CHAPTER 1

1. Introduction

1.1 Brief History of Wind Power

There are five basic constituents’ of the universe. These are Prithvi (earth), Apa (water), Tejas (fire), Vayu (air), and Akash (ether). They are known as Panchbhatta. According to ancient Indian philosophy the entire physical universe and every living and non-living element in it (including our bodies) is composed of these five basic elements. Man has been harnessing these energy sources for various purposes since times immemorial.

Vayu or air is one such element which has been used by man for different purposes such as using wind turbines installations to make electricity, wind mills for mechanical power, wind pumps for pumping water or drainage, or sails to propel ships. Wind is nothing but moving air. It is caused by difference in air pressure within the atmosphere. Wind power is derived by converting the Kinetic energy of the wind into other forms of energy like mechanical energy, electrical energy etc.

In around 5000 B.C., wind energy was used to sail ships. In the second century A.D, Heron of Alexandria built a windmill to grind grains. (A.G. Drachmann). The use of wind mill was widespread in Iran, Afghanistan, China, India and later spread to Europe. In 1887, Professor James Blyth built the first wind turbine to produce electricity from a cloth sailed wind turbine (Hardy, Chris.). Danish scientist Poul la Cour is credited with inventing fast moving wind turbines with few rotor blades used to generate electricity. (Geoffrey Jones and Loubna Bouamane).

The importance of wind power declined in the 19 th century. The demand for fossil fuels like coal, oil and gas increased and till date are important sources. This was due to the fact that power from these sources was more reliable. The wide spread use of electricity
generated through fossil fuel became the preferred source of the power for the industrialized world. (Per Dannemand Andersen, Ph.D.).

The interest in wind energy was revived due to oil shocks of 1970s and the environmental degradation due to use of fossil fuels. The world realized the importance of using clean, green and renewable sources to meet its power requirements. Mass production of wind turbines was undertaken by Danish manufacturers Kuriant, Vestas, Nordtank and Bonus in the year 1979 (IRENA, 2012). This was the beginning of modern use of wind power.

The early wind turbines had small capacities ranging from 10 KW to 30 KW. The modern day wind turbines have capacities ranging from 2MW to 5MW. Wind turbines are installed in groups and are called wind farms.

1.2 Need for wind power

The demand for power is growing in the world. The main reasons for this growing demand are rapid industrialization, growing population and increased urbanization. This growing demand cannot be met by fossil fuels alone. This is because of fast depleting reserves of fossil fuels. Secondly; reserves for fossil fuels are concentrated in few countries. The oil shocks of 1970 and its impact on world’s economies has made the world aware of the danger of relying only on fossil fuels for its power requirements (Soren Krohn, Poul Erik Morthost, Shimon Awerbuch.) Thirdly, fossil fuels have a negative impact on environment by emitting green house gases. Hence, need was felt for an alternate source of power generation which can reduce the fuel price risk as well as has no negative impact on environment.

Renewable Energy sources like wind, solar, bio gas have emerged as viable alternatives. They have no fuel cost and are environment friendly. Amongst Renewable Energy sources also wind has emerged as the most commercially viable source. An estimated 72 terawatt of wind power on the Earth potentially can be commercially viable, as compared to about 15 terawatt average global power consumption from all sources. (Greenworld 2010).
Peter Meisen has made the following comparison between wind energy and fossil fuel.

**Table 1: Comparision of Wind Energy with Fossil Fuel**

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Wind</th>
<th>Fossil Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Availability</strong></td>
<td>It is usable as it in its present form.</td>
<td>It has to be procured and has to be made usable through laborious and environmentally damaging process.</td>
</tr>
<tr>
<td><strong>Limitation on availability</strong></td>
<td>It is an Inexhaustible resource.</td>
<td>The reserves are limited, expected to be completely exhausted in 60 years.</td>
</tr>
<tr>
<td><strong>Transportation</strong></td>
<td>It is used where it is available or transported where needed.</td>
<td>It has to be transported from its source site for further processing, exposing the environment to pollution from accidents.</td>
</tr>
<tr>
<td><strong>Environmental effect of use</strong></td>
<td>It has zero emission.</td>
<td>It is used in production of electricity releasing green house gases.</td>
</tr>
<tr>
<td><strong>Geo-political implications</strong></td>
<td>It reduces reliance on oil, safeguarding national security. Allows for self sufficiency. There is no adverse impact on global environment. The whole</td>
<td>The over reliance on oil as a resource has undermined India’s energy security eg OPEC crisis of 1973, Gulf war of 1991 and</td>
</tr>
</tbody>
</table>
1.3 Cost Constituents of Wind Power

The following components constitute the cost of generating power from any sources

1) Capital costs (the cost of land acquisition, building the power plant and connecting it to the grid)

2) Running costs (such as buying fuel and operation and maintenance) and

3) The cost of financing.

