Entrepreneurship in the Environmentally Friendly and Economically Sound Renewable Energy Conversion System

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Abstract: - Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible and environmentally friendly. During the last few decades a number of governments have started to increase their focus on clean and renewable energy sources. Wind energy is one of the vital inputs for the social and economic development of India. It supplies affordable, inexhaustible energy to the economy. The growth of renewable energy has been fuelled by increased awareness of both public and private entrepreneurship in wind energy conversion system. This technical research paper deals with a mission to combat unemployment and improve urban environment with the help of entrepreneurship in wind energy conversion systems in India.

Key-Words: - Entrepreneurship, Economic growth, Green energy, Wind energy conversion system.

1 Introduction

Wind power capacity has developed very rapidly in recent years, on an average by 25 to 30 per cent per year over the last ten years. At present, the total India's economy has become globally relevant in recent years due to the country's high economic growth and rising concerns about the environmental impacts of energy use [8]. Primary energy demand grew at the rate of 6 per cent a year during 1981-2001 and India now ranks fifth in the world in terms of primary energy consumption [13]. It accounted for about 3.5 per cent of the world's commercial energy demand in 2003. Fig.1 shows the global energy sources by year 2000 – 2060. Over the past five years, global wind power capacity has expanded at an average cumulative rate of 32%. In the year 2003, 8.2 GW of new capacity was added to the electricity grid worldwide [5]. A clean energy economy generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and other natural resources [2].

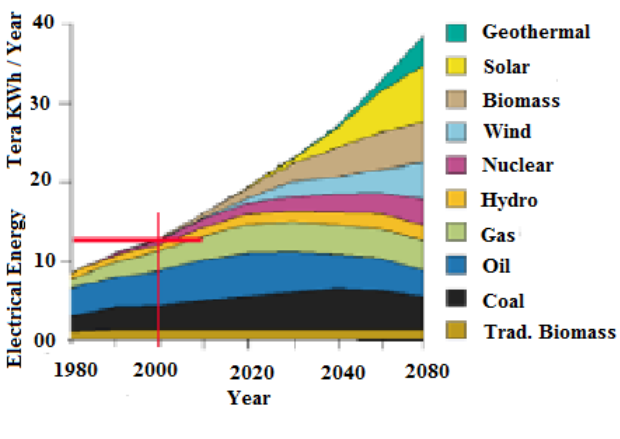

Fig.1 Energy sources for power generation by year 2000 – 2060

In 2008, India was the country that brought online the third largest amount of wind energy, after the US and China, and it now ranks fifth in total installed capacity with 9750 MW of wind power installed at the end of 2008. A strong domestic manufacturing base has underpinned the growth of the Indian wind energy market. The Indian wind turbine manufacturer M/s Suzlon Energy Limited is now a recognized player on the global market, and many international companies are established in India [6].

India has a great untapped potential for wind energy. According to official estimates [14], the country's total wind energy resource amounts to 48 GW of installed capacity, but some experts think that this figure is on the conservative side, and that technological improvements could significantly increase this potential. India's rapidly growing economy and population leads to relentlessly increasing electricity demand. As a result, the country's installed power generation capacity has increased from just 1.4 GW in 1947 to over 150 GW in 2009. The current generation mix in India is dominated by coal (78.5 GW), large hydropower (36.9 GW) and gas (16.4 GW).

Renewable energy sources installed capacity is of around 13.2 GW. Despite the massive capacity additions, the Indian government is struggling to keep up with growing demand. The Indian Energy Association (IEA) predicts that by 2020, 327 GW of power generation capacity will be needed, which would imply an addition of 16 GW per year. This urgent need is reflected in the target the Indian government has set in its 11th Five Year Plan (2007-2012), which envisages an addition of 79 GW in this period, 51 GW of which is coal) [14]. The annual wind power generation is shown in Fig.2. It is found that there is a fluctuation of generation from year to year due to climatic and technical factors. The generation reached a maximum (7.5 GWh) in the year 2002 because of higher turbine availability.

