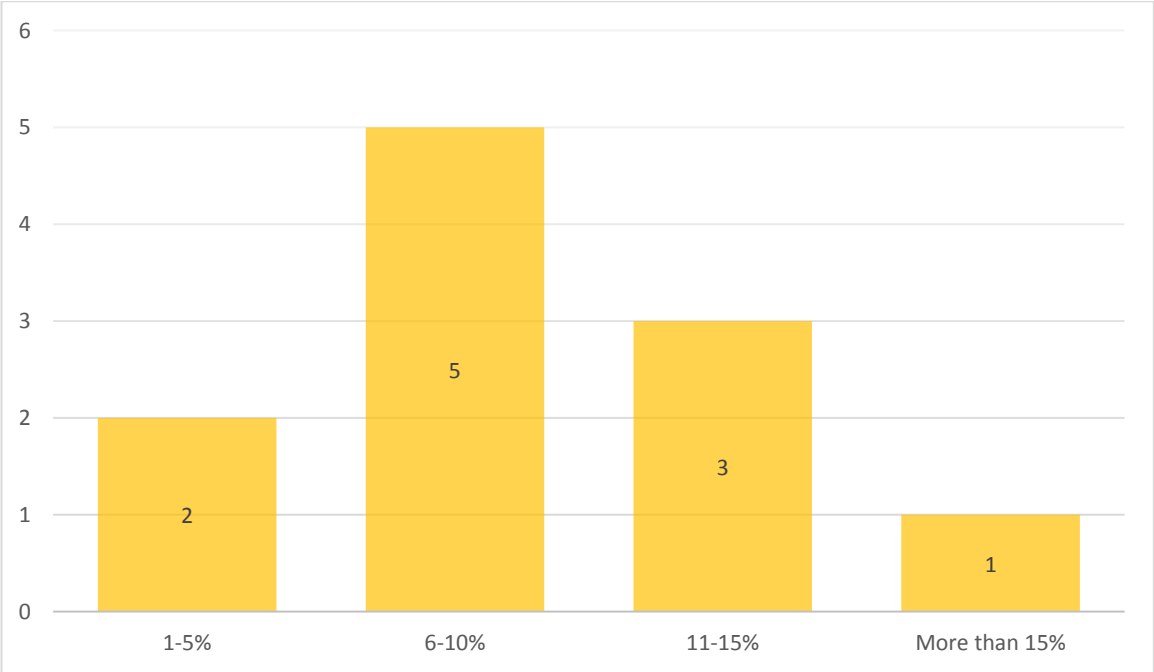


*Figure 4:9 Willingness to pay*

### 4.4.10 Pollution in India

Respondents were asked to rate the given factors what they are the reasons of increasing pollution. For this question the 5 point Likert scale was used as: 5 = strongly agree, 4 = agree, 3 = no opinion, 2 = disagree and 1 = strongly disagree. Out of 44 respondents, 30 (68.2%) were strongly agreed that auto vehicles are one of the major cause of pollution and 14 (31.9) were agreed with this too. When it comes to factories, only 9 (20.5%) respondents were strongly agreed and 32 (72.3%) were agreed to consider it as a reason of pollution, whereas in power stations 35 (79.6%) respondents were neutral/no opinion and 4 (9.1%) disagreed with that.

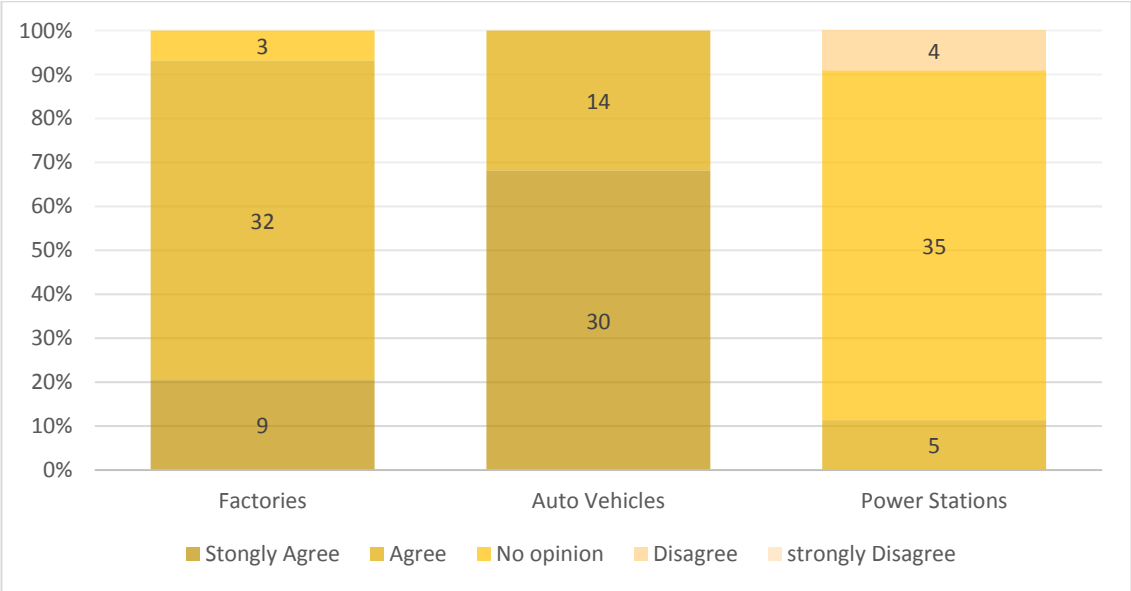


*Figure 4:10 Respondents view on pollution in India*

### 4.4.11 Satisfaction with the current solar energy subsidies and grants

The next question was about the satisfaction with the current subsidies and grants, 31 (70.5%) respondents out of 44 have chosen the option 'poor' and 2 chose 'very poor'. The 11 (25%) responses had stated that subsidies and grant are 'satisfactory' but individuals chose the 'good'.