In order to become profitable the cost of generation should be less than selling price of electricity. In case of wind, the fuel that is wind is free and in abundant supply hence once the capital costs are covered the only cost that remains is the maintenance and financial costs. The capital cost comprises of around 75% to 90% of total costs. The financial costs will vary depending upon the cost of funds, the policies of the government relating to tax and incentives offered (Dr Gary L. Johnson)

There are two major factors that influence the cost of wind power generated.

1) Technical factors.

2) Financial factors.

The following technical factors influence the quantity of wind power generated. These are as follows:

a) The wind resource available at the site:

The power available from the wind is a function of the cube of the wind speed. Therefore, if the wind blows at twice the speed, its energy content will increase eight fold. Hence, turbines at a site where the wind speed averages eight meters per second will
produce around 80% more electricity than those where the average wind speed is six meters’ per second.

b) Capacity of wind turbines:
The capacity of wind turbines is the capability of turbines to operate when the wind is available.

c) The arrangement of the wind turbines in the wind farm:
The turbines in wind farms are arranged in a way so that they do not shadow each other.

Financial factors: The financial factors that influence the feasibility of project are

1. The return on investment

2. The rate of interest on debt funds.

3. The loan repayment period.

4. Subsidies and tax incentives offered by the State.

All the above factors determine the financial feasibility of the project. If the loan repayment period is shorter and the rate of return is higher it will increase the cost of generation. (Conomics of Wind Energy)

The cost of generation from wind energy differs between countries. However, the overall cost of generation from wind energy is coming down. This is due to various reasons. The turbines are getting cheaper because of improvement in technology. They are also able to produce more electricity. There is also a trend towards larger machines. This reduces infrastructure costs, as fewer turbines are needed to produce the same output.
1.4 Status of Wind Power in the World at the end of 2012

Currently eighty five countries spread across five continents generate power from wind. The United States of America and other European countries like Denmark, Spain and Germany have been the pioneers in making use of wind power. However, Asian countries like China and India have also realized the importance of wind power. By the end of 2010, China had ended the dominance of the United States and other European nations by having the highest installed capacity in megawatt, as shown in the table below. India continued its fifth position three years in a row slipping from its earlier fourth position.

Table 2: Top 10 countries by cumulative wind power capacity (2012)

<table>
<thead>
<tr>
<th>Country</th>
<th>Capacity in MW(mega watt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>75,324</td>
</tr>
<tr>
<td>United States</td>
<td>60,007</td>
</tr>
<tr>
<td>Germany</td>
<td>31,308</td>
</tr>
<tr>
<td>Spain</td>
<td>22,796</td>
</tr>
<tr>
<td>India</td>
<td>18,421</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>8,445</td>
</tr>
<tr>
<td>Italy</td>
<td>8,144</td>
</tr>
<tr>
<td>France</td>
<td>7,564</td>
</tr>
<tr>
<td>Canada</td>
<td>6,200</td>
</tr>
<tr>
<td>Portugal</td>
<td>4,525</td>
</tr>
<tr>
<td>Rest of the world</td>
<td>39,853</td>
</tr>
</tbody>
</table>

Source: GWEC, 2012
Till the early 1990, very few countries in the world had renewable energy policy. However, from 2005-10 many countries in the world adopted some policy measures to promote renewable energy. The most common policy measures adopted are enlisted below.

1. Feed in tariff: It is the most common policy measure adopted by the countries. Tariff at a higher rate is paid for purchasing electricity generated from a renewable energy source. This tariff is calculated keeping the cost of generation in view. A long term power purchasing agreement based on feed in tariff ensures marketability of energy generated.

2. Renewable Purchase obligations: This policy measures makes it mandatory for the power utilities to purchase a certain quota from renewable energy source. Those utilities that are not able to purchase electricity can purchase the Renewable certificates. These certificates are similar to carbon credit certificates.

