EIWEN

EU-India Wind Energy Network

Policy Paper on Collaboration between European and Indian Wind Energy Sector

Suman Kumar (CII), Jos Beurskens (ECN)

January 2007

This document has been produced with the financial assistance of the European Union. The contents of this document are the sole responsibility of the project partner and can under no circumstances be regarded as reflecting the position of the European Union.

Policy Paper on
Collaboration between European and Indian Wind Energy Sector

Suman Kumar (CII)
Jos Beurskens (ECN)

January, 2007

List of Abbreviations

CEN: Committee for Standardization
CENELEC: European Committee for Electrotechnical Standardization
CDM: Clean Development Mechanism
CERC: Central Electricity Regulatory Commission
C-WET: Centre for Wind Energy Technology
DANIDA: Danish International Development Agency
DCP: Department of Consumer Protection
DPR: Project Report
ECN: Network, the Netherlands
EHV: High Voltage
EPA: Energy Purchase Agreement
ERC: Electricity Regulatory Commission
EU: European Commission
FDI: Foreign Direct Investment
FIs: Financial Institutions
FIPB: Foreign Investment Promotion Board
GIS: Global Information System
GW: Giga Watts
GPS: Global Positioning System
IEA: International Energy Agency
IEC: International Electro Technical Committee
IREDA: Indian Renewable Energy Development Agency (IREDA)
INWEA: Indian Wind Energy Association
IPP: Independent Power Producer
IT&LS: Information, Training & Commercial Services
IWTMA: Indian Wind Turbine Manufacturers Association
Km: Kilometer
LIDAR: Light Detection and Ranging
MAT: Minimum Alternate Tax
MERC: Maharashtra Electricity Regulatory Commission
MNRE: Ministry of New and Renewable Energy
MW: Mega Watts
MWh: Mega Watt Hours
NGO: Non-Government Organization
OECD: Organization for Economic Co-operation and Development
O&M: Operation and Maintenance
PPA: Power Purchase Agreement
PSU: Public Sector Unit
PFC: Power Finance Corporation
PTC: Power Trading Corporation
PTC: Production Tax Credit
PURPA: Public Utilities Regulatory Commission
R&D: Research and development
RD&D: Research, Development and Demonstration
REC: Rural Electrification Corporation
RIDF: Rural Infrastructure Development Fund
RISø: A national laboratory, Denmark
S&C: Standards and Certification
SEB: State Electricity Board
SERC: State Electricity Regulatory Commission
SNAs: State Nodal Agencies
SODAR: Sound Detection and Ranging
TWh: Tetrawatt Hours
WRA: Wind Resource Assessment
WASP: Wind Atlas Analysis and Application Program
WT: Wind Turbine

Recommendations

The growing importance of wind energy sector in an era of rapidly depleting fossil fuels cannot be overemphasized. Europe, unequivocally, is the world leader in research, development and deployment of wind energy resources. Amongst developing countries, India is the frontrunner in the exploitation of wind energy. The Indian wind energy programme has successfully implemented strategies most of which had European assistance in some form. However, challenges to the larger exploitation of wind energy resources in India and the opportunities that exist between Europe and India for further co-operation in the wind energy sector are not over.

After studying the present challenges in the Indian wind energy sector, under the backdrop of changing energy dynamics and power sector reforms, under EIWEN research framework, the following recommendations have been made with the aim of enhancing competitive edge and growth potential of the wind energy sector in India, possibly with European co-operation.

1. Wind Resource Assessment

Wind resource assessment needs to be scaled up for discovering better sites. Services for micro siting are required at a greater scale on a competitive basis. C-WET and a few consultants can provide this service. Several agencies in Europe are in this business. They can consider offering these services in India as well. MNRE should issue guidelines on wind resource assessment, in accordance with IEC standards. Issues like anemometer calibration, site calibration, maintaining long-term wind measurement at select important sites should also be addressed. Efforts must be made to create, with the help of C-WET/MNRE, independent autonomous wind measurement service providers to be linked to financial wind derivative product development.

2. Improvements in Productivity

Industry, service providers and research institutions should undertake collaborative projects for bringing about improvements in technology, particularly with regard to cost reduction, efficiency enhancements and capacity utilization. SNAs/utilities may induce such initiatives by monitoring existing installations (in line with manufacturers central monitoring system – SCADA), encouraging growth of need based consultancy services and initiating suitable policies and measures. Particularly studies need to be undertaken to assess generation loss due to grid outages and abnormalities in voltage, harmonics and current asymmetry. Studies should highlight those aspects of critical components, which have increased failure rate particularly for Indian grid and atmospheric conditions. For example, higher grid outages result in increased cost of wind operation and maintenance and increased cost due to frequent fatigue failure and increased wear and tear of parts.

3. Up-scaling

As the market moves towards larger machines, manufacturers may have to upgrade and expand their manufacturing capacity. Healthy practices and competition should be encouraged for the comfort of policy makers, financial institutions and regulators. IWTMA should play a greater role for a sustainable development of the wind industry.

Indian regulatory environment should quickly transcend from a self-regulatory to a more systematic and well-defined regulatory framework. For example, there has to be uniformly enforced grid code and standards on quality and safety to ensure best practices in a competitive environment. Policies to encourage investments in expansion and up-gradation of manufacturing capacities should be evolved.

4. Grid Integration

The electric grid needs to be strengthened in order to provide - a) increased flexibility in the generation mix (future investment strategy) to enable the utilization of distributed intermittent generation b) demand side management and storage technologies and c) grid-planning to build interconnection capacity for power exchange and balancing of intermittent generation.

The SEBs or other state level utilities should have adequate mechanism to strengthen the grid for easy evacuation of wind power. This could be done by generating internal surplus or be supported by a financing scheme from international donors through IREDA, PFC or REC.

The states, which have enforced requisite policy framework for the development of the wind industry under the guidance of the state regulatory commissions have issued Renewable Portfolio Standards (RPS) framework. This is to integrate renewable energy into their energy mix for all state/private distribution companies. As indicated earlier, they should also be pro-active in supporting and creating power evacuation facilities for integrating wind energy into the grid, as typically wind farms are located at the end of the weak rural distribution grids. The proposed penalty on any shortfall in meeting the RPS-specified electricity quantity from renewable should be earmarked to create proper evacuation/infrastructure facilities for effective capture of generated wind power.

5. Small Wind Machines

Based on feedback from past Indian experiences, the small wind program needs to be redesigned, taking clues and technical support from the successful practices for catering to such markets in the EU nations. This is particularly important in context of urban wind turbines (in the range of 50-150 kw), wind-diesel, wind-solar etc, where lot of research, development and demonstration work has already been done in Europe and are used at some places commercially. There are several possible niche demand segments of these small wind turbines in India. To enable proliferation of these small wind turbines, it is extremely important to create awareness among target consumer segments in India.

6. Quality

It makes a lot of sense for the Indian wind industry to work together with EU partners for improving the quality control strategies. This includes selection of right sites, quality improvement and standardization of machines/equipments and should cover all other aspects from installation to commissioning, operation and maintenance, grid connectivity, spares availability and eventually after sales services.

7. Standards and Certification

C-WET should continue working with its international counterparts from Europe, and strengthen its RD&D initiatives such as Standards and Certification**.** Particularly, C-WET should:

- Get itself accredited by MEASNET and

- Work with IEC, MEASNET and other institutions like RISO, ECN etc. to evolve specific standards for wind turbines/wind farms operation in a weak grid, tropical conditions and off-shore wind farms.

These collaborations should enable C-WET to evolve standards for

- Evaluation of wind characteristics for specific sites

- Assessing the quality of the grid for abnormalities in voltage, harmonics and current asymmetry and efficient utilization and performance of wind energy generators**.**

8. Research Infrastructure

For a sound development of the sector, experimental capabilities both within industry and the R&D institutions must be state-of-the-art, attuned to the short and medium term needs of the sector. This area needs substantial efforts in the form of involvement of the R&D community seeking funds from all local stakeholders and international agencies. Particularly, sandwich courses in Phd and Master degree courses should be introduced as collaboration between Indian and European institutions. This should include areas like aero-elasticity, meteorology and wind predication, and power system integration studies of intermittent sources.

9. Public Support and the Environment

A strategy to create awareness of the positive aspects of wind technology would be useful. Substantial factual information needs to be gathered and consolidated. The media should be adequately addressed on such a strategy.

10. Fiscal Policies

Regulatory commissions, utilities and policy researchers could possibly study and learn from the experiences of the European countries for sustaining the tempo of the wind energy program. India needs to redesign the support framework available to wind industry with the objective of promoting efficiency and competition in the sector. The following policy instruments are proposed to enable this:

- 80 % accelerated depreciation tax shield benefit should pave the way for performance-based incentives such as US Production Tax Credit.

- In the interim period, the depreciation tax credit should be made transferable to create a market for these credits, which will enable serious developers (even those without sufficient tax liability) to enter wind projects, bundle tax credits and sell to those who require it.