The annual average generation was 7.4 GWh. There was minimum generation of 7.2 GWh was in the year 2001 because of increased break down and maintenance time. The accumulated dirt, grime, and insect deposits on the blade, slightly impaired and reduced the power generation of Wind Technology Generators (WTGs) [4]. Market growth rates in these scenarios are based on a mixture of historical figures and information obtained from analyses of the wind turbine market. Annual growth rates of 25% per annum, as envisaged in the 'Advanced' version of the scenario, are high for an industry which manufactures heavy equipment. The wind industry has experienced much higher growth rates in recent years, however. In the last five years, the average annual increase in cumulative installed wind power capacity in India was more than 35%; for the nine year period from 2000-2008, it was over 28%. It should also be borne in mind that while growth rates eventually decline to single figures across the range of scenarios, the level of wind power capacity envisaged in 20 years time means that even small percentage growth rates will by then translate into large figures in terms of annually installed megawatts [15].

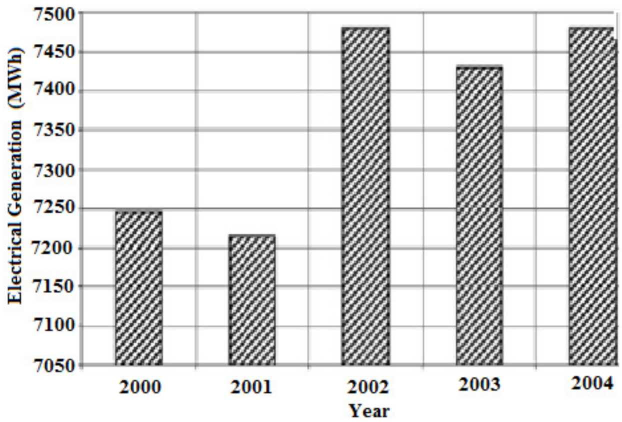

Fig.2 Annual wind power generation.

Vibrant, creative, and energetic – these words essentially sum up today's youth. Ironically, the same qualities in youth, if thwarted, lead to social unrest, conflict, and economic instability. Young people when productively employed are an asset to their communities and to the world. It is imperative that structures be generated to ensure sustainable employment and sustainable environments for young people. But the reality is that there are a billion young adults – between the ages of 15 and 24 in the world today, eighty-five percent of them live in developing countries where there are few opportunities for productive work. The use of renewable sources of energy and renewable energy technologies should therefore be an important element for supporting entrepreneurial initiatives and employment.

2. Problem Formulation

India is the sixth largest green house gas (GHG) emitter in the world, and the fastest-growing one after China. The 1994 inventory of GHGs for India provides an estimate of emissions by sources and removals by sinks of carbon dioxide, methane, and nitrogen oxide. In 1994, 1230 kilo giga-grams (Gg) of carbon dioxide equivalent GHGs were emitted from India.

2.1 Impact of Gaseous Emissions

Carbon dioxide emissions were the largest at 800 kilo - Gg, or 65 per cent of the national carbon dioxide equivalent emissions (Fig.3) [10].

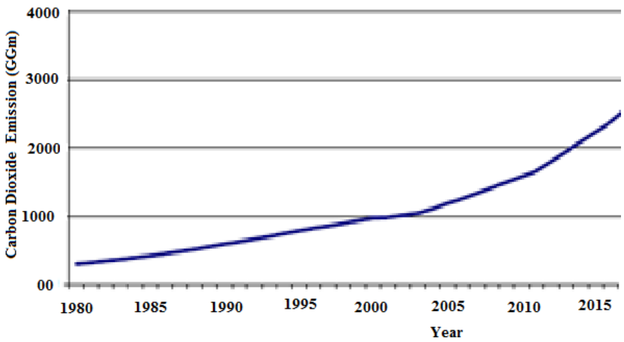

Fig.3 Carbon dioxide equivalent emissions

Urban air pollution results from the combustion of fossil fuels used in transportation, power generation and industry while indoor air pollution (IAP) results from unprocessed biomass use. Several studies have reported the adverse health impacts of IAP. The WHO has reported that IAP doubles the risk of pneumonia and other acute lower respiratory tract infections among children below five years, and triples the risk of chronic obstructive pulmonary diseases among women [17].

The Planning Commission's Integrated Energy Policy notes that lowering the energy intensity of GDP growth through higher energy efficiency (EE) is critical to meeting India's energy challenge and ensuring its energy security. The Integrated Energy Policy sets a goal of a 25 percent reduction in India's energy intensity from current levels. The major areas where energy efficiency (EE) can play a key role are mining, electricity generation, transmission and distribution, water pumping, ventilation, air conditioning, lighting, and household appliances [16].