Source: GWEC, 2012
3. Many other policy measures are adopted, for example, some type of direct capital investment subsidy, grant or rebate may be provided. At least forty five countries have adopted these measures.

4. Tax incentives: Tax incentives like investment tax credits, import duty reductions are also popular policy measures adopted by the countries.

5. Competitive bidding: Many countries adopt competitive bidding for fixed quantity renewable power capacity. Net metering laws for distributed generation exist in at least ten countries and forty three U.S states. (Renewables 2010 Global Status Report)

1.5 Growth of Wind Power In India

The demand for energy in India has been increasing due to increased economic activities and growth in population. In order to meet the rising energy demand, power generation capacity must increase to nearly 8,00,000 MW by 2031-32, from the current capacity of around 1,60,000 MW. Indian government has taken many steps to bridge the gap between demand and supply of energy. It has formulated policies and enacted legislation to promote renewable energy and energy efficiency. India is the first country in the world to establish a separate ministry for promotion of renewable energy. An independent Ministry of Non-Conventional Energy Sources was set up in 1992. In the last decade, India has created strong legal, policy and regulatory framework for promotion of clean energy. The Wind power programme in India started in 1983-84. A market-oriented strategy was adopted from the very beginning. This has led to the successful commercial development of the technology. The broad based National programme includes the following:

- Wind resource assessment activities;
- Research and development support;
- Implementation of demonstration projects to create awareness
- Opening up of new sites;
- Involvement of utilities and industry;
• Development of infrastructure capability and capacity for manufacture, installation, operation and maintenance of wind electric generators;
• Policy support.

India has a good wind resource. The strong south-west summer monsoon, which starts in May-June, influences the wind resource in India. During the period March to August, the winds are uniformly strong over the whole Indian Peninsula, except the eastern peninsular coast. Wind speeds during the period November to March are relatively weak. However, higher winds are available during a part of the period on the Tamil Nadu coastline.

Table 3: Wind power installed capacity addition in India (2005-12)

<table>
<thead>
<tr>
<th>India</th>
<th>Up to 2005</th>
<th>05-06</th>
<th>06-07</th>
<th>07-08</th>
<th>08-09</th>
<th>09-10</th>
<th>10-11</th>
<th>11-12</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulated MW</td>
<td>3635.7</td>
<td>1716.3</td>
<td>1742.2</td>
<td>1663.5</td>
<td>1484.9</td>
<td>1564</td>
<td>2349.5</td>
<td>3196</td>
<td>17353.6</td>
</tr>
</tbody>
</table>

Source: MNRE

Another notable feature of Indian wind power is that the Centre lays down broad policy guidelines within which states frame their own rules. The states monitor the growth of wind power in their respective states. Table 4 shows state wise installed capacity in India.

Table 4: State-wise Wind Power Installed Capacity in India

<table>
<thead>
<tr>
<th>Sr.</th>
<th>States</th>
<th>Potential in MW</th>
<th>Installed till 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Andhra Pradesh</td>
<td>5394</td>
<td>245.20</td>
</tr>
<tr>
<td>2.</td>
<td>Gujarat</td>
<td>10,609</td>
<td>2996.30</td>
</tr>
<tr>
<td>3.</td>
<td>Karnataka</td>
<td>8591</td>
<td>1933.50</td>
</tr>
<tr>
<td>4.</td>
<td>Kerala</td>
<td>790</td>
<td>35.10</td>
</tr>
<tr>
<td>5.</td>
<td>Madhya Pradesh</td>
<td>920</td>
<td>376.40</td>
</tr>
<tr>
<td>6.</td>
<td>Maharashtra</td>
<td>5439</td>
<td>2733.30</td>
</tr>
<tr>
<td>7.</td>
<td>Rajasthan</td>
<td>5005</td>
<td>2070.70</td>
</tr>
</tbody>
</table>
1.6 Policy and Regulatory Environment in India

India has established an enabling environment for the development of wind energy in the country. The policy and regulatory environment, according to IRENA-GWEC, 2013 report, can be broadly divided into the following four phases.

Phase 1.

This phase covers a period of ten years from 1981-1990. It can be called as technology demonstration and Research and development phase. The highlights of this phase have been the establishment of Commission of Additional Sources of Energy (CASE), in 1981, under the Department of Science and Technology. This department has been entrusted the task of formulating policies for the growth and development of renewable energy. In 1982, an independent department called as Department of non-conventional energy sources (DNES) was set up under the Ministry of Energy. This phase was marked with setting up of demonstration projects and research and development in this sector with the collaboration of Danish aid agency (DANIDA).