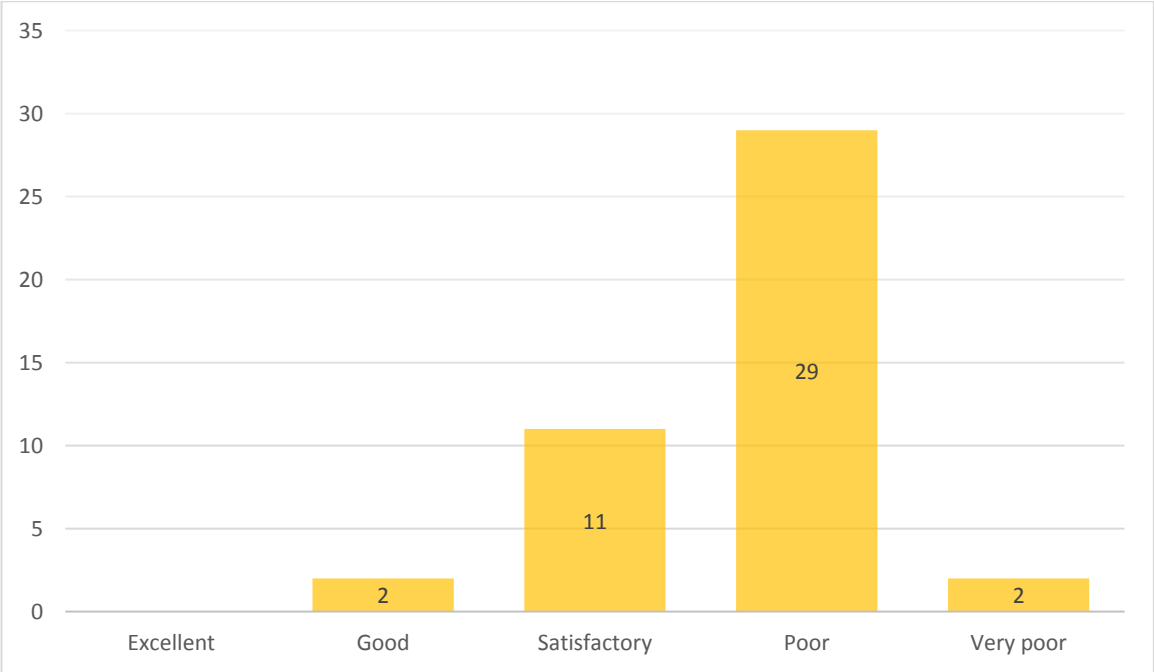


*Figure 4:11 Satisfaction with the current solar energy subsidies and grants*

### 4.4.12 Availability of information on financial support

The researcher asked respondents about what their opinion on the financial information available for customers and five points Likert scale has been used from 'strongly agree' to 'strongly disagree', 21 (47.8%) respondents were 'disagreed' with the statement. About 19 (43.18%) respondents have chosen the option of 'no opinion' and 3 (6.8%) were 'agreed'.