11. Financing

All avenues, including innovative financings, such as carbon trading have to be tapped for wind energy programs. Both domestic market and overseas funding sources should also be explored. MNES, SNAs and other stakeholders should work jointly for this challenging task[1].

[1] For discussion on various financing possibilities and mechanisms in wind energy sector in India and Europe, EIWEN Financing Paper can be referred.

TABLE OF CONTENTS

I. Introduction

1. Relevance of Wind Power

Energy is the basic building block for socio-economic development. Though fossil fuels will continue to be a play a major role in most countries, its availability is limited and may not be sufficient in the long run to sustain the demand.

Renewables are therefore expected to become increasingly significant for accelerating development and sustainable growth in the second half of the next century. It might even account for 50 to 60 per cent of the total global electricity supplies then.

2. Short History of Wind Power

Wind power was exploited for grain grinding and water pumping in various cultures across continents for several centuries, in particular in the Netherlands. (Figure 1). With the invention of the steam engine in 18th century, the demand for power shifted to techniques and machines based on thermodynamic processes. Especially, with the introduction of fossil fuels (coal, oil and gas), these machines offered many advantages.

Figure 1. Corn grinding wind mill in the Netherlands

These new machines provided power more reliably than wind turbines. Thereafter, the importance of wind energy as a power source decreased during the 19th and the 20th century. Its prominence in a grid network system is a development in the recent past.

Post World War II was an era of cheap and convenient energy sources. Prices for fossil energy like petroleum and electricity were fairly low, and the utilization of wind energy did not evoke much interest. The worldwide energy crisis of 1973 and soaring oil prices rekindled interest in non-conventional energy sources including like wind. Its attractiveness as source of electricity has fostered ambitious targets for wind power in many countries around the world.

3. Significant Advantages of Wind Power

- Very low lifetime emissions of harmful gases, particularly CO_2
- Significant economically exploitable resource potential

- No cost uncertainties from fuel supply price fluctuations
- Increased diversity and security of supply
- Modular and rapid installation
- Opportunities for industrial, economic and rural development.
- Substantial socio-economic and environmental benefits
- Direct and indirect generation of employment

4. Growth in Wind Power

In the 1990s, wind emerged as the fastest growing energy sector. In many parts of the world, wind energy has already grown to be a mainstream new electricity source. Wind Capacity has doubled every three years in the last decade. From just 4800 MW in 1995, the world total has crossed more than twelve- fold to reach over 75,000 MW at the beginning of 2007. The World Energy Council stated that it was doubtful whether any other energy technology is growing, or has grown, at such a rate. See figure 2.

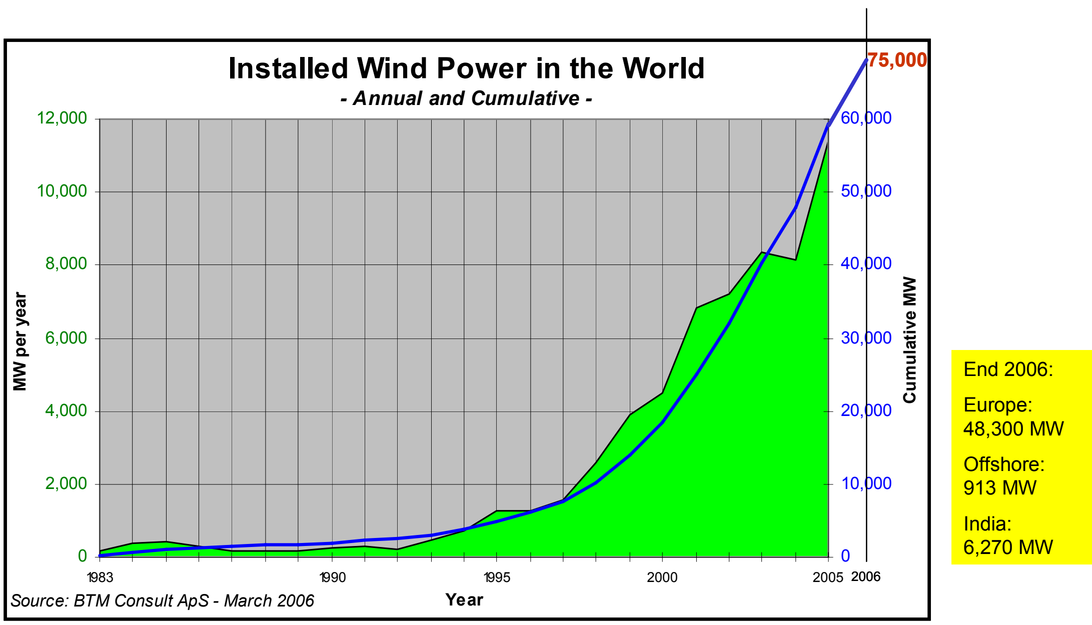


Figure 2. The development of the wind energy market since 1983

Global wind resource estimates depict huge potential covering broad geographical areas. The total technically recoverable resource is estimated to be 53,000 Terawatt hours (TWh). To put this in context, in 2002 world wind electricity generation was 16,054 TWh. The IEA's 2004 World Energy Outlook estimates that by 2020 global electricity demand will be 25,578 TWh per annum.

This growth has long been driven by a number of factors such as security of supply, concerns about global climate change, mainly in the developed world and especially in Europe and techno-economic developments.

5. Developments in Technology

Over the past fifteen years, production costs have been cut by 50 per cent. Governments, industry and international collaborative RD&D have led major design improvements and increased technical and economic performance. According to an evaluation of wind turbines in Denmark by the Risø National Laboratory, the cost per unit of wind electricity fell from €15.8 cents to €5.7 cents per kWh between 1981 and 1995 due to improved turbine design and better siting. The wind industry cost estimate for state-of-the-art onshore wind turbines in 2003 was €804 per installed kW with a unit price of €3.79 cents per kWh.

Enhanced performance and cost reductions have been closely related to increases in turbine size. Until the mid-1980s, the rated power of wind turbines were typically less than 100 kW with rotor diameters of about 20 meters. This increased to a few hundred kilowatts by mid-1990s - turbine sizes ranged from 0.5 - *2 MW* (Figure 4. depicts the growth in turbine size). New turbines deployed in 2002 averaged about 1,170 kW. In the future wind turbines may have rotor diameters up to 160 meters, twice the span width of an Airbus 380. See figure 3.

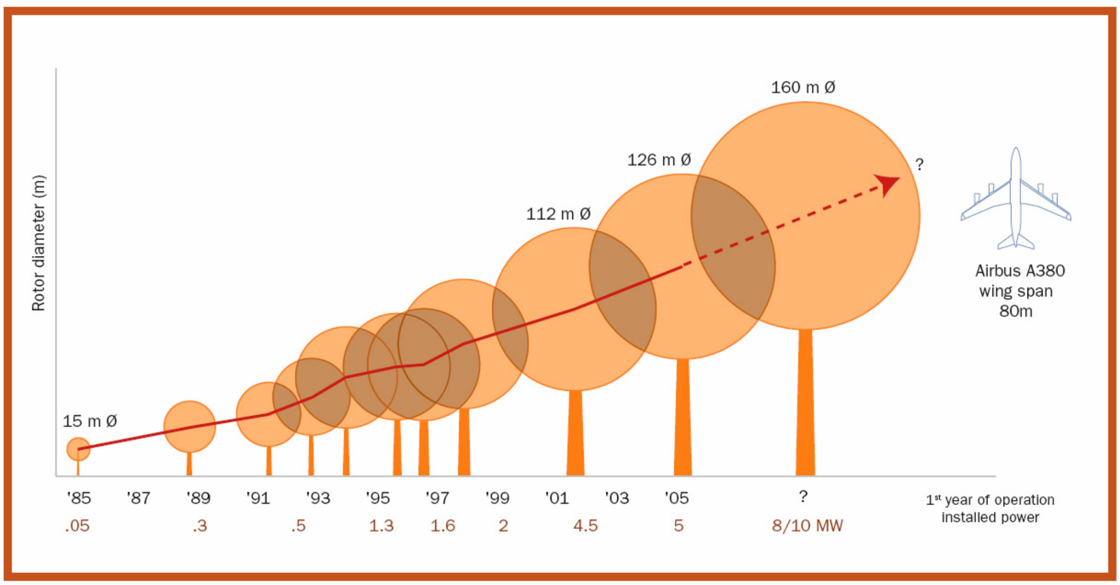
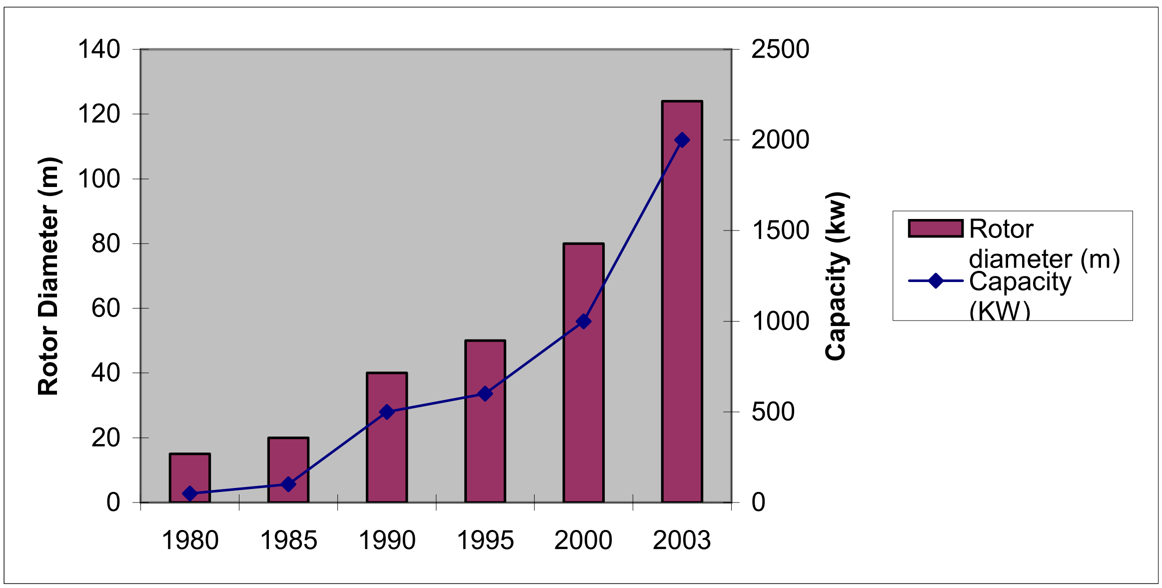