The policy framework laid down during this phase was to encourage a market oriented strategy (Mizuno, 2005). The Government provided a lot of incentives which encouraged the private sector to venture into wind energy. A Government owned public limited company called Indian Renewable Energy Development Agency (IREDA) was set up to provide soft loans to this sector, in 1987.
Phase 2
This phase covers a period from 1991-2000. This was a period of economic liberalization. The economic reforms allowed the foreign entities to participate in wind energy sector through joint ventures, financial and technical collaborations. The domestic manufacturing with the help of Danish and German companies like Vestas, Enercon and other foreign companies started. This transfer of technology took place through a series of licensing agreements. To ensure quality, procedures and guidelines were issued in 1995. This phase marked the starting of early commercialization phase in the development of wind power.

Phase 3
This phase covers a period from 2000-2008. During this period the Electricity Act 2003 was passed. This Act mandated the formulation of National Electricity Policy (2005), National Tariff Policy (2006) and the Rural Electrification Policy (2006). The Tariff policy 2006 ensured a price certainty for renewable energy projects. The centre gave broad policy guidelines, within which the states could frame their own policies relating to tariff rates, Setting quotas for purchase of Renewable energy, known as Renewable Purchase Obligations (RPO), and encouraging renewable energy in the state. The responsibility of laying down tariff rates and quota was entrusted to State Electricity Regulatory Commission (SERC). In 2006, the Ministry of Non Conventional Energy Sources was renamed as Ministry of New and Renewable Energy (MNRE).

Phase 4
This phase covers a period from 2009-2012. During this phase the Generation based incentive (GBI) were introduced. Generation based incentives are incentives over and above the preferential tariffs and are applicable to projects commissioned before 31st March, 2012. These were introduced to encourage Independent Power Producers (IPP). The incentive of GBI and Accelerated Depreciation (AD) was mutually exclusive. Central Electricity Regulatory Commission also started the system of Renewable Energy Certificates (REC). Those entities who could not procure their quota of renewable energy could purchase these certificates to meet their Renewable Purchase Obligations (RPO).
1.7 Ministry of New and Renewable Energy (MNRE)

The Ministry of New and Renewable Energy (MNRE) has an important role to play in tapping alternative resources to meet the growing energy needs. A comprehensive Renewable Energy Policy has been formulated by MNRE with following broad guidelines:

- Providing decentralized energy supply to agriculture, industry, commercial and household sectors.
- 10% of total grid power generation capacity (approximately 20,000 MW) to be from Renewable Energy Sources by 2012. It is envisaged that more than 50% of this capacity addition that is > 10,000MW would come from Wind Power.

The major functions of this ministry include

- Policy making and planning
- Programme formulation and implementation
- Research and development
- Technology development and commercialization
- Promotion of demonstration, pilot projects and extensive programmes.
- Implementation of fiscal and financial incentives
- Human resources development
- Training
- Promotion of intellectual property rights
- Protection, international co-operation, consultancy services and co-operation.
- International co-operation

The ministry has taken several new initiatives for promotion of renewable energy outlined below:

- Export promotion and business development
- Non conventional energy technology commercialization fund (NETCOF)
- Project preparatory assistance
- Human resource development
1.7.1 Institutions under MNRE

Programme for dissemination of Renewable Energy Technologies (RET) are implemented through State Nodal Agencies (SNA). Administratively the state nodal agencies are under the respective State Governments, but they receive financial support from MNRE for programme implementation. In order to promote RET on commercial basis MNRE has established Indian Renewable Energy Development Agency (IREDA).

a) Indian Renewable Energy Development Agency (IREDA).

The Indian Renewable Energy Development Agency was incorporated as a public limited Government company in 1987 under the administrative control of the Ministry of New and Renewable Energy, Government of India. It has been notified as a public financial institution under section 4A of the Companies Act, 1956. It is classified as Non–Banking Finance Company (NBFC) by the Reserve Bank of India. It is an ISO 9001:2000 company. It has been earning profit since inception and is a dividend paying company.