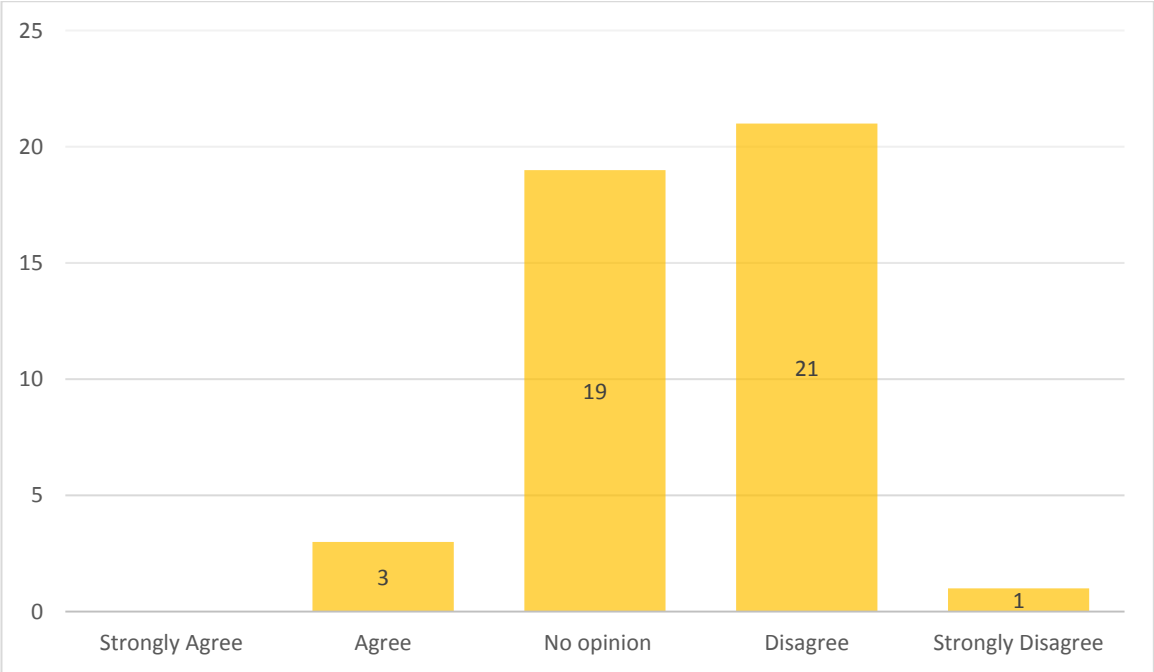


*Figure 4:12 Availability of information on financial support*

### 4.4.13 Financial support provided by government

Respondents were asked that what they think about the financial support provided by the government. A five-point Likert scale has been used for this question from 'excellent' to 'very poor'. Out of 44 respondents, 28 (63.7%) have selected the option 'poor' while 7 (15.9%) respondents have chosen 'very poor'. Only 6 (13.6%) people have selected the option of satisfactory.

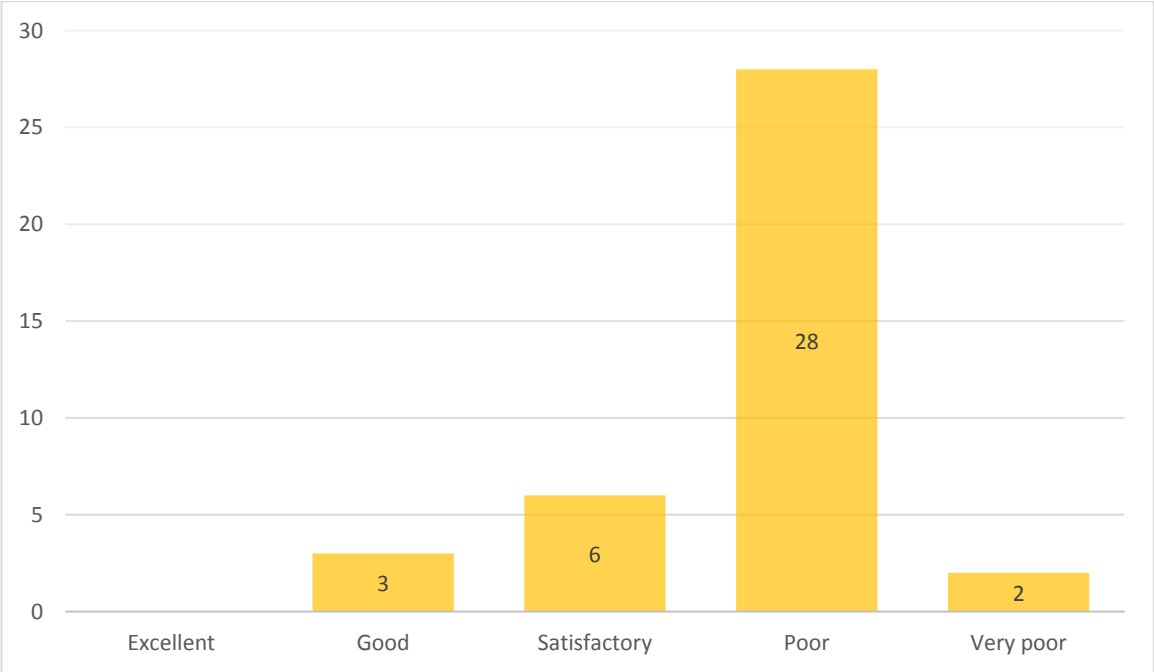


*Figure 4:13 financial support provided by government*

### 4.4.14 Transparency in solar energy policies

Respondents were asked that 'what they think about the transparency in solar energy policies' and for this a five points Likert scale has been used from 'strongly agree' to 'strongly disagree', most of the respondents (27) stayed with the option of 'no opinion' and 8 (18.2%) respondents chose 'disagree'. Only 2 (4.6%) respondents were 'strongly agree' and 6 (13.6%) were 'agree'.