2.2 Renewable Energy Scenario in India

Renewable energy can play an essential role in enabling the country to diversify its energy sources and harnessing domestic supply options. While the contribution of renewable is expected to be a small fraction of India's commercial energy mix from the long-term perspective, its distributed nature can provide numerous socio-economic benefits [14].

The Renewable Energy Plan 2012 calls for achieving a 10 percent share for renewable energy in incremental power capacity by adding about 10 GW of new renewable energy (RE) based generation. In addition to the grid-connected RE goal, other major RE initiatives in India include: (1) Installment of 1 million household solar water heating systems; (2) Electrification by renewable mini-grids for 24000 villages without electricity; (3) Deployment of 5 million solar lanterns and 2 million solar home lighting systems; and (4) Establishment of an additional 3 million small biogas plants.

2.2.1 Fiscal and financial incentives follow:

(1) Concession on import duty on specified wind turbine parts.
(2) 80% accelerated depreciation over 1 or 2 years.
(3) 10 year income tax holiday for wind power generation projects.
(4) Reduced wheeling charges as compared to conventional energy charges.
(5) Some states have also announced tariffs, ranging from Rs 3 - 4 per kWh, with a national average of Rs 3.5/kWh (53Rs =1 $)
(6) Wheeling, banking and third party sales, buy-back facility by states
(7) Guarantee market through a specified renewable portfolio standard in some states, as decided by the state electricity regulator by way of power purchase agreements.
(8) Excise duty relief on certain components and
(9) R & D incentives to Energy technologies.

2.2.2 Land policies:

The Ministry of Environment and Forests has issued guidelines for diversion of forest lands for non-forest purposes, particularly to enable wind generation. Clearance of leasing and forest land for up to a period of 30 years for wind developers has been implemented. Important actions taken by the ministry in this regard are as follows:

1. Financial assistance: Formation of the Indian Renewable Energy Development Agency (IREDA) was made in India. The main role of IREDA is to finance and provide soft loans for renewable energy projects, particularly for demonstration oriented projects in Indian states.

2. Wind resource assessment: The Indian government has set up the Centre for Wind Energy Technology (C-WET) to map wind energy potentials in different parts of Indian states.

(a) The C-WET has set up more than 1000 wind monitoring and wind mapping centers across 25 states in the country.

(b) Wind mapping had been performed at 50 meters height by C-WET and 60 - 80 meters height by private companies.

(c) Fig.4 shows the power curve for 225 kW

Wind Turbine Generator (WTG).

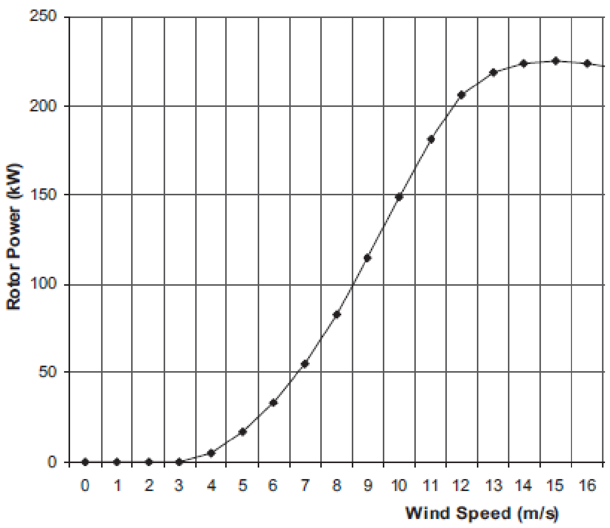

Fig.4 Power curve for 225 kW WTG
(Source: Indian Wind power Directory 2004.)

Finally, and most importantly, energy technologies must be closely linked with income-generation, creation of jobs, sustainability, and empowerment in order to have a real effect on income and people's wellbeing for a sustained period of time, an idea that shares a consensus between different experts and institutions [18]. Energy for income-generation has two different potentials: firstly, increasing income by allowing locals to produce and sell energy services to their community, and secondly increasing productivity by the added value that the use of energy-for-business provides, allowing entrepreneurs to start certain businesses and allowing already-existent business to grow [1].