IREDA has the following objectives

- To operate a revolving fund for development and deployment of New and Renewable Sources of Energy (NRSE)
- To give financial support to specific projects and schemes for generating electricity and energy through new and renewable sources and conserving energy through energy efficiency.

IREDA gives financial assistance for the following purposes

- Project financing
- Equipment financing
- Loans for manufacturing
- Market Development including export promotion
- Energy Centers
- Financial intermediaries
- Business Development Associates
Renewable Energy Efficiency Umbrella Financing

b) Centre for Wind Energy Technology (C-WET)

The centre for wind energy technology known as C-WET in short, is an autonomous research and development institution established at Chennai in 1998, by the Ministry of Non-conventional Energy Sources (MNES) now known as Ministry of New and Renewable Energy (MNRE) of Government of India. It is a knowledge-based institution of high quality. C-WET has been actively supporting the wind turbine industry in developing the knowhow and promoting export of products and services. It also promotes inter-institutional research and development projects involving national laboratories, universities, academicians, and industry in a co-ordinated way for niche areas of wind energy technology. C-WET comprises of five functionally organized units which are as follows;

- Research and development
- Wind resource assessment
- Wind turbine testing (WIT) and wind turbine testing station (WITS)
- Standards and Certification (S&C)
- Information, Training and Commercial Services (ITCS)

Each unit has its own charter keeping in view the overall objectives for C-WET. Each unit is independent at operational level but they supplement and complement each other’s activities so as to give a holistic solution to the stakeholders. (Indian Wind Power Directory, 2009)

1.8 Role of State Government under the Electricity Act 2003.

The role of State Government, under this Act, is limited to framing Renewable Energy Policy. The State Governments are also required to take suitable measures, as given below, to keep the project cost within reasonable limits and to reduce the impact of purchase of electricity at a higher cost.
• Providing Government land at a nominal cost wherever available
• Subsidizing the cost of infrastructure development like approach road, improvements required in extra high voltage (EHV) grid substations for evacuations of the generated power from the project site.
• Subsidizing the cost of electricity purchase by the licensees from such sources to minimize the impact on average cost of energy sold in the state.

The Government policies are implemented either through State Nodal Agencies (SNA) or through State Electricity Regulatory Commissions (SERC).

1.9 Regulatory bodies of different states under study

1.9.1 Maharashtra

The state of Maharashtra is situated in the western parts of India. It is one of the largest states in the country, with an area of approximately 308,000 sq km (119,000 sq miles). The total population of 96,752,247 is divided into 43.4% urban and 56.6% and rural sector as per 2001 census. Per capita income in the state is approximately Rs.17, 295 as compared to the national average of Rs. 10,771. The state contributed almost 14.7% of the country's industrial output and 13.2% of its Gross Domestic Product in 2005-06.

Over the last few decades, economic growth, liberalization and rapid expansion of urban areas have affected the electricity consumption patterns in Maharashtra significantly. Total consumption has more than trebled in the last two decades. The state achieved 100% electrification only in 1991 after which demand has outstripped the supply.

Maharashtra Energy Development Agency

The Government of Maharashtra, in exercise of the powers conferred under clause (d) of section 15 of the Energy Conservation Act (Central Act no.52 of 2001), has designated the MEDA or Maharashtra Energy Development Agency as "The Designated Agency" to coordinate, regulate and enforce the provisions of the Act, and also to implement
Schemes under the said Act within the State of Maharashtra. MEDA as an organization commenced functioning from July 1986. MEDA's objective is to undertake development of renewable energy and facilitate energy conservation in the State of Maharashtra, as a state nodal agency under the umbrella of MNES. The controlling body of MEDA is the governing body with the Honorable Minister for Energy, Maharashtra State, as Chairman and the Honorable Minister of State for Energy as Vice-Chairman.

1.9.2 Tamil Nadu

Tamil Nadu is the eleventh largest state in India by area and the seventh most populous state. It has the third largest economy (2007–2008) among all states in India, and also the most industrialized state in India. It is the fourth largest contributor (as of 2010) to India's Gross Domestic Product. According to the publications of the Tamil Nadu government the Gross State Domestic Product at Current Prices (Base year 1999–2000) for the year 2008–2009 is 339,212 crores. Tamil Nadu’s gross state domestic product for 2011 is estimated at US$ 97.970 Billion in current prices and Tamil Nadu is also the most urbanized state in India. The state has the highest number (10.56%) of business enterprises and stands second in total employment (9.97%) in India, compared to the population share of about 6%. The per capita income in 2007–2008 for the state was 43,000 ranking second among the South Indian states and steadily been above the national average.