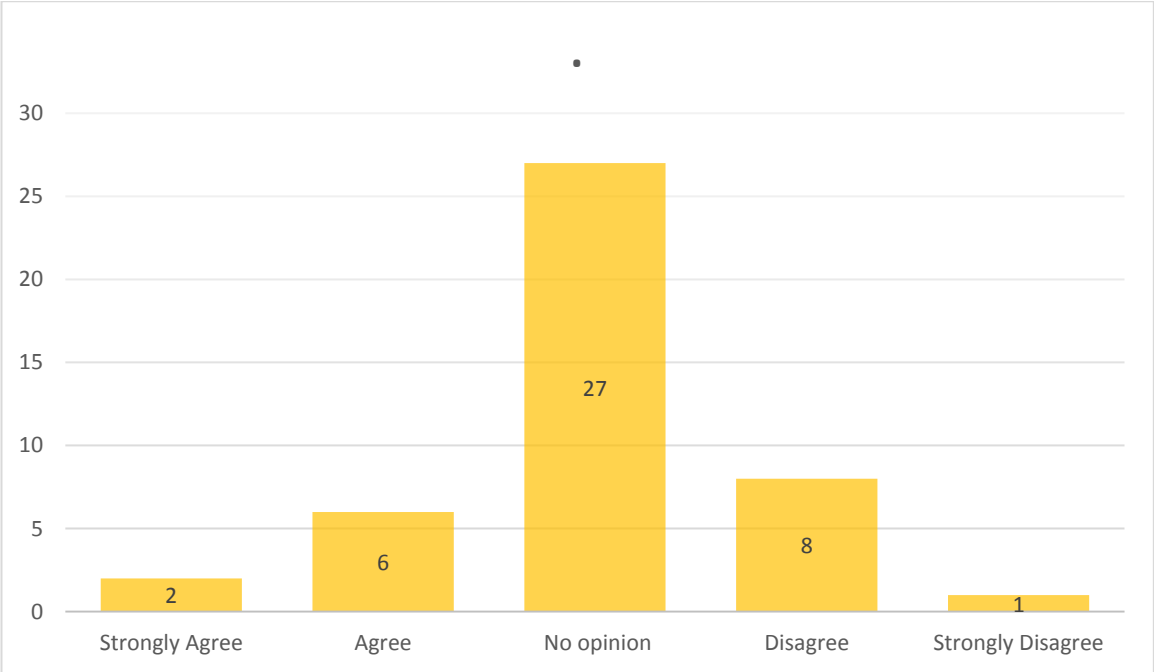


*Figure 4:14Transparency in solar energy policies*

### 4.4.15 Feed-in tariff

The researcher asked the respondents what they think about the feed-in tariff provided by the government and for this five points, Likert scale has been used from 'strongly agree' to 'strongly disagree'. About 23 (52.3%) respondents were stayed with the option 'no opinion' while 11 (25%) have selected 'disagree' and 6 (13.7%) were 'strongly disagreed'. Only 4 (9.9%) respondents were 'agreed' and thinks that there is a guaranteed feed-in tariff in solar energy.

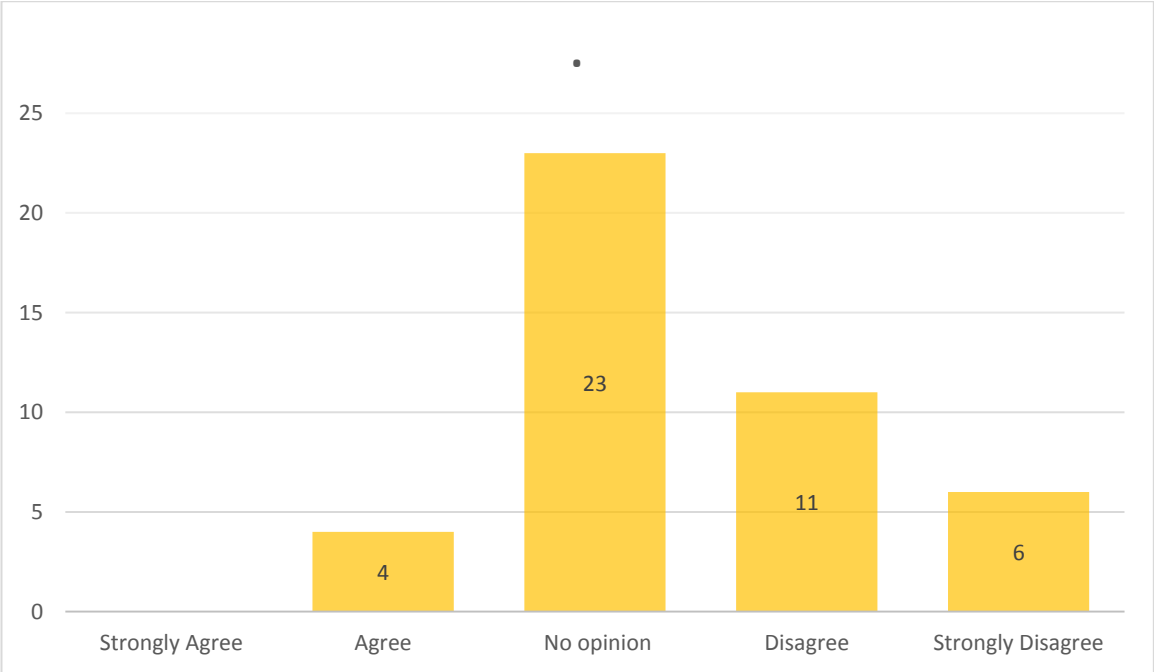


*Figure 4:15 Feed-in tariff*

4.4.16 Factors that play a vital role in solar energy development

Respondents were asked to select an appropriate option for each given factor on the basis of importance. A five-point Likert scale has been used for this question from very low to very high. The following are the responses for each factor:

1. Technology is reliable or durable – respondents were asked that how much technology is important when it comes in reliability and durability. About 34 (77.3%) respondents have chosen the option 'moderate' for this and 6 (13.7%) have chosen 'high' when it comes for technology.