2.3 Barriers to Renewable Energy Eentrepreneurs in India

The need for enacting policies to support renewable energy is often attributed to a variety of 'barriers' or conditions that prevent investments from occurring. Often the result of barriers is to put renewable energy at an economic, regulatory, or institutional disadvantage relative to other forms of energy supply. Barriers include subsidies for conventional forms of energy, high initial capital costs coupled with lack of fuel-price risk assessment, imperfect capital markets, lack of skills or information, poor market acceptance, technology prejudice, financing risks and uncertainties, high transactions costs, and a variety of regulatory and institutional factors. Many of these barriers could be considered 'market distortions' that unfairly discriminate against renewable energy, while others have the effect of increasing the costs of renewable energy relative to the alternatives. Barriers are often quite situation-specific in any given region; nevertheless, three broad categories of barriers are discussed in this research technical paper.

2.3.1 Costs and Pricing

Many argue that renewable energy 'costs more' than other energy sources, resulting in cost-driven decisions and policies that avoid renewable energy. In practice, a variety of factors can distort the comparison. For example, public subsidies may lower the costs of competing fuels. Although it is true that initial capital costs for renewable energy technologies are often higher on a cost-per-unit basis (i.e., US $/kW), it is widely accepted that a true comparison must be made on the basis of total 'life-cycle' costs. Life-cycle costs account for initial capital costs, future fuel costs, future operation and maintenance costs, decommissioning costs, and equipment lifetime. Here lies part of the problem in making comparisons:

1. **Subsidies for competing fuels:** Large public subsidies, both implicit and explicit, are channeled in varying amounts to all forms of energy, which can distort investment cost decisions. Organizations such as the World Bank and International Energy Agency put global annual subsidies for fossil fuels in the range of $100-200 billion, although such figures are very difficult to estimate (for comparison, the world spends some $1 trillion annually on purchases of fossil fuels).
2. **High initial capital costs:** Even though lower fuel and operating costs may make renewable energy cost-competitive on a life-cycle basis, higher initial capital costs can mean that renewable energy provides less installed capacity per initial money invested than conventional energy sources. Thus, renewable energy investments generally require higher amounts of financing for the same capacity..
3. **Difficulty of fuel price risk assessment:** Risks associated with fluctuations in future fossil-fuel prices may not be quantitatively considered in decisions about new power generation capacity because these risks are inherently difficult to assess. Historically, future fuel price risk has not been considered an important factor because future fossil fuel prices have been assumed to be relatively stable or moderately increasing. Thus, risks of severe fluctuations are often ignored. However, with greater geopolitical uncertainties and energy market deregulation has new awareness about future fuel price risks. Renewable energy technologies avoid

fuel costs (with the exception of biomass) and so avoid fuel price risk.

4. Unfavorable power pricing rules: Renewable energy sources feeding into an electric power grid may not receive full credit for the value of their power. Two factors are at work. First, renewable energy generated on distribution networks near final consumers rather than at centralized generation facilities may not require transmission and distribution (i.e., would displace power coming from a transmission line into a node of a distribution network). Second, renewable energy is often an 'intermittent' source whose output level depends on the resource (i.e., wind and sun) and cannot be entirely controlled. Utilities cannot count on the power at any given time and may lower prices for it.

5. Transaction costs: Renewable energy projects are typically smaller than conventional energy projects. Projects may require additional information not readily available, or may require additional time or attention to financing or permitting because of unfamiliarity with the technologies or uncertainties over performance.

6. Environmental externalities: The environmental impacts of fossil fuels often result in real costs to society, in terms of human health (i.e., loss of work days, health care costs), infrastructure decay (i.e., from acid rain), declines in forests and fisheries, and perhaps ultimately, the costs associated with climate change. Costs of environmental externalities are difficult to evaluate and depend on assumptions that can be subject to wide interpretation and discretion. Although environmental impacts and associated tangible costs are often included in economic comparisons between renewable and conventional energy, investors rarely include such environmental costs in the bottom line used to make decisions.