Tamil Nadu Energy Development Agency

The Government of Tamil Nadu realized the importance and need for renewable energy, and set up a separate Agency, as registered society, called the Tamil Nadu Energy Development Agency (TEDA) in 1985, as per G.O.Ms.No.163, P. & D. (EC) Department, dated 29.11.1984 with the following specific objectives:-(www.teda.in).

i. To promote the use of new and renewable sources of energy (NRSE) and to implement projects for.

ii. To promote energy conservation activities.

iii. To encourage research and development on renewable sources of energy.
The promotion of grid connected and decentralized power generation from locally available sources would reduce the dependence on conventional power. The decentralized power systems can also make power available at remote places in the State where grid power could not be extended and will facilitate development of rural and remote areas.

1.9.3 Gujarat

The state of Gujarat is in western India. It has an area of 75,686 sq mi (196,030 km²) with a coastline of 1,600 km, most of which lies on the Kathiawar peninsula. Gujarat Population Census Data shows that it has Total Population of 6.03 crore which is approximately 4.99% of total Indian Population. The Urban Population of the State is 42.6% while the rural population in the state in 2011 was 57.4%. The share of Gujarat State for the year 2006-07 at current prices and at constant (1999-2000) prices in Gross Domestic Product at all India level works out to 6.7 percent and 6.5 percent. The per capita income at constant (1999-2000) prices has been estimated at Rs. 27027 in 2006-07 which is higher than national average.

Gujarat Energy Development Agency (GEDA)

Gujarat Energy Development Agency (GEDA) is a State Government grant in aid, Nodal Agency for promotion and popularization of new and renewable sources of energy in the State of Gujarat. (www.geda.org.in)

i. The Agency also promotes and popularizes improved and efficient technologies. The Agency provides appropriate subsidy on various schemes and projects using non-conventional sources of energy like solar energy, wind energy, bio energy etc. The agency promotes research programs in the fields of renewable sources of energy.

ii. Appropriate subsidies and incentives are being provided on various schemes which include Wind Mills for water pumping, Wind farm for power generation, Anemometers for wind power potential assessment.
1.10 Concluding Remarks and Discussion about Present Research

The above discussion on the importance of wind power brings out the fact that there has been a substantial growth of wind power both in India as well as in the world. The main reason for such a phenomenal growth has been the supportive policies adopted by the respective Governments. This is because the world has realized the danger of overdependence on fossil fuel. Wind energy has emerged as a viable alternative because of its clean, green and renewable nature. A wind turbine power project installation can commence its operation within 6-8 months of its installation. Hence, the Governments have promoted wind energy by offering incentives which will make investment in wind energy more attractive.

In India also the increasing gap between demand and supply of power has compelled the Government to explore alternative sources of power. Renewable Energy has evolved as a potential energy source. It is fuel effective and environment friendly. Among Renewable energy sources also wind is the most feasible source. Hence, the Government has promoted this resource through suitable policy measures. The impact of Government policies on the investment scenario in wind turbine power project installations has been brought out by this research.

1.11 Rationale behind selection of the topic.

The demand supply mismatch in the power scenario in India is a matter of great concern. If India has to progress economically there should be availability of surplus power. The researcher, like any other concerned citizen of the country wanted to understand the current power scenario prevailing in the country and the ways and means of reducing the gap between demand and supply of power. After going through the available literature the researcher reached a conclusion that wind is the most feasible source which can be promoted as one of the sources of power generation.
The policies framed by the Government play a major role in promoting a particular sector. The researcher wanted to understand the impact of Government policies on the financial viability of wind turbine installations. If these policies were encouraging investment in wind turbine installations and what more could be done on the policy front to encourage investment so that this sector can become one of the solutions to India’s increasing power demand.

Hence, the researcher decided to study the impact of Government policies on the financial viability of wind turbine installations. This was the rationale behind selection of the topic.