2. Reduces electricity costs – for this factor the replies of respondents were straight, about 38 (86.4%) out of 44 have chosen 'very high' and remaining chose 'high'. From looking these numbers, a straight answer came in front of us that if a person is choosing the solar energy that means he wants his electricity costs will be minimised.

3. Meets the current electricity needs – there are 36 (81.9%) individuals who have selected ‘very high’ for this factors, whereas 7 (15.9%) selected this as ‘high’, that means fulfilling electricity needs is a very crucial factor that must be fulfilled.

4. Benefits the environment – when it comes to the environment, people give it less importance and 15 (34.9%) people have chosen ‘very low’ while 11 (25%) chosen ‘low’. There is only an individual who gave this factor ‘very high’ importance and 16 (36.7%) respondents stayed ‘moderate’.

5. Policies – about 34 (77.3%) respondents have chosen ‘very high’ for the importance of sufficient and encouraging policies and 8 respondents have followed them and chosen ‘high’ for this factor.

6. Subsidies – 35 (79.5%) respondents have chosen ‘very high’ for subsidies and 9 (20.5) respondents given this factor a ‘high’ importance.

7. Easy installation and maintenance – respondents were acted totally opposite for this factor in compare of policies and subsidies. 25 (56.9%) respondents gave ‘low’ importance to easy installation and maintenance while 10 (22.8%) respondents stayed ‘moderate and 7 (15.9%) have chosen ‘high’ but 2 respondents selected this factor as ‘very high’ importance.

8. Maintenance and safety level – about 28 (63.7%) respondents have selected this factor as a ‘low’ importance factor while 15 (34.1%) have chosen it as a ‘moderate’ factor.

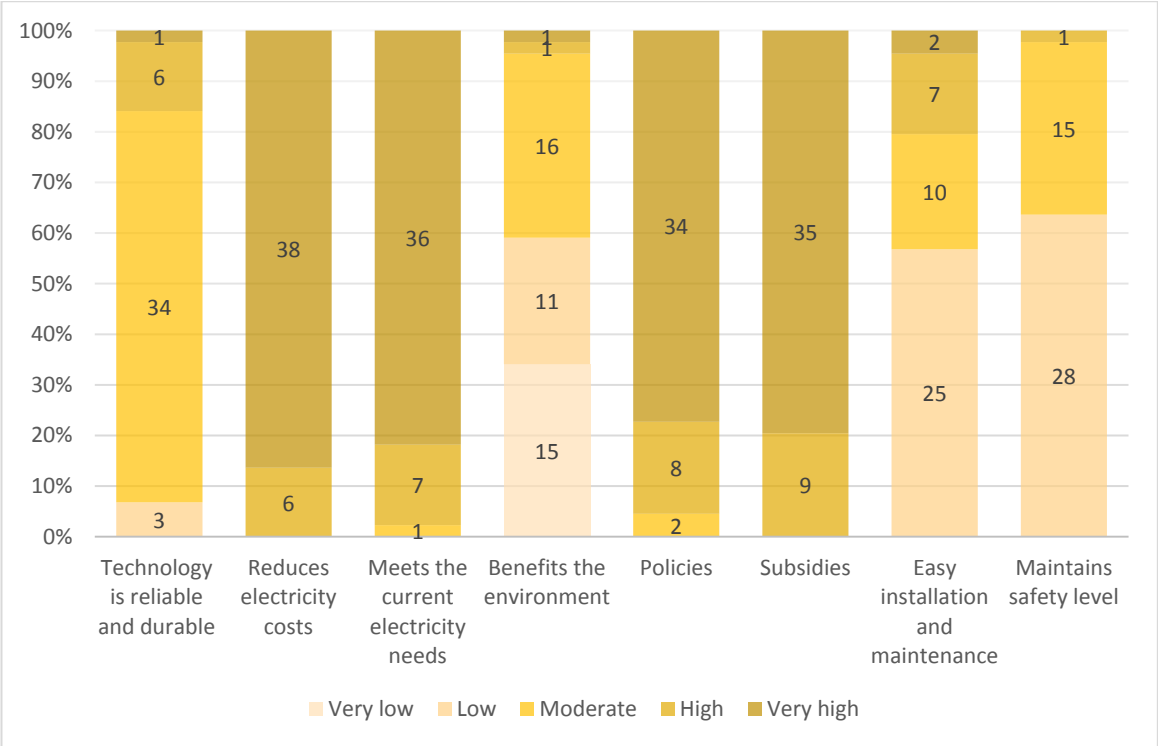


*Figure 4:16 Factors that play a vital role before choosing solar energy.*

### 4.4.17 Barriers in development of solar energy

Respondents were asked to select an appropriate option for each given factor, which can be considered as the barriers and should be improved for further solar energy development. A five-point Likert scale has been used for this question as: 5 = strongly agree, 4 = agree, 3 = no opinion, 2 = disagree and 1 = strongly disagree. The following are the responses for each factor:

1. Cost-effectiveness of solar –most of the respondents (19) were 'agreed' with this factor and consider it as a barrier and 12 (27.3%) respondents stayed 'moderate'. But 4 (9.1%) respondents were 'strongly agreed' with the importance of this factor while (18.2%) respondents were 'disagreed' and didn't consider cost effectiveness as the barrier.