2.3.2 Legal and Regulatory Aspects

In many countries, power utilities still control a monopoly on electricity production and distribution. In these circumstances, in the absence of a legal framework, independent power producers may not be able to invest in renewable energy facilities and sell power to the utility or to third parties under so-called 'power purchase agreements.'

1. Lack of legal framework for independent power producers: Utilities may negotiate power purchase agreements on an individual ad-hoc basis, making it difficult for project developers to plan and finance projects on the basis of known and consistent rules.

2. Restrictions on site location and construction: Wind turbines, rooftop solar hot-water heaters, photovoltaic installations, and biomass combustion facilities may all face building restrictions based upon height, aesthetics, noise, or safety, particularly in urban areas. Wind turbines have faced specific environmental concerns related to site location along migratory bird paths and coastal areas. Urban planning departments or building inspectors may be unfamiliar with renewable energy technologies and may not have established procedures for dealing with site location and permitting.

3. Transmission access: Utilities may not allow favorable transmission access to renewable energy producers, or may charge high prices for transmission access. Transmission access is necessary because some renewable energy resources like windy sites and biomass fuels may be located far from population centers. Transmission or distribution access is also necessary for direct third-party sales between the renewable energy producer and a final consumer. New transmission access to remote renewable energy sites may be blocked by transmission-access rulings or right-of-way disputes.

4. Utility interconnection requirements: Individual home or commercial systems connected to utility grids can face burdensome, inconsistent, or unclear utility interconnection requirements. Lack of uniform requirements can add to transaction costs. Safety and power-quality risk from non-utility generation is a legitimate concern of utilities, but a utility may tend to set interconnection requirements that go beyond what is necessary or practical for small producers, in the absence of any incentive to set more reasonable but still technically sound requirements. In turn, the transaction costs of hiring legal and technical experts to understand and comply with interconnection requirements may be significant. Policies that create sound and uniform interconnection standards can reduce interconnection hurdles and costs.

5. Liability insurance requirements: Small power generators (particularly home Photo Voltaic systems feeding into the utility grid under 'net metering' provisions) may face excessive requirements for liability insurance. The phenomenon of 'islanding,' which occurs when a self-generator continues to feed power into the grid when power flow from the central utility source has been interrupted, can result in serious injury or death to utility repair crews. Although proper equipment standards can prevent islanding, liability is still an issue

2.3.3 Market Performance

1. Lack of access to credit: Consumers or project developers may lack access to credit to purchase or invest in renewable energy because of lack of collateral, poor creditworthiness, or distorted capital markets. In rural areas, 'micro-credit' lending for household-scale renewable energy systems may not exist. Available loan terms may be too short relative to the equipment or investment lifetime. In some countries, power project developers have difficulty obtaining bank financing because of uncertainty as to whether utilities will continue to honor long-term power purchase agreements to buy the power [12].

2. Perceived technology performance uncertainty and risk: Proven, cost-effective technologies may still be perceived as risky if there is little experience with them in a new application or region. The lack of visible installations and familiarity with renewable energy technologies can lead to perceptions of greater technical risk than for conventional energy sources. These perceptions may increase required rates of return, result in less capital availability, or place more stringent requirements on technology selection and resource assessment.

3. Lack of technical or commercial skills and Information: Markets function best when everyone has low-cost access to good information and the requisite skills. But in specific markets, skilled personnel who can install, operate, and maintain renewable energy technologies may not exist in large numbers. Project developers may lack sufficient technical, financial, and business development skills. Consumers, managers, engineers, architects, lenders, or planners may lack information about renewable energy technology characteristics, economic and financial costs and benefits, geographical resources, operating experience, maintenance requirements, sources of finance, and installation services. The lack of skills and information may increase perceived uncertainties and block decisions.

2.3.4 Knowledge and technological evolution in the wind energy industry.

Knowledge accumulation has played a central role in the growth of the wind energy industry. Early developments were based on knowledge gained through the use of classic windmills as well as a high degree of experimentation. Today the wind energy industry is a non-high tech growth industry mainly based on knowledge in mechanical and electrical engineering as well as some software and aerodynamics technology [19]. We believe that development of the wind turbine industry forms the integral part of the growth of wind energy sector in India.