1.12. Identification of problem related to the Thesis

In India also the incentives provided by the Government have been the main drivers for growth of wind energy. As a result India ranked fourth and then slipped to fifth position in the World in development of wind energy. Tracing the growth of wind energy in India it can be said that it has entered the market commercialization stage. (Akanksha Chaurey, M Kamal Gueye and N.Yuvraj Dinesh Babu, (2004)). The gap between the cost of wind power and that of fossil fuel is slowly narrowing down to the extent that it will be completely eliminated in the very near future. In such a scenario and after going through the available literature, the basic question that came in the mind of the researcher was that,

“Are the incentives being provided by the Government required in the current situation or can wind turbine power projects become commercially viable without these incentives also?” This was the research gap identified by the researcher.

On the basis of the research gap the research problem that has been identified is as follows:

1) Understanding the cost structure of wind turbine power project installations: This means studying the capital and cost, operations and maintenance cost and financial cost of wind turbine power project installations.
2) Understanding the policies of Central and state Governments: In India the Central Government lays down basic guidelines within which the states frame their own policies.  
3) Analyzing the impact of Government policies on the profitability of wind turbine power project installations.

1.13 Plan to address the problem in the Thesis

The research problem stated above has been addressed as follows:
1. The private research reports, Government research reports, Government regulations, research papers, books, articles and important websites have been accessed to understand the following:
   a) Overall power scenario in India,
   b) Wind power scenario in India;
   c) Cost structure of wind turbine power project installations;
   d) The policies of the Central and state Governments.

   In order to study the policies adopted by the state Governments, three states have been selected based on their installed capacity. In the above three states the growth of wind power installations has been substantial. Hence, the researcher wanted to analyze the policy measures adopted by these states.

2. The implications of policies on the profitability and investment decision of wind turbine power project installation have been studied in two ways:

   • By Financial Analysis:
     The income statement and cash flow statements have been prepared on the basis of Tariff policies of the above three states. Cash flow statements and income statements have also been prepared on the basis of incentives offered by the Government. Ratio analysis and Capital budgeting techniques like Pay back, IRR as well as sensitivity analysis has been adopted to find out the returns from wind turbine power project installations.

   • By Primary Data Analysis:
Primary data has been collected from wind turbine power project owners to understand their views regarding the Government policies, the working of Government agencies, the reason for investment in wind turbine power project installations and the willingness to reinvest in wind projects.

1.14 Relevance of Research

The demand for power in India is increasing due to rapid industrialization, increased urbanization and growing population. As a result there is demand and supply gap in the availability of power. Fossil fuel is the major source of power in India which is scarce in supply in the country hence has to be imported. Secondly, it is not environment friendly. These two reasons have led the Government to look into alternative situation of producing power and one of the viable alternatives is wind power.

The current research helps in bringing out the following:

a) Analyzing the tariff policies of the states under study and the limitations of the same,

b) Analyzing the incentives provided their need and their impact on profitability of wind turbine installations;

c) Understanding the views of wind turbine installation owners regarding Government policies and their expectations from the Government in terms of policy measures;

d) Understanding the views of wind turbine installation owners regarding working of Government agencies;

e) Understanding the views of wind turbine installation owners regarding reinvestment in wind turbine power project installations;

f) Recommending suitable policy measures on the basis of the above study.

Hence, the present study is very relevant from the viewpoint of promoting investment in wind energy.
Fig 1: OVERVIEW OF RESEARCH

LITERATURE REVIEW
BOOKS, RESEARCH PAPERS, RESEARCH REPORTS, MAGAZINES
Ph.D. THESIS, MAGAZINES, WEBSITES

PILOT STUDY
UNSTRUCTURED INTERVIEW
OF STAKEHOLDERS

DATA COLLECTION
SECONDARY DATA
PRIMAR Y DATA

1. CEA Reports.
   owners.
2. MNRE Reports.
3. Central & State G.R.
4. WISE.
5. CECL.

1. Wind Turbine Installation
2. Wind turbine manufacturers & developers.
3. Financial Institutions
4. Other stakeholders

DATA ANALYSIS

Secondary Data
Financial Data
Primary Data

Analyzed by

1. Cash flow statement
2. Income statement
3. Ratio Analysis
4. Capital Budgeting

1. T-test
2. Descriptive Analysis
3. Bar Diagram
4. Pie chart

Analysis of Overall Power Situation

Analysis of wind power sector

Analyzed by Mathematical tools like percentages & Bar Diagram
PROVING THE HYPOTHESES

Statistical & Secondary Data Analysis  Ratios & Capital Budgeting Tools

FINDINGS

General  Specific

CONCLUSIONS

RECOMMENDATIONS