2. Policy barriers – when it comes to policies, about 19 (43.2%) respondents were 'strongly agreed' and thinks the policies plays a vital part in development. And around 16 (36.4%) respondents had followed them and chose option 'agree'.

3. Installation and maintenance – for this factor, respondents stayed neutral and 22 (50%) respondents have chosen 'moderate'. The same number (9) has been appearing for 'agree' and 'disagree'.

4. Technical problems – for this issue, 16 (36.4%) respondents have chosen 'moderate' and 11 (25%) were 'disagree'. But about 13 (29.6%) respondent's selected 'agree' option and that shows that still some technical barriers are there that need to be eliminated for further development.

5. The subsidy is not sufficient – when it comes to the subsidy, the vote undoubtedly were on one side, out of 44 respondents 31 (70.1%) has chosen 'strongly agree' and 12 (27.3%) chose 'agree'.

6. Political barriers – researcher asks respondents to choose one appropriate category from the given options. About 23 (52.3%) respondents have chosen 'agree' for political barriers while 11 (25%) selected 'strongly agree'.

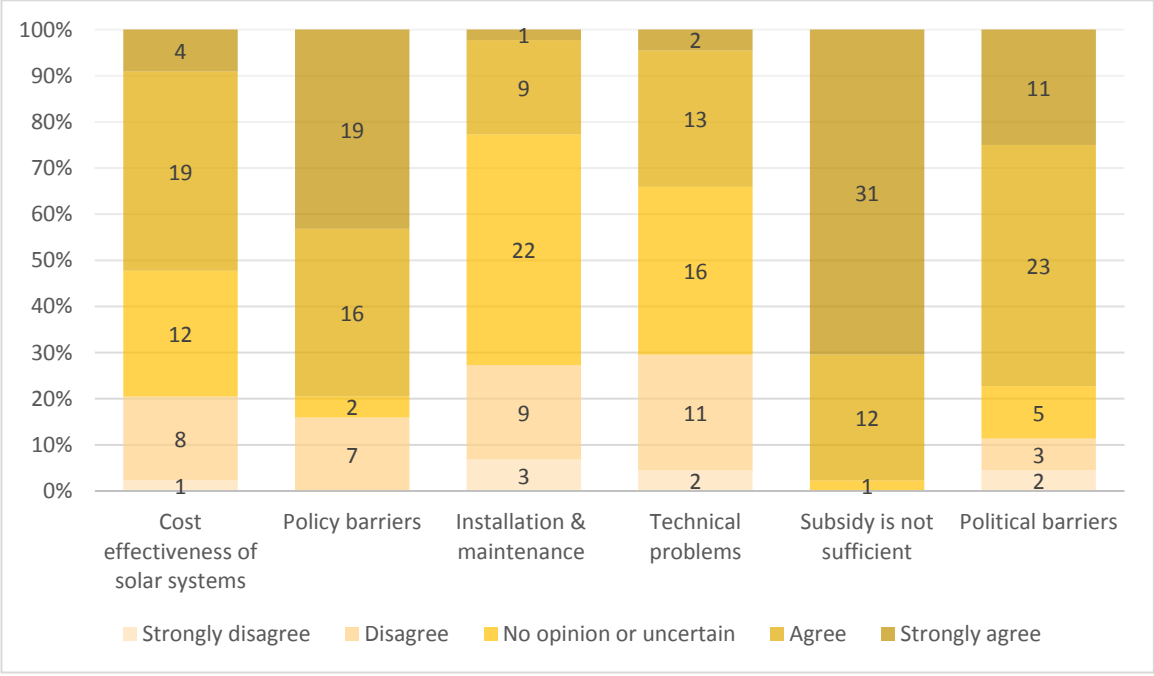


*Figure 4:17 Barriers in development of solar energy*

4.4.18 Key factors where government should focus

Respondents were asked to select an appropriate category from the given points that need to be improved by the government. For this question the 5 point Likert scale was used as: 5 = strongly agree, 4 = agree, 3 = no opinion, 2 = disagree and 1 = strongly disagree. The following are the responses for each factor:

1. Reduce cost – respondents were asked that what should the government do to promote electricity and 32 (72.8%) respondents were 'strongly agree' with the fact that government should reduce the cost of solar energy for its further development while 9 (20.5%) respondents 'agreed' with this fact.

2. Better policies – about 24 (54.5%) respondents were 'agreed' with the option that government should improve its policies to encourage people for solar energy and 19 (43.2%) respondents were 'strongly agreed' with 'better policies'.

3. Better subsidies – the opinion of 35 (79.6%) respondents out of 44, was straight and they 'strongly agree' with the 'better policies' and 9 (20.5%) has selected the option 'agree' for 'better subsidies'.