The Government of India initially gave incentives to grid quality power generation by wind turbine technology in 1985. However, India's knowledge base in wind energy generation as well as wind turbine manufacturing was weak and needed significant growth to be competitive at an international level [8]. As a result the Indian government embarked on a series of cooperation projects with leading actors to develop the knowledge needed. This policy was made easier by India's unique position as a market with a huge potential for the wind turbine industry as well as its status as a developing country. As seen from the Figure 5, the initial wind power production in India was mainly demonstrative in nature, where the government was the major instrument. Thus, one of the major actors in the development of the wind energy sector in India has been the Government and its wind energy friendly policies. Today the biggest Indian state in wind energy is Tamil Nadu, in the south of India.

In the Indian wind turbine market there were firms like M/s Suzlon Energy Ltd., Pioneer Asia Wind Turbines, Shriram EPC Ltd., NEG-Micon India (Pvt.) Ltd., Enercon (India) Ltd., GE India Industrial Pvt. Ltd., Vestas RRB India Ltd. and LM Glasfiber (India) Pvt. Ltd. Thus, one of the results of this liberalization policy has been the substantial presence of foreign especially, in the Indian wind turbine industry. Many of foreign firms came into India in the mid-80s or early 90s, just as the pro-reform governmental policies were being put into effect. Although many of the firms were 100 per cent-owned subsidiaries of foreign firms, some of them were joint ventures like for example; Vestas RRB India Ltd. was a partnership between Danish firm Vestas and RBB, an Indian firm. There were some firms that were fully indigenous like M/s Suzlon Energy Ltd.

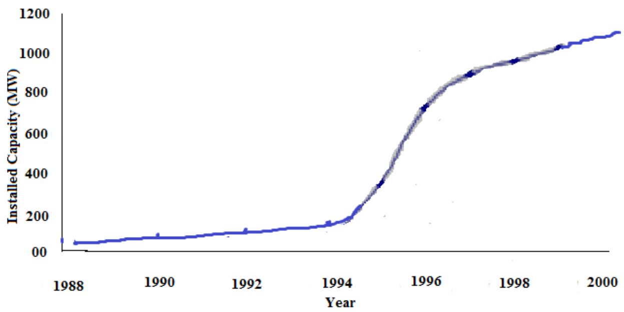

Fig. 5 Wind power development in India
(Source: TERI Project Report No. 2000RT45)

Where opportunities arise, one finds entrepreneurs. It has become apparent that the magnitude of the energy-related challenges we face will require more than incremental changes to existing patterns of production and consumption. Entrepreneurs are likely to play a significant role in this discontinuous change.

The promoters of new combinations and individuals can see both new possibilities and assess market needs. While research on corporate sustainability management – with its interest in the connection between the natural environment and various organizational levels of analysis – has gained significant sophistication and legitimization, the role of entrepreneurs in this process remains relatively unexplored. It is therefore important to consider the role of entrepreneurial activity in the development and commercialization of breakthrough energy technologies in both start-up and established firms [11], [20] and [21].

In addition to business opportunities as a result of deregulation in the electricity market, wind power generation has great potential to create employment in wind system development, manufacturing, maintenance and operation particularly in developing countries like India [4]. Table 1 shows the direct job creation by wind power as compared to other power generation technologies [5].

3 Problem Solution

Worldwide development of wind energy expanded rapidly starting in the early 1990s. As shown in Figure 6, the average annual growth rate from 1994 to 2001 of the world installed capacity of wind power is 31% [6], making the wind industry one of the fastest growing. Unlike the last surge in wind power development during 1970s and early 1980s which was due mainly to the oil embargo of the OPEC countries, the current wave of wind energy development is driven by many forces that make it favorable.

These include its tremendous environmental, social and economic benefits, its technological maturity, and the deregulation of electricity markets throughout the world, public support and government incentives. In recent years a number of new approaches have emerged for promoting renewable energy in off-grid rural areas, including energy service concessions, private entrepreneurship, micro-credit, and comparative line extension analysis.

3.1 Recent Development in Wind Industry.

One of the difficulties for many countries in developing their wind energy industry has been the role of energy utilities. Energy utilities have had a substantial effect on the way the wind energy industry develops through their stewardship of the energy grid but are usually not big investors in wind energy technology. Their involvement can therefore both hinder and facilitate the development of a successful wind energy industry. Table 1 presents a recent cost analysis for various wind power plants. In the table 1, large wind plant is targeted at utility grade power generation and small turbine is used for distributed generation for residential loads and remotely located areas.