Figure 3. The history and future of up scaling of modern electricity producing wind turbines.

A modern wind turbine has seen a steep fall in cost. It actually produces 180 times more electricity (ref: economics- page 5, Global Wind Energy Outlook, 2006) at less than half the cost per unit (kWh) than its equivalent twenty years ago. A well conceived wind project on a windy site, not too far away from an electric sub station is quite competitive with the fossil fuel ones, especially in the context of prevailing high oil costs scenario even without discounting the external costs associated with the pollution and adverse effects on the health and environment.

Wind energy has opened ample opportunities for employment generation in manufacturing, project development, erection, commissioning and testing and allied activities in the services related to this field. A crucial factor worth noting is the socio-economic development in some abandoned areas due to topographic and poor infra-structure in dispersed locations.

After the installation of the first single offshore wind turbine in 1990 in Sweden, in 1991, an offshore demonstration project in Denmark was commissioned using 0.5 MW turbines. This project was followed up by a Dutch offshore wind park of 0.5 MW machines as well. All these wind farms were located in relatively sheltered waters. The first real (North Sea) large scale wind farm (120 MW) made up of 1.7 MW machines was realised in Denmark in 2002. At the same time, in Germany, average wind turbine size reached 1.4 MW. The largest turbines manufactured today are of 5 MW capacity with rotor diameters of 126 meters and are located offshore at distances varying from about 8 to over 20 kilometers from the coast. Modern wind machines are modular units, quick to install with the wind farm sizes touching upto several hundred megawatts. Wind energy business is becoming quite tempting for the prospective investors, business firms and banks.



Source: Wind Power Technology, European Wind Energy Association, 2004.
Figure 4: Growth in Size of Commercial Wind Turbine Designs

RD&D in wind technology appears to have a strong link with the development of markets and a supportive industry. In Denmark, Germany and the United States, significant RD&D funds were invested in the years preceding rapid market growth. During 1987 - 2001, seven countries accounted for 85 per cent of the total wind RD&D investments in IEA countries. The seven countries had 94 per cent of the installed wind power capacity in 2002.

In conjunction with RD&D, the deployment of wind power technology has been strongly supported in some countries, by government incentives and policies such as feed-in tariffs and various forms of obligations such as renewable energy portfolio standards. Most countries have used a combination of policy instruments. Investment incentives such as capital subsidies and tax credits have been coupled with payment of premium prices for electricity produced.

6. New Players

Structural changes to the industry have taken place in recent years, and new companies have emerged on the global arena. The increased size of wind farms, growth of business at approximately 30% per annum, improved technology and, in particular, improved turbine availability, have all allowed the wind energy business to be considered seriously by main players in the power industry especially the ones interested in the green businesses. Shell has formed a wind energy subsidiary, Shell Wind Energy; and the Enron subsidiary, Enron Wind Corporation, was purchased by General Electric to form GE Wind Energy.

SIIF, a French company 35% owned by Electricité de France, is emerging as a major player with global aspirations, recently purchasing the US operations and maintenance provider and developer enXco. Substantial construction by the Italian conglomerate EDENS, as well as ongoing activity by FPL and most of the Spanish utilities, all underline the nature of today's wind developers, as compared with those of the previous decade, which tended to be small and independent. Last year has also seen the separation of Gamesa Eolica, the leading supplier in the Spanish market, from its Danish partner, Vestas. This step is in the direction of major new competitors worldwide. The Indian company, Suzlon, has also emerged on the world market as a turbine supplier.

7. Markets

The market may be split into two separate segments - the 'conscience' market and the 'needs' market.

a) Conscience Market

In the conscience market, the driver for development of wind energy has hitherto been a desire to produce electricity by cleaner means. This has been supported by incentives including CDM. There are signs, however, that as the cost of wind energy continues to fall, and the nature of these markets will therefore change. Besides there are some applications for which wind energy is competitive in its own right.

b) Needs Market

For the needs market, motivations are somewhat different. Such markets are characterised by a growing, and unsatisfied need for energy, and a limited amount of new generating capacity. In these markets, wind energy is considered to be one of the several alternatives. Given the relative ease with which wind technology adapts to different countries and requirements, and the short gestation period, it has become the most attractive alternative. This is relevant for economies seriously concerned with energy security.

The key difference between the two market types is that, for the conscience market, comparisons are always made between wind costs and, say, combined cycle gas costs. Whereas, for the needs market, the comparison may be between the cost of having power rather than not having power. The conditions for commercial viability are, therefore, quite different.

In both conscience and needs market there is a political risk. Though the cost of wind energy has declined sharply over the last decade, it still requires some form of incentive to encourage its widespread development. This incentive is inevitably political in nature although it may be drafted in any number of ways, from tax credits to premium prices, to tradable green certificates. If the political attitude changes in any one of the active countries, the market in that country can undergo radical alteration. This has been evident on many occasions. For example, in Germany, there was some uncertainty in 1999 about the planning regime within which wind energy developments were built. Whilst that uncertainty was being clarified, the market declined, but it has since recovered and achieved three record years. Early in 2003, the premium price in Spain fell, although this was coupled with an increase in pool price and hence the composite kWh (kilowatt hour) price was almost unchanged. Nevertheless, the risk of price change was accentuated.

In the case of the EU, underpinning individual domestic policies for renewable energy and environmental policy, there is strong support from both the European Commission and the Parliament. Targets for renewable energy have been set and enshrined in EU law. Hence, at a higher level of policy, significant support exists for ongoing development of renewables, including wind. Wind energy is particularly well received in this context as it has demonstrated an ability both to reduce its price significantly with increases in volume, and to create significant employment.

c) Market incentives

Gradually wind energy markets are developing into self sustaining commercial ones. In the mid 70's in the countries most severely effected by the energy crisis, either physically, economically or politically, the development of wind energy, in parallel with other renewable energy technologies, started by government initiated technology R&D programmes. Later, in the late 70's until the mid 80's these R&D programmes were supplemented with demonstration projects, market introduction incentives and in some countries also industrial development schemes.
A widely varying range of incentives, R&D activities and industrial projects and their combinations were put into practice. The effectiveness of these schemes in terms of of technical progress, development of the industrial sector and installed wind power varied significantly as well. For the development of installed power, figure 5 illustrates this very clearly. Each dip or sudden increase in the annually installed amounts of wind power can be related to the change in or introduction of new incentive schemes. The effects of the the type of incentive on the market development were analysed frequently. For example

Very roughly the incentives can be classified into the following categories:
- demonstration projects
- investment subsidies
- output based subsidies
- tax facilities
- obligatory targets in terms of newly to install wind energy power, possibly based on public tenders
- other categories, like prioritising wind energy in trading systems.

After more than 25 years of experience with various systems in Europe, the United States and India some general conclusions can be drawn (See EWEA 'On the future of EU support systems for the promotion of electricity from renewable energy sources', November 2004).

- Even a small adjustment to the policy framework, including payment mechanisms can have a profound negative effect on the markets.
- More fundamental changes will have an even a greater effect. A dramatic shift would undermine investor confidence.
- There is little evidence of effectiveness beyond output based systems like fixed feed in tariffs and premiums. However it should be kept in mind that the amount of subsidies are to be maximised in order to keep a reasonable balance between government support and regular entrepreneurial risk.
- The system of maximising government support should be a physically sound one. Rules to calculate maximum limitations should not be sensitive for artificial manipulation and fraud.
- The simples the incentives, the more effective they are.
- Tenders, e.g. connected to obligatory regulations can have an on-off effect of market sales and could have disastrous effects on the manufacturing industry.
- The elements of a policy framework should be in balance. Frameworks require not only good payment mechnisms, but also effective policies to remove barriers to grid access, barriers in the form of administrative and encourage public support, such as spacial planning, nature conservation policy and environmental regulations.
- Problems with cross-border (states and countries) trade problems with additionality, double counting of amounts of generated wind electricity and CO_2 emission reduction, could hamper national schemes.