4. Improved technology – opinion of 44 respondents for this factor were mixed. Out of 44 respondents, 19 (43.2%) have chosen 'agree' while 16 (36.4%) chose 'strongly agree'. But 7 (15.09%) respondents stayed neutral and 2 (4.5%) have selected the option 'disagree' for 'improved technology'.

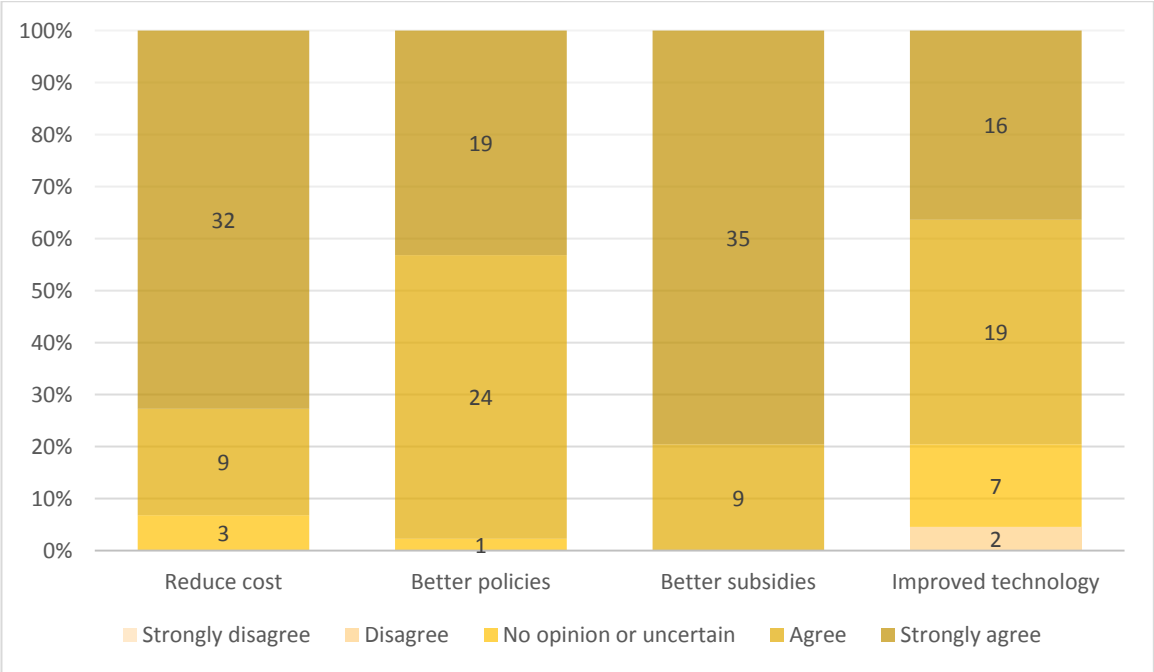


*Figure 4:18 Key factors where government should focus*

## 4.5 Main findings

### 4.5.1 Issues that need to be solved for the further development of solar energy -

From the questionnaire, a point on which government should focus on is policies. The policies play a vital role in development on any sector. The most of the respondents were not happy with the subsidies provided by the government, so the primary goal for the government should be to focus on subsidies. As this factor is also mentioned in the literature review and many researchers also suggested that subsidies are one of many factors that impact the development of solar energy. Subsidies are the vital instrument to support the development of solar energy. As government decrease, the share of subsidies from 30% to 15% on total cost and it leaves a negative impact of people. The government should increase access to financial incentives and this could be done by different forms like the subsidy, tax exemption, long-term credit, low-interest loan, the special fund for solar plants that are connected to the grid and providing energy in remote areas. The financial part is a very crucial for the people because nobody wants to invest heavily on solar until some kind of relief they are

getting back from the government. A one more reason of providing more financial support can be a high payback period of solar energy. With the current subsidies and other financial incentives, it takes too much time to recovery of investment. So looking at all above point's government should focus on subsidies and financial incentives.

One another important factor that arise from the questionnaire is the feed-in tariff. Many reports suggest that India should move its solar energy sector to a fixed pricing model like Germany. The senior president of Yes Bank Ltd, Sanjay Mandavkar said on an interview that 'it's the time to move over to feed-in tariff (Pearson, 2014). To attract more investment in clean energy, these steps are very essential and since India launched the JNNSM, the competition in the solar market is increasing. The project developers have offered an almost discount of around 50% over the base tariff just because of increasing competition in solar energy auctions. According to Chadha (2014), "The recent auctions have seen developers offering to sell solar power at costs like the cost of coal-based power" (Chadha, 2014).

As for India's scenario, political barriers have not been discussed much. A great emphasis have been given on various factors related to solar energy but from the questionnaire survey it has been found that changes made by newly elected government directly impact the policies related to solar energy which create confusion between the policies implemented by state government and central government as both have the right to change policies on their own .This affects the subsidies provided by the government and due to this access to solar energy by local people also reduces. Most of the times subsidies have to be decreased by the government in order to save the revenue which makes solar energy equipment's more expensive.