Table 1

Cost in $	**Large Wind Plant**	**One Small Turbine**	**Remote Community**
Plant Capacity (kW)	75000	10	65
Turbine Size (kW)	750	10	65
Capital Cost ($/kW)	$1400	$3500	$3000
Financing Rate (%)	7.5%	10%	8.5%
Capacity Factor (%)	35%	23%	25%
Energy Cost($/kWh)	$0.058	$0.237	$0.195

Table 2 presents the direct job creations in various energy conversion systems.

Table 2

Technology	**Job / TWh /Yr**
Nuclear	100
Geothermal	112
Coal	16
Solar Thermal	248
Wind	542

3.2 Technological Advance

Thanks to extensive R&D efforts during the past 33 years, wind energy conversion has become a reliable and competitive means for electric power generation. The life span of modern wind turbines is now 25-30 years, which is comparable to many other conventional power generation technologies. The average availability of commercial wind power plants is now around 98% [6]. The cost of wind power has continued to decline through technological development, increased production level, and the use of larger turbines. The cost of energy from wind power has fallen from around 35 ¢US/kWh in 1980 to 4-6 ¢US/kWh today [6].

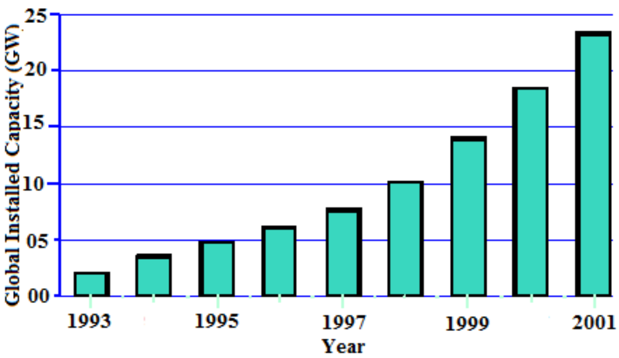

Fig. 6 World installed capacity of wind power

3.2.1 Structure of Wind Energy Conversion Systems: The major components of a typical wind energy conversion system include a wind turbine (WT), Permanent Magnet Synchronous Generator (PMSG), interconnection apparatus and control systems, as shown in Fig.7. Wind turbines can be classified into the vertical axis type and the horizontal axis type. Variable speed wind turbines can produce 8% to 15% more energy output as compared to their constant speed counterparts, however, they necessitate power electronic converters to provide a fixed frequency and fixed voltage power to their loads.

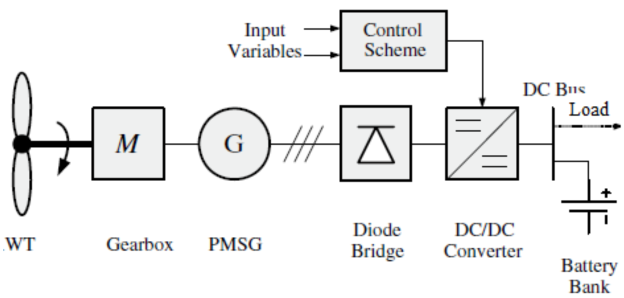

Fig.7 Structure of a Typical Wind Energy System

Most turbine manufacturers have opted for reduction gears between the low speed turbine rotor and the high speed three-phase generators. Direct drive configuration, where a generator is coupled to the rotor of a wind turbine directly, offers high reliability, low maintenance, and possibly low cost for certain turbines [3]. Several manufacturers have opted for the direct drive configuration in the recent turbine designs [7]. Induction generators, permanent magnet synchronous generators and wound field synchronous generators are currently used in various high power wind turbines. Most modern turbine inverters are forced commutated PWM inverters to provide a fixed voltage and fixed frequency output with a high power quality. For certain high power wind turbines, effective power control can be achieved with double PWM (pulse width modulation) converters which provide a bi-directional power flow between the turbine generator and the utility grid.