As a result a list of requirements of effective measures could be formulated. These requirements include:

- Compatibility with the 'polluter pays' principle.
- High investor confidence.
- Simplicity and transparency in design and implementation.
- Encouraging technology innovation, technology development, reliability and reduction of cost.
- Compatibility with the power market and other policy instruments.
- Facilitating a smooth transition ('grandfathering').
- Encouraging local and regional benefits and public acceptance.
- Transparency and integrety: protecting consumers, avoiding fraud and free riding.

With these lessons learned from the past and present, the following chapters about the European and Indian developments can be interpreted much better than without learning from the past.

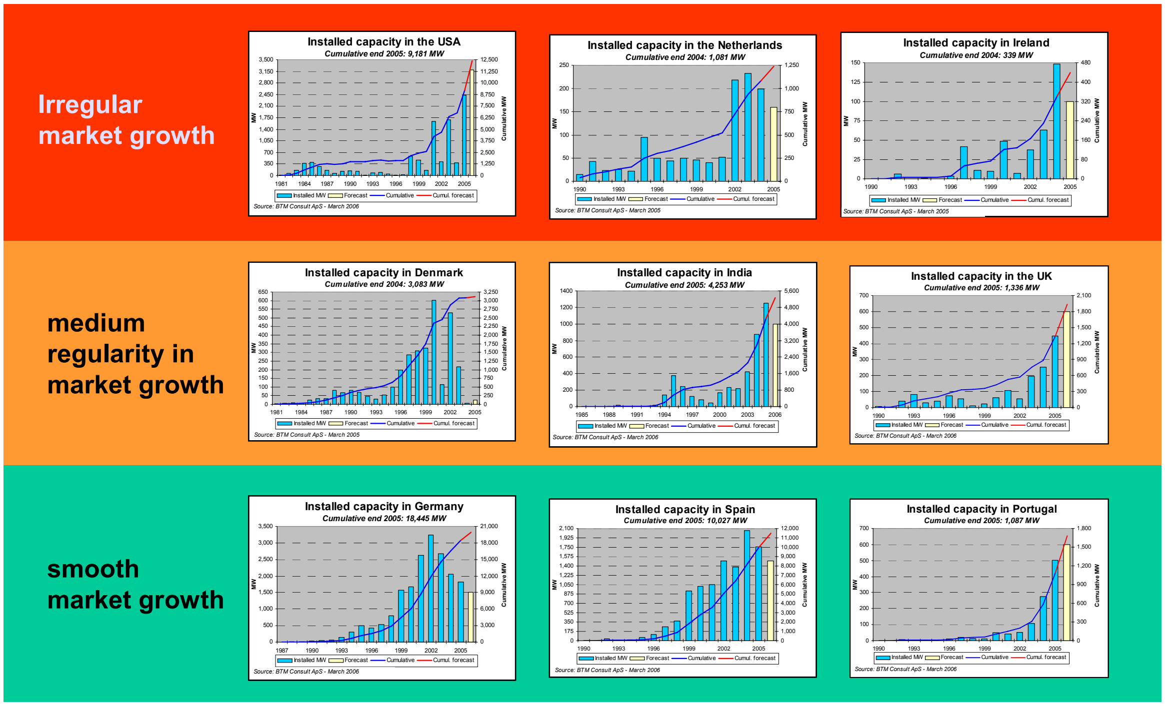


Figure 5. Market development and payment mechanisms.

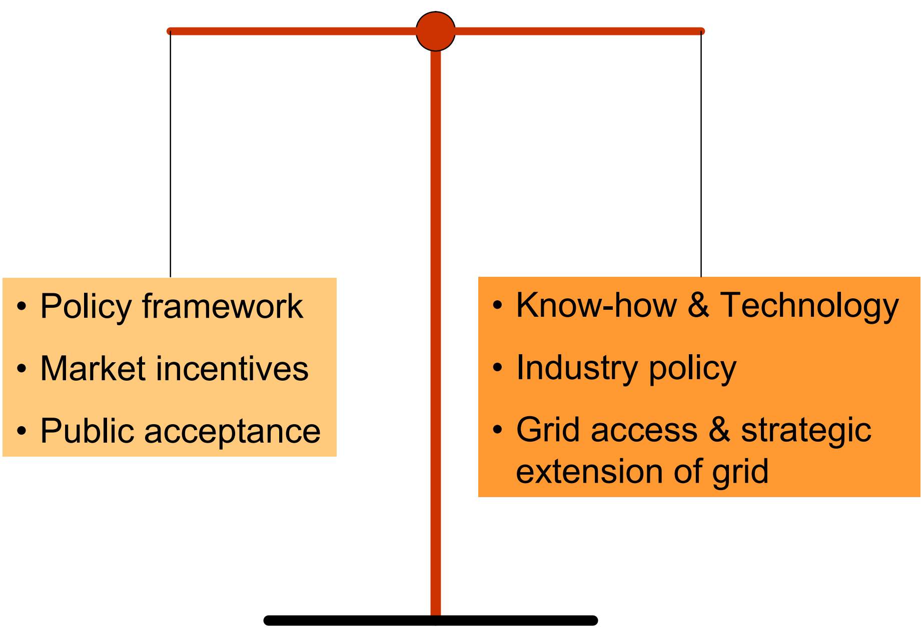


Figure 6. Illustration of the need for balancing the elements of a successful policy framework.

II. The European Wind Energy Sector

The European Union leads the world in the domain of wind power with installed wind capacity touching 48,300 MW at the beginning of 2007, representing almost 65% of the global total. The European Wind Energy Association (EWEA) current targets are 75,000 MW of wind capacity in Europe by 2010, and 300,000 MW by 2030.

The success of wind energy expansion programs since late eighties is attributed to the technological progress and appropriate wind power support policies by individual members. Wind power has emerged as a top contender in the field of renewable energy. EWEA predicts that by 2010 the wind energy alone will save enough green house emissions to meet one- third of the European Union's Kyoto obligation. The leading countries for wind energy in Europe are Germany, Spain and Denmark. These market leaders are now being joined by a second wave of countries including Portugal, France, the UK, Italy, the Netherlands and Austria. Besides, the ten new states, which have joined the European Union in 2004 including Poland, Hungry and Baltic States, are not lagging behind- they are taking initiatives, which are expected to take off in the next few years.

1. Policy Development in the Wind Energy Sector in the Three Leading EU Countries

Out of the world's five leading countries in terms of installed wind power capacity, three are European. We discuss briefly the profiles of the wind power development in the context of policy initiatives of these countries.

a) Germany

One-third of the world's installed wind power is in Germany. In 1990 it was 48 MW. According to industry associations, it increased to 16.6 GW in 2004. This is more than 3 per cent of Germany's total electricity production, which was around 22 TWh, in 2004. In 2002 there were about 16,000 wind turbines, mostly situated in northern Germany bordering Denmark.

The 100 MW Programme initiated in 1989 was the impetus for the German wind power market. This was expanded to 250 MW in 1991. The programme provided grants as well as remuneration under the Electricity Feed-in Law. The Renewable Energy Sources Act 2000, further strengthened market deployment by providing an incentive of 'production payment' for the first five years of operation. This was followed by a decreasing output payment in the subsequent years. Investment support provided up to 80 per cent of the total investment costs at low interest rates. Rapid deployment of wind power is also attributed to changes in codes that awarded wind farms the same legal rights as fossil and nuclear power plants.

The significant growth of onshore wind power led to collaborations between the transmission system operators and German research institutions for developing advanced forecasting and modeling tools besides cooperation in international and European research programs. .

The German government has a target of increasing the share of renewable energy in electricity generation to 20 per cent share of by 2020. Most of this is expected to come from wind power. Concerns regarding network integration and infrastructure capacity to accommodate around 37 GW of wind power by 2015 were the impetus for a report released in February 2005 - ‘Energy Planning for the Integration of Wind Energy in Germany on Land and Offshore into the Electricity Grid’. The federal government and the industry jointly financed the report. It found that reinforcement and extension of the grid, and technical solutions for reliability are the preconditions for achieving the envisaged wind power development, besides avoiding 20 - 40 million tons of CO_2 emissions in 2015. It would entail construction of about 850 km of new high-voltage lines and 400 km of grid upgrades, at an estimated cost of €1.1 billion. The study cautions that planning and legal authorization process for transmission lines could hinder implementation. It suggests that the additional cost for the expansion of wind power will be 0.39 – 0.49 € cents per kWh in 2015 for a residential consumer.

b) Spain

The installed wind power capacity in Spain was 2 MW in 1990. It increased to 4.8 GW in 2002, the second largest in the world. According to industry associations, it was 8.2 GW in 2004. Electricity production from wind turbines was an estimated 14 TWh in 2004 - about 4 per cent of Spain’s total electricity production.

Strong growth is attributed to local manufacturing of turbines and policy support through feed-in tariffs and low-interest loans. A significant impetus came from regional governments that support construction of factories and creation of local jobs. Favorable lending arrangements, in which banks guarantee the cash flow of the project, thus reducing risks, have been very effective.

Three Spanish companies are among the world’s ten largest manufacturers of wind turbines. The incentive structure has favored the development of large wind projects connected to high voltage transmission network.

Weak grid infrastructure in some areas inhibited the development of wind farms. This led to a comprehensive review of the transmission and distribution requirements by the grid operator, which is concerned about system impacts from more large-scale wind farms and the costs of integration. At present, Spain’s transmission system interconnections with the neighboring countries are weak. This presents limited opportunities in power pools.

c) Denmark

In Denmark, the installed wind power capacity was 2.9 GW in 2002, the fourth largest in the world. According to industry associations, it increased to 3.1 GW in 2005. Denmark has successfully and flexibly employed both demand pull and technology push policy instruments to achieve its wind power targets. In Denmark, each MW of capacity produces an average of 2,129 MWh a year – much more than the world average.

In 1976, as part of the Danish wind power initiatives Wind Guilds were set up to own and operate turbines. Members of the Guild originally had to live within 3 km of the site, in order to help mitigate concerns regarding noise, environmental effects, etc. The rules have been gradually relaxed in cases related to living or owning property in the borough where the turbine is built. The Guilds contributed to the Guild magazine - Naturlig Energi, a list of the turbines and the problems encountered, thus helping development of technology.

Denmark has the highest penetration of wind power in its electricity supply systems of any country. About 93% of the wind generation is fed into the distribution networks. Wind farms in Denmark are generally small clusters in the 10-20 MW range and are widely dispersed across the country, which means lower volatility of output in the short-term and therefore less need for balancing power. With this profile, the variations in output are less than for very large and isolated wind farms and therefore more manageable for network operators.

Following liberalization of the electricity market and maturing of the wind power technology, the economic commitment shifted to consumers. The support scheme is being reorganized. Following a transition period, wind turbines will have to produce on market terms, but with a bonus that capitalizes on the environmental and societal benefits of wind power.

At a global level, Denmark has the highest penetration of wind power in its electricity supply systems. About 93 per cent of the wind generated is fed into the distribution networks. Wind farms in Denmark are generally small clusters in the 10-20 MW range and are widely dispersed across the country. Hence, it has lower volatility of output in the short-term and therefore less need for balancing power. With such a profile, the variations in output are less than those in very large and isolated wind farms, and are therefore more manageable for network operators.

In addition, wind power, along with combined heat and power generation that is widespread in Denmark, provides some of the needed power regulation flexibility, as the district heating systems can be used as a short-term energy buffer. Also, the Danish transmission system has strong interconnections with Germany and the Nordic countries. Participation in the Nordpool power market is important for selling excess capacity and purchasing additional balancing power as and when needed. Danish network operators, utilities, government and research institutions are active in international and European collaborative research on grid integration matters.

The key policies contributing to success and growth of wind energy programs as highlighted above are:

Summary of Major Policy Initiatives by the three EU Wind Leaders

a) Germany:

- Farmers were the First to invest and “Farm the Wind” thus generating additional Income. Germany’s Success was first based on Small wind farms of 1-3 turbine. Both the German government and the European Union have made renewable energies a clear political priority. With over 15,100 members, BWE is by far the largest association within the German Renewable Energy Association (BEE) and the World Wind Energy Association (WWEA). BWE is a national organisation that is independent of firms and other organisations. The thirteen state-level boards and forty regional associations are the principal organs of the BWE and guarantee that the needs of the members are served. Permanent and experienced staff in the Osnabrück national office support the activities of the Board and of the regional associations. An office in Berlin and a representative in Brussels work to influence political decisions and to keep members informed about European and German energy policy discussions.

- Mature technology and highly competitive business.

- Successive laws, the 2000 Renewable Energy Source Act (updated in 2004) permit paying a premium tariff for the output by the generators, gradually reducing over a 20 year contract period has contributed to attracting a large number of small business investors and double digit growth rates since the 1990s.

- Although the rate of development on land has already stared to slow down due to a shortage of available sites, re-powering the old ones and new offshore market in the North and Baltic seas would compensate. A study by the German Environment Ministry (BMU) estimates that offshore wind power could reach a level of 12,000-15,000 MW by 2020.

- Germany has used simple mixture of Mechanisms- Higher fixed Payments

  - Tax Advantages & Cheap Loans to encourage
  - Renewable energy development
  - RE support mechanisms in Germany
  - Renewable Energy Sources Act (“EEG”)
  - Ecological Tax Reform
  - Subsidies (federal, regional and municipal level)

- RES Act features and incentives for success

- Guaranteed compensation rate
- 20 years sales guaranteed at the compensation rate
- Electricity produced must be purchased
- Balances out competitive advantage of conventional energies
- Legal certainty (20 years amortisation period)
- Attractive for investors: rate of return

- Does not put a burden on public funds
- The Electricity Feed-In Law (EEG)-
- The Success of the German renewable Supports can be attributed to the 1990 “Stromeinspeisungsgesetz”, meaning the Law on Feeding Electricity from Renewable Sources into the Public Network (Electricity Feed Law or EEL). It required electric utilities to pay a fixed rate, equal to 90% of the retail residential price, for electricity generated from wind energy and other renewable.
- The utilities are obliged to connect and buy this wind power.
- It was amended in 1997 and replaced by the Renewable Energy Act (REA) in 2000.
- Current Support Scheme

  •A payment for wind power plants at a fixed price of 0.09 Euro during their first Five years of operation, after this reduced to a lower rate, depending on the quality of the site.

  •Coastal site price falls to 0.061euro after the first five years of operation (result is an average rate of 0.068 euro over life-time of 20 years)

  •Wind turbines inland receive a higher payment because of the lower wind speeds - average 0.084 euro over 20 years.

  •Low-wind sites of less than 5.5 m/sec receive up to 20 years 0.089 euro on a 20 year-average.

b) Spain:

- Most of the wind turbines deployed are manufactured domestically. Encouraged by the national premium tariff and policy based on regional industrial regeneration, prospective developers have only been able to access project sites if they commit to establishing manufacturing base in the region. This has led to economic development of a relatively poor but windy province of Navarra where wind power accounts for nearly 60% of its electricity supply. In both densely populated provinces of Castilla and Galicia, the level has reached more than 20%.

c) Denmark:

- Demark is a pioneer in wind power. The Risø National Laboratory established a test station in 1978 for wind turbines that was responsible for type approvals that were a precondition for obtaining plant and production subsidies. Risø functioned as a technological service centre for the nascent Danish wind turbine industry, whose individual companies at that point did not have the resources to undertake technological development. Government RD&D has been directed towards basic research rather than actual turbine or component development and had enjoyed a relatively stable level of support.

- The technological developments led to significant growth in demand for wind turbines in the 1990s in both domestic and export markets. Within Denmark, the technological advances were coupled with market deployment strategies building on a policy combination of feed-in tariffs and subsidies for installation costs. Utilities were required to connect private wind turbines to the grid. An agreement was established between utilities, government and wind turbine owners in the early wind power development period.

- Among other features, it established the grid connection rules, and particularly who should pay. Grid integration costs are paid by the network and allocated to all customers.

- The Danish Government supported wind to help achieve energy goals and other policy objectives, e.g., industrial development and rural employment. Investments were made in RD&D and learning in a niche market to improve technology cost and performance.

- Through the development years, the Danish state financed the additional costs involved.

- Following liberalisation of the electricity market and reflecting the maturing of the wind power technology, the economic commitment shifted to consumers. The support scheme is being reorganised and following a transition period, wind turbines will have to produce on market terms, but with a bonus that capitalises on the environmental and societal benefits of wind power.

- In 1990s, Denmark pioneered the development of off shore wind farms. One of the primary reasons for moving wind farm development offshore is the lack of suitable wind turbine sites on land. This is particularly the case in densely populated countries like Germany, Denmark or the Netherlands. It has advantages of more space, higher wind speed, less turbulence, less visible despite disadvantages of expensive foundation, - expensive grid connection, sometimes difficult access, corrosion and no long-term experience.

2. The EU Wind Energy Program: A SWOT Analysis

The EU wind energy program owes its success to a variety of factors relevant to its member nations, which are to an extent equally relevant to other developed and developing nations. The discussion below presents SWOT analysis for wind energy program as relevant to EU nations.

a) Strengths

- Security of supply - most EU nations rely on imported fossil fuels. Wind energy is a massive indigenous program safeguarding against conflict and political instability threatening energy supply.

- Environmental concerns - urge of the EU to curb CO2 emissions and achieve Kyoto targets is an important consideration.

- Economics is an important driver - a) Competitiveness of wind power as a consequence of dramatic fall in the cost of wind power and b) Fossil fuel price has shot up in the recent past with little respite in the future. It makes lot of sense to switch to renewable option on the ground of its being reasonably competitive now.

- Rapid expansion and improvement in wind power technology and industry. Wind power equipment manufacturing, service and testing organizations are passing through a boom.

b) Weaknesses

- Having tapped virgin areas, sustenance of growth, research into new avenues and cost cutting and continuation of supportive policy regime is a challenge.

c) Opportunities

- Application areas such as re-powering existing sites, exploiting on-shore potential in the vicinity of EU nations as well as other global locations) and joint initiatives with developing nations offer opportunities for EU. Wind players to expand their on-going achievements in the future years.

d) Threats

- Competitive pressures from new players for global partnerships
- Pressure of scarce land resources
- Environmental concerns- land and marine, lobbies against developmental programs.

III. The Indian Wind Energy Sector

The Asian continent is developing into one of the main powerhouses of wind energy. The strongest market leader in wind energy in the continent is India. With a total of 4,430 MW of wind capacity in 2005, India is in the fourth position in the international wind power league. The Indian Wind Turbine Manufacturers Association (IWTMA) expects between 1,500-1,800 MW to be commissioned every year for the next 3 years.

Over the past few years, both the government and wind power industry have succeeded in injecting greater stability into the Indian market. Incentives by the Central and State Governments have encouraged large private and public sector enterprises to invest in wind projects stimulating the domestic manufacturing sector. Some companies now source more than 80% of the components for their turbines. This has contributed to both more cost effective production and additional local employment.

The geographical spread of Indian wind power has so far been concentrated, especially in the southern state of Tamil Nadu, which accounts for more than half of all installations. This is beginning to change with other states including Maharashtra, Gujarat, Rajasthan and Andhra Pradesh, catching up in this drive to tap this emerging renewable energy option. With the potential for up to 65,000 MW of wind capacity across the country, the sector can continue further strides over the next decade. Industry and research programs are geared up to meet this challenge.

With the notable exceptions of Tamil Nadu, Andhra Pradesh and Gujarat, other states view wind farms more as a nuisance than a benefit, due to the low reliability and non-dispatchability. Government policy has placed them in a position where they have to pay higher prices for wind-generated electricity. This has caused them significant financial hardship and has not heightened their enthusiasm and support of the technology. In addition, India's relatively poor infrastructure previously meant that transport and installation of megawatt scale wind power technology was impossible (WPM, June 2004:38). In 1996 grid abnormalities induced a 20% loss in potential revenue due to 'direct generation loss' (inability of wind plants to operate when the wind is blowing). Half of all these losses are due to weak grids in the region. Utilities are suffering the burden of having wind farms connected to their grids.

The rapid growth in wind power development in the 1990s, rendered grid capacity in the wind farm regions in Tamil Nadu and Gujarat inefficient in accommodating the wind power. It caused frequent outages of the grid and reduced return from the wind farms. In 1998, Risø and C-WET collaborated on a research project to study wind power integration in weak grids in India.

1. Wind Power Development in India

The Government of India realized the importance of private sector participation in wind power as early as 1983/84. Accordingly, a national program was initiated to tap the then estimated potential of 20,000 MW by adopting a market-oriented strategy. This ultimately led to a successful commercial development of wind power technology and substantial additions to power generation capacity in the country.

The reassessed gross wind power potential of the country stands at 45,000 MW. However, the technical potential, assuming 20 per cent grid penetration, works out to be 13,000 MW. The technical potential would increase as the grid capacity increases.

According to the Indian Wind Association, the installed wind power capacity was 30 MW in 1990. It increased to 3,568 MW, now the fourth largest in the world. The first wind power development was a government-supported demonstration plant in 1986. India witnessed notable wind power developments by the late 1990s, largely due to incentives such as accelerated depreciation allowance of capital costs and exemptions from excise duties and sales taxes, and regionally administered feed-in tariffs.

India has been an active supporter of wind development since the 1990s. In the 1990s, India's market experienced a significant boom as a result of various tax incentives, attractive buy-back rates, and some preferential loans. For example, 100% depreciation of wind equipment was allowed in the first year of project installation, and a 5-year tax holiday was allowed (Rajsekhar et al., 1999). The national Guidelines for Clearance of Wind Power Projects implemented in July 1995 (and further refined in June 1996) mandated that all State electricity boards and their nodal agencies make plans ensuring grid compatibility with planned wind developments, and that they seek Detailed Project Reports (DPRs) from independent consultants (for capacities above 1 MW) on all proposed wind development projects to verify project capital costs and proposed power generation against certified wind turbine power curves and wind data at the site, before granting approval for projects (Rajsekhar et al., 1999). The expectations for future market growth in the early-mid 1990s attracted a number of firms to the Indian market.

India has also developed a national certification program for wind turbines administered by the Ministry on New and Renewable Sources (MNRS), based in large part on international testing and certification standards.

However, even with extensive government regulations pertaining to wind farm development, inaccurate resource data, poor installation practices and poor power plant performance led to a dramatic slowdown of installed capacity in the Indian market in the late 1990s and early 2000s (Rajsekhar et al., 1999). Policy drivers also became unstable during this period.

The early perception of growth prospects for India had led to the presence of local manufacturing of wind turbines by international companies, and more recently Indian companies. As far as the domestic industry is concerned, there are 8 major companies manufacturing wind turbines and components. These companies are either joint ventures or licensee of reputed international companies, a majority of them from the EU. Of these, 5 are ISO certified.

The manufacturing base not only meets domestic needs but also caters to the emerging export markets, including Europe. The annual production capacity is of the order of 500 MW, which can be increased to 750 MW. Large capacity wind turbines in the range of 1 to 1.25 MW are being produced in the country. Wind turbines of 250 kW - 1,650 kW are being manufactured. These systems require an average wind speed of about 2.5 m/s to 30 m/s velocity. Wind turbine components are exported to Europe, Australia and the USA.

India has taken some direct steps to encourage local manufacturing. For example, customs duties have been levied in favor of importing wind turbine components over importing complete machines. There is no customs duty on special bearings, gearboxes, yaw components and sensors for the manufacture of wind turbines, or on parts and raw materials used in the manufacture of rotor blades. There is a reduced customs duty on brake hydraulics, flexible coupling, brake calipers, wind turbine controllers and rotor blades for the manufacture of wind turbines, and the excise duty is exempted for parts used in the manufacture of electric generators (Rajsekhar et al., 1999).

The MNES is implementing a program on small wind energy and hybrid systems, with the main objectives of - (i) field testing, demonstrating, and strengthening the manufacturing base of water pumping windmills, aero-generators/hybrid systems, and (ii) undertaking research and development for improvements in design and efficiency of these systems. Presently, the program is being implemented mainly in the states of Andhra Pradesh, Bihar, Gujarat, Karnataka, Maharashtra, Rajasthan and Tamil Nadu, owing to the felt need for water pumping and small power generation. The program is, however, being extended to other potential states also. The program has made very slow progress and not very popular with the beneficiaries, financial institutions, NGOs, etc. By year 2003-04, 945 water pumping windmills, aero-generators and hybrid systems of about 370 kW capacity wind-solar hybrid systems have been installed in the country.

The program on water pumping windmills is being implemented through the SNAs/departments. The manufacturers and suppliers of water pumping windmills are also eligible to market them to users directly. The program on small aero-generators and hybrid systems is implemented through the SNAs or user organizations like research institutions, NGOs, Central and State government organizations, defense organizations, para military forces and autonomous non-commercial institutions.

Despite subsidies ranging from 30 to 75 per cent, the programs are still not popular due to a variety of reasons. The entire project had been heavily subsidized. It was a failure for two main reasons. The equipment in use was not adapted to Indian circumstances (hence it broke down and could not be fixed by the locals) and the communities involved had no sense of ownership in the project.

However, a useful lesson that can be learned from this example is that these wind pumps have a big role to play in a decentralized rural community, besides avoiding the aforementioned mistakes. The SNAs have not put in the desired spadework in developing the interests of the community and entrepreneurs and in addressing their apprehensions. High transaction cost is also a serious concern. At times, the user prefers grid supply, which is almost free.

2. The Wind Energy Policy Structure in India

A range of policy support measures and incentives announced by the government for introducing state-of-the-art wind energy technologies on the one hand, while encouraging private entrepreneurs to take up commercial projects on the other led to significant progress in the sector. A tax rebate of 80 per cent on income from power generation for the first ten years of operation has encouraged commercial investment, as has the attraction of power supply for use in businesses.

However the spurt in private sector participation started only in 1992, after the announcement of the 'private power policy' of 1991. This, along with a booming economy and attractive fiscal incentives, provided the impetus for accelerated growth of the sector. In some cases wind farms are not well integrated, as the wind turbines produce more power than that can be handled by the weak distribution system.

The Indian Government has been taking policy decisions with consistent efforts for over a decade now. Ministry on New and Renewable Sources (MNRS) has set a target of realizing 10 per cent of the new capacity additions through renewable from 2012. Wind power generation may constitute 50 Per cent of the additional renewable capacity amounting to plus 1,200 MW of power every year.

While style and content differs, the basic policy structure is similar across states. This is to provide legal support and economic incentives, while obligating (by means of legislation) the power company to buy electricity from wind power, and encouraging businesses to develop wind power through incentives such as investment, tax, and price. A number of infrastructural situations have also spurred wind energy use. This was perhaps the strongest initiator in promoting wind power adoption and investment. The policies adopted allowed all the other factors to flow together in a way that made wind energy very attractive to businesses and investors. Apart from the ongoing efforts of the Ministry on New and Renewable Sources (MNRS) which first of all instilled confidence in the technical and commercial viability of wind energy by performing the Demonstration Program, monitoring the entire country for windy sites, and putting the tax incentives in place, a few other policy initiatives by the State government of Tamil Nadu, an Indian leader state are worth also to be noted. For example, the state of Tamil Nadu adopted the following measures:

- The windy sites were close to towns for accessibility in bringing labor and providing accommodation for the personnel involved in the projects.
- The sites were well interlinked with highways.
- Grid network by Tamil Nadu Electricity board (TNEB) was well connected and mainly passing through the sites.
- Most of the wind turbine manufacturers/suppliers were located in Tamil Nadu and so gave investors confidence in the supply of machines and after-sales service of the machines.
- Chennai port of Tamil Nadu has excellent facilities for import of heavy machinery of the turbine components and this facilitated inter-state and international transportation.
- Active promotional steps were taken by TNEB and the Tamil Nadu Development Agency (TEDA). For example, TEDA took the first steps in setting up wind farms at sites like Muppandal, Kayathar and Kethanur to prove the viability of wind farms.
- TNEB extended all facilities for private entrepreneurs like consultancy services, processing of the application for issuance of No Objection Certificate (NOC), and other clearances, extending grid connections to wind farms and executing new dedicated sub-stations.

- TNEB established an effective system for registering the energy generation by each turbine and so enabled turbine owners to adjust their energy bill in accordance, or effect payment to those who sold to TNEB.

The suppliers provided turnkey solution by looking at the land development issues. This has helped in boosting the acceptance of wind farm projects by Indian investors who do not feel comfortable in tackling the related issues, reduce delays in execution and negotiate the land related costs with the owners and civil contractors.

However probably the most damaging factor for the wind industry was the very thing that really started the boom, namely the 80% (previously 100%) accelerated depreciation. The policy had a number of negative impacts. Among these are enabled large-company finance officers to make hasty decisions around the time of tax-filings to install wind plants. These hasty decisions often led to bad siting of machines and consequent low performance. The rule relies on the ability of promoters of the technology to absorb the tax benefits - this restricted the number of potential entrepreneurs to companies with huge profits, such as the textile and cement industries, which were actually big investors in the technology. Smaller entrepreneurs were not incentivized.

3. The Current Scenario

In recent years, the market has begun to re-establish itself. State governments in India are running concession programs, and have already earmarked 50 sites for wind farm development. In Gujarat the government has signed agreements with Suzlon, NEG Micon, Enercon and NEPC India to develop wind farms on a build-operate-transfer (BOT) basis, with each manufacturer given land for the installation of between 200-400 MW in the Kutch, Jamnagar, Rajkot and Bhavnagar districts (WPM, March 2004:57). Additional policies established in certain provinces have helped to spur recent development.

India may be poised for growth with Suzlon planning global expansion, but fundamental risks in the Indian market remain, making international manufacturers somewhat reluctant to invest. For example, the power grid has such severe reliability problems that day and night voltages differ.

India's policy scheme, in particular the major tax advantages offered to manufacturers, helped to promote the industry throughout the 1990s. However, the current policy outlook is less clear, and wind power will likely be directly affected by the current restructuring of India's electric power industry. The Indian government continues to show it support for wind power and has set aggressive targets to bring 5,000 MW of new wind power capacity online by 2012 (WPM, March 2004:57).

4. Foreign Investment Policy

India has put a lot of thrust on the promotion of renewable sources of energy. It has adopted liberal foreign investment policies in the non-conventional energy sector. Some of the salient features of India's foreign investment policies in the renewable sector are as follows:

- Foreign investors can enter into a joint venture with an Indian partner for financial and/or technical collaboration and also for setting up of renewable energy based power generation projects.

- Liberalized foreign investment approval regime to facilitate foreign investment and transfer of technology through joint ventures.

- The proposals for up to 74 per cent foreign equity participation in a joint venture qualifies for automatic approval.

- 100 per cent foreign investment as equity is permissible with the approval of the Foreign Investment Promotion Board (FIPB).

- Various chambers of commerce and industry associations in India can be approached for providing guidance to investors in finding appropriate partners.

- Foreign investors can also set up a liaison office in India.

- The Government of India is also encouraging foreign investors to set up renewable energy based power generation projects on built, own and operate basis.

- Further, the government also provides several fiscal and financial incentives for investments in the wind energy sector. These are available to foreign investors. They include capital subsidy, interest rate subsidy, 80 per cent accelerated depreciation benefit and exemption/reduction in custom duty, sales tax, excise tax etc.

The policy adopted by the government successfully attracted several European players who have their presence in India today, either as a wholly owned subsidiary or joint ventures, or as technology collaborations.

However, most of the investments made were in the form of private equity in manufacturing ventures. Financial intermediation of other forms such as debt, working capital and other sophisticated financial services such as insurance, risk management solutions, etc. is still lacking.
In the recent past, several European banks and FIs have entered the Indian market. Given below is a compilation of the European banks and financial institutions operating in India.

Most European banks and FIs have not yet realized the attractiveness of the Indian market, or consider it too risky. As per stakeholders, a couple of existing European banks in India are active in wind energy investment. Therefore, there remains a significant potential for financial intermediation between Europe and India.

5. Regulatory Issues

Power reforms were initiated by the Central Government in 1991.Due to this the sector is witnessing transformation characterized by unbundling of functions, ownership changes, the emergence of competitive markets, and the establishment of Regulatory Commissions. In such a changing scenario government policies and regulatory approaches are going to have significant influences on the development of grid-connected wind power.

Setting up of the CERC and the SERCs was a key element of this process. The Central Government passed legislations enabling the setting up of independent and autonomous regulatory bodies at central and state levels in July 1998. These regulatory bodies are expected to promote competition, efficiency, and economy in the consumption of electricity, and in investments for the development of the sector.

The Electricity Act 2003 has certain provisions for renewable energy sources. One additional responsibility of the SERCs, defined by the Act, is to promote cogeneration and generation of electricity from renewable sources. Hence it also encourages providing suitable measures for connectivity with the grid, sale of electricity to any person, and also specify if it considers appropriate, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution license.

The role of the state governments assumes significance in wind power generation. Though the Electricity Act 2003 did away with the need for licenses for setting up small power plants in rural areas, none of the states have notified this provision. The Electricity Act has not become fully operational. In each state, wind farms have to sign power purchase agreements with the respective SEBs. ERCs fix the prices at which the unit of power will be purchased.

While the Regulatory Commissions are in the process of evolution, one may encounter conflicting situations and undue interferences from the political class. Regulatory functions are expected to be fair and unbiased to all stakeholders.

The box below presents an interesting case.

Conflict of interests - Power utilities and prospective wind power producers

Subsidies, in the form of huge tax concessions and preferential tariff given to wind power projects in Maharashtra have been a highly controversial issue. A capacity addition of about 750 MW of wind power in Maharashtra was envisaged in the 10th Plan by MERC through its order dated November 24, 2003.

For projects commissioned after April 1, 2003, MERC had fixed a tariff (power purchase rate) Rs. 3.5 / unit with an annual escalation of 15 paise for the next 13 years. Once this period of 13 years was over, the firms were free to sell power directly to a consumer of their choice with MSEB having no right. This participation was on first-come-first-served basis and MSEB would have to enter into EPAs with all the private wind energy projects, which wish to do so. In light of the high tariff being given to private wind developers, MSEB found it cost-effective to undertake development of wind projects on its own.

To this effect, MSEB came up with a plan of erecting wind energy projects of 600 MW through a competitive bidding route. MSEB claimed that it would be possible to buy power through such competitive bidding route at a rate much less than MERC determined rate.

During the course of hearing by MERC on the issue, it claimed that if they are allowed to adopt such competitive bidding based approach, then there would be a saving of about Rs. 262 Cr / 100 MW of wind capacity addition (cumulative for 13 years). Also there would be a possibility of MSEB getting access to low cost generation after 13 years (when all loans are repaid).

MSEB pleaded for a time of about only six months to test the validity of such an approach by floating competitive bids and not having to enter into EPA at MERC determined rates. MSEB claimed that if it fails to bring down costs then it would immediately enter into EPA with wind developers at MERC determined tariff. Consumer groups also strongly supported such an approach.

But, MERC rejected the request and firmly directed MSEB to enter into EPA at MERC determined rates. Though MSEB is free to adopt competitive bidding, with the MERC directive of having to enter into high tariff EPA on first-come-first-serve basis there is little chance of success in bidding route.

This clearly illustrates the maturity of the regulatory process. However, it calls for a participatory process by the stakeholders to put across their case. Often entrepreneurs want short cuts or quick results without hassles.

The role and policies of the SERCs are vital for renewables, which are mainly driven by central policies. Unlike other developed countries, particularly those in Europe, the absence of legislation for the mandatory purchase of renewable power, absence of a green power market, and financially weak utilities are some of the barriers the SERC faces in promoting renewable power.

6. The Indian Wind Energy Program: A SWOT Analysis

The wind energy program in India is a positive development. In this context, a SWOT analysis has been attempted with the viewpoint of enhancing the uptake of this program in the future years.

a) Strengths

- Continuing demand- supply gap and escalation in the cost of fossil fuel-based power generation and electricity tariffs for industry and organised sector.

- Encouragement by Central and State Government policies - fiscal incentives such as accelerated depreciation and reasonable tariffs for industry and organised sector.

- Growth in wind manufacturing sector- joint ventures as well as indigenous industry contributing to adoption of the merging technologies, upscaling size of machines and cost cutting initiatives.

- Massive nation-wide efforts for wind resource assessment covering 25 states, comprising 900 stations and micro-survey of sites.

- Setting up a well managed C-WET, an institution in the public sector with EU support testing, R & D and advisory functions.

- Tactical project management orientation by wind industry, which involves land procurement, site selection, installation of the wind generation facilities on a turn key basis by the project developers/ equipment suppliers.

b) Weaknesses

- Low capacity utilization of the wind generation plants - this is not attributed to availability of wind but also factors such as

- Over- capacity due to biasing of the market mechanism to tax incentives for installing of wind farms rather than efficient operation. This led to inadequate resource assessment in advance of construction and poor engineering.

- Forced outages due to technical factors such as weak grid integration, mechanical problems, etc.

- Dearth of O & M skills and service organizations.

- Small wind power generation program not successful due to techno- economic considerations and inadequacy of the demonstrative efforts taken up so far.

- Rising land costs and developmental issues.

c) Opportunities

- Substantial untapped market- off- shore and on- shore.

- Enhancing productivity of existing installations by re- powering existing ones.

- CDM credits for clean technologies.

- Tried and tested technologies for such small applications is under developed due to mismatch, poor project design, dearth of trouble shooting skills and barriers in commercial operations. The small wind industry implementation Strategy (SWIIS) project, co-coordinated by Socie'te' d' Etudes Et de Development (SEED) to increase the sector's impacts through provision of tools such as sectoral market analyses, a catalogue of manufacturers, comprehensive listing of available turbines, their applications and detailed information on hybrid technologies such as wind-diesel and wind-PV. Similar initiatives are needed in the Indian context.

d) Threats

- Technical progress and financial outlays may not keep pace with the prospective markets in the future years.

- Wind power subsidies may be rationalized or pegged down discouraging prospective buyers.

- Cost cutting may not work out favorably- land costs may shoot up & cost-cutting ideas by equipment suppliers may dry up.

IV. Opportunities for EU Wind Energy Companies in the Indian Wind Energy Sector and visa versa

The total wind based generation capacities globally are approximately 47,317 MW. The largest incubators, amounting to more than 73 per cent of the capacity, are in Europe. It is poised for further growth. EWEA projections suggest that a target of 1,80,000 MW is feasible for 2020. This is expected to account for 12.1 per cent of the electricity needs in Europe.

In India, wind power has emerged as a potent renewable source. The wind energy sector has grown significantly despite ups and downs. The private sector has invested about Rs 10,000 crores in the wind sector. This has positioned it as the fourth largest producer in the world. The enabling Renewable Energy Act, to make 10 percent remix mandatory by 2012, is expected to boost the on-going campaign for cost effective wind energy programs.

Presently, the focus is on higher capacity machines and low-wind regime turbines, which operate in class two wind regimes. Higher tower heights and wider swept areas have resulted from the experiences gained in the last two decades. Equally important has been the ability of wind power producers in dealing with grid problems.

India and Europe presently account for about 80 per cent of the world wind power capacity. The present state of wind power and the Indian wind industry is the result of a close and fruitful collaboration between the European Union and India in the fields of wind power exploration, manufacturing and research, especially establishment of C-WET.

Both EU and India can work together for developing untapped markets in their domain. There is huge scope for exchange of ideas, experiences and innovations amongst industry, professionals and policy makers.

EU best practices in training and HRD can be adopted to train the large Indian work force to function in an open market environment. EU companies can leverage India's technical capabilities by setting up basic research and development centers. The challenge lies in the development of training and HR programs to reposition this force.

While Indian utilities are mainly publicly owned, they need to adopt private sector approaches. In this regard best practices in the EU can help Indian institutions. This can also be extended to the neighboring SAARC countries like Bhutan, Nepal etc.

There is vast potential through EU-India co-operation for technological up-gradation of wind turbines and balance-of-systems. A collaborative approach would also be beneficial in imbibing best practices of wind farm management in the Indian context. The technology related priority areas where further developmental work is required are as follows:

- MW size wind power systems
- Wind machines for low wind regimes

- Improved rotor blades and gear boxes
- Advanced control systems
- Development of cheaper materials
- Integration of wind farms with weak grids
- Power quality improvement

On the policy front, India has a lot to learn from the European countries, where innovative policy and regulatory frameworks have been designed to give the much-needed push to renewables based electricity. Also, the promotion of wind power is expected to make a huge impact on carbon emissions and provide a respite to environmental challenges.

Thus, a meaningful exchange could occur, for instance, with the Netherlands concerning 'Green Power Certificates' and 'Regulatory Energy Tax', with Denmark on 'Electricity Supply Act' and the 'CO2 Quota Act', with Germany on 'Renewable Energy Sources Act' and the 'Green Pricing Scheme', and with UK concerning 'The Renewables Obligation' and 'Climate Change Levy'.

1. Network

The EU-India Wind Energy Network, co-funded by the European Commission's EU-India Economic Cross-cultural program, is led by ECN in the Netherlands. The main objective of the 36-month project is to facilitate partnerships among wind energy actors in Europe and India.

The Indian industry stands to gain improved technological collaboration, cheaper capital and outsourcing opportunities, while the European industry will have improved access to the Indian market and the exciting returns that it offers. EIWEN aims to include the creation of opportunities for SME collaboration, platforms on financial intermediation and know-how, exchange missions to Europe and India, and workshops.

The main purpose of the project is to achieve dynamic co-operation in the wind energy sector between various European and Indian Industries and SMEs, financial institutions, universities, research institutes and civil society associations. This is envisaged to lead to the development of economically competitive wind power plants resulting in an increase in the off-take of wind energy in India and the world.

The project intends to develop a forum/network to specially address the following:

- Enable knowledge and information exchange on best practices in policy, O&M and technical issues such as wind forecasting, grid integration, machine/component design, engineering and manufacture, and facilitate collaborative research/ commercial projects.

- Facilitate academic and research institutions in India and Europe to interact with each other (and its industry) to bring about knowledge creation or commercialization of research findings.

- Create awareness among financial institutions for greater participation in the Indian wind energy sector.

- Identify commercial and regulatory barriers in EU-India trade policy in the wind energy sector and suggest new policy initiatives to remove the same.

- Facilitate programs and policies that aim to assist in building new markets and transforming existing markets must engage all stakeholders, along the commercialization chain, in an integrated and pre-emptive fashion. Policy designers must understand the interests of those involved in the market, and must therefore effectively communicate with the stakeholders and the research community.

- Incentives to stakeholders to collaborate should include the need to 'learn' from technical and operational solutions and failed approaches of others. This will lead to improvement in reliability of tools, such as models for wind farm dynamics and grid operation, developing standardized approaches across market areas, providing technical expertise for regulatory and standards setting processes.

- RD&D and market deployment programs must take account of 'learning effects'. It involves looking at issues beyond the immediate needs of the stakeholders. They must foresee technical requirements in anticipation of deployment, particularly when new infrastructure is required such as offshore wind farms.

- Responding to challenges, such as the need to find immediate technical and operational solutions to grid interconnection issues, can foster more co-operative research at regional, national and international levels. The benefits of international collaboration for emerging low-carbon energy technologies include, pooled resources, shared costs, harmonization of standards, and strengthened national R&D capabilities.

- As energy technology advances from RD&D to commercialization, costs and risks shift from the government to industry. As illustrated by the collaborative groups profiled in this study, grid integration research includes, participation and financial support from wind and electricity supply industries to a significant degree.

The project intends to hold comprehensive workshops targeting all European and Indian actors, players and stakeholders in the wind energy sector, besides disseminating the project findings to create awareness and better understanding of the scope, prospects and benefits of EU-India co-operation.

2. Specific Areas of Mutual Interest

a) Developing Service Providers

Indian breed of professionals need to collaborative arrangement to train and pursue joint activities with EU partner playing a senior partner's role for taking up the following key sub- activities Joint Projects (Global- India Europe and other countries).

Indian technical staff can engage in variety of global jobs such as wind resource assessment, site assessment and development, manufacturing, turnkey erection and commissioning, operation and