One more thing that showed up from the questionnaire is that most of the respondents were not happy with the information providing by the government on financial support. The financial support information is very important for the making solar energy attractive and accessible for the people. The government of India did some good financial support implements, but the problems were that there was not sufficient information available. The government should advertise these support via

print media (newspaper) so that these implementations come in front of people and they know that government is doing a good job in the solar sector. This will motivate them to come forward and they have a trust in government that in future government will come with some good plans to help them.

## 4.6 Summary

In a nutshell, the chapter discussed the analysis of surveyed data and discussion of results. From the responses by questionnaire, it can be considered that the solar energy could be one of the best alternatives for the government of India to develop the energy sector. The solar energy can solve the problem of energy needs that are increasing rapidly. From the questionnaire, respondents share their opinion and suggest the areas where the government should focus like policies, feed-in tariff and more. Policies should be the priority for government and needs immediate action. The second area by the respondents where government should concentrate is the feed-in tariff, the current feed-in tariff is not effective and a new 'fixed-pricing model' is suggested by many officials for further development like Germany. There are some political barriers that creating a negative effect in people's mind-set, as new government come in power, they changed the running policies and financial support and the state government also do the same thing and that create a massive confusion. There should be only one department that control everything related to solar energy in the country. Another important factor this chapter discuss is information available on financial support. The government should broadcast the new and improved support just to inform people about that.

# CHAPTER 5- Conclusion

## 5.1 Introduction

Solar energy can play a vital role for any country if the country wants to fulfil the energy requirements in future. Development of energy sector is the top priority of Indian government in compared with other sectors and it needs a huge amount of fund to develop on next level. India has a massive solar potential and it is developing slowly. It is forecasted that Indian solar sector will grow about $6 billion to $7 billion in upcoming ten years. If right steps will be taken in future, solar energy can be India's new and improved method of energy generation. The research has explored each and every part of the solar energy. This chapter discusses the findings, suggestions, limitations and recommendations for further study.

Today or tomorrow India is going to need an another option to generate more energy which is cheap and sufficient for the whole country, it's better if government start implementing some effective changes that help the country in future. In this research, an in-depth study of current renewable energy policies has been done. The main objective from this study was to find out the important areas within the policies that consider as most important and affect the development if there is a tampering. There were many areas which were covered in the section of a literature review. Firstly the literature review discusses the current production of energy and how much more energy India still need. A study on current renewable energy sector has been done and the policies were discussed. After that, a deep analysis on solar energy sector has been done by the researcher and in literature review, a policy and regulatory constraints in the energy sector has also been discussed. It's very important to learn from other and china is a country which is a world leader in solar energy and India should learn from them because they have more population, but still they are improving their solar energy sector rapidly, so a researcher discusses the policies of China and Germany which consider as game changing in the field of solar energy.

At last, the researchers discussed the barriers which are impacting the development of solar energy in India. The government should focus on these barriers and come up with a solution to solve this problem.

These above mentioned important factors were then used in building the questionnaire and tried to find out the opinion of the respondents and what they think about these factor. A study on the positive and negative side of these policies has been done and it helps the researcher in finding out the areas which still demand more attention. These positive and negative sides were used in the questionnaire and asked in the form of the statement.

The analysis of other countries policies helps the researcher to compare it with India's solar policies and this helped in building the questionnaire. The next step was to find the barriers that are impacting the development of solar energy. There were many barriers that come out during the research and all were discussed, but the prominent barriers were asked by the researcher in the questionnaire.

From the questionnaire, the changes were discussed that need to be done for further improvement in the solar sector. These changes can be policies, feed-in tariff, financial support information and political barriers.

## 5.2 Recommendations and Limitations

The important part which is responsible of the development of any sector is Government itself. The policies and support which government implement for the development of any sector are very important, but unfortunately, India's record on governance and accountable institutional mechanisms is weak. An example of BEE has been given in literature review which shows the serious concern of governing institutions. The government should start making changes that will benefit the country in future, these changes can start from policies. As these policies include important factor like subsidies, financial support, feed-in tariff etc. The government should focus on subsidies and other financial support because more attractive subsidies can attract more people towards solar energy. The government should provide more subsidies

and financial support till country not reach its goal to generate 22,000 MW of electricity by 2022 from solar grids.

Another thing which is also important in the development of solar energy is that government should not change policies too many times. When a new government comes in power, they come with a new ideas and approaches and they change the policies but the people don't want these changes because sometimes these new policies are in favour and sometimes not. For example, in one Indian state 'Haryana', a new government comes in power and they change the subsidies from 30% to 15%. Such kind of new policies leave a negative impact on people and it should not be like this.

One more important thing is that the government should advertise the new policies/schemes that they implemented for the development of solar energy and these new schemes can be advertised via print media or social media and television so that people will know about the schemes and efforts government is making for the development of solar energy.

The R&D department and institution of India should more focus on developing more advanced solar equipment's that can help in the development of solar energy and they should come up with the new technology which is advanced and cheap. The government should invest more on R&D department so that there is a continuous improvement on solar sector so that the new improved technology help the people and government.

The research could have discovered some more barriers but due to the financial problems it was hard to travel back to the country and due to this face to face interviews and understanding of real scenario wasn't possible.