3.2.2 Operation and Maintenance Costs of Wind-Generated Power: Operation and maintenance (O&M) costs constitute a sizeable share of the total annual costs of a wind turbine. For a new turbine, O&M costs may easily make up 20–25 per cent of the total cost per kWh produced over the lifetime of the turbine. If the turbine is fairly new, the share may only be 10–15 per cent, but this may increase to at least 20–35 per cent by the end of the turbine's lifetime. As a result, O&M costs are attracting greater attention, as manufacturers attempt to lower these costs significantly by developing new turbine designs that require fewer regular service visits and less turbine downtime. O&M costs are related to a limited number of cost components, including:
1. Insurance charge 2. Regular maintenance values 3. Repairing charge 4. Engineering spare parts and 5. Administration costs. Some of these cost components can be estimated relatively easily. For insurance and regular maintenance, it is possible to obtain standard contracts covering a considerable share of the wind turbines total lifetime.

3.2.3 Cost and Investment Structures

The main parameters governing wind power economics include:

(a) Investment costs, such as auxiliary costs for foundation and grid connection;
(b) Operation and maintenance costs;
(c) Electricity production/average wind speed;
(d) Turbine lifetime; and
(e) Discount rate.

The most important parameters are turbine electricity production and investment costs. As electricity production depends to a large extent on wind conditions, choosing the right turbine site is critical to achieving economic viability. Table 3 shows the comparison of various renewable sources of energy economy in India (53 Rs. = 1$).

Table 3

Source	Capital Cost (10 Million/MW)	Generator (Rs/kWh)
Wind Power	3.5	2.25
Small Hydro	3.5 – 6.0	1.5-3.5
Co-Generation	2.0 – 2.5	2.0- 2.5
Solar	30	15-20
Photovoltaic	9.0	5.80
Sea-Wave	2.4	1.10

Source: Indian Wind Turbine Manufacturers

3.3 Improve and Refine the Regulatory and Institutional Framework for Scaling-up Renewable Energy:

Although renewable energy power generation is a genuine clean development success story, there are some problems that need to be addressed to make the industry sustainable and self-supporting. There is currently some retrenchment going on with respect to RE policy amongst the State regulators. States with strong RE policies include Andhra Pradesh, Tamil Nadu, Maharashtra, and Gujarat. A strong RE policy consists of: (i) preferential treatment; (ii) portfolio standards; and (iii) standardized price.

3.4 Clean Technology Initiatives (CTI)

The CTI currently focuses on the following areas:

1. Awareness raising and information outreach: stimulating interest and participation of Indian industries in improved environmental management.
2. Private sector environmental incentives: strengthening and publicizing market-based incentives for corporate environmental responsibility.
3. Indian industry capacity development: strengthening the organizational learning process within Indian firms related to environmental management. Table 4 shows the entrepreneurial effort in the area of wind energy in different states of India [9].

Table 4

State	Gross Potential (MW)	Technical Potential (MW)	Installed Capacity
Andhra Pradesh	2200	1231	88
Gujarat	3100	121	167
Karnataka	4120	687	34
Kerala	380	353	2
Madhya Pradesh	3000	77	22
Maharashtra	1920	2108	79
Orissa	840	338	2
Rajasthan	900	1011	771
West Bengal	180	775	--
Other States	2150	--	2
Total	20000	8946	116

Wind farms in India therefore often consist of clusters of individually owned generators. Much of the installed capacity in % is in the states of Tamil Nadu (61), Gujarat (14), Maharahtra (12), and Andhra Pradesh (7).

4 Conclusion

Renewable energy is a means to combine the goals of youth employment and environmental protection, thereby contributing to sustainable development. One method to implement this potential link between youth employment and environmental protection is to develop youth-led enterprises to produce and market renewable energy to off-grid consumers. Youth-led renewable energy enterprises are a viable means of achieving sustainable development, as they promote technologies that are less harmful to the global environs (as compared to conventional technologies), while at the same time providing sustainable income-generating opportunities for youth. Tapping the energy of youth for promoting renewable energy will have a three-fold effect.

1. It will release new energy in accomplishing many of the goals set by the global community for climate change.
2. It will move young people into productive and long term nation building activities, away from non-productive pursuits and
3. It will direct youth to income generating activities in this sector.

The renewable energy industry can be termed a “sunrise” industry. It has been predicted that globally, jobs in the renewable energy and energy efficiency industries will rise to more than 3 million over the next twenty years and lead to the opening up of a new range of career opportunities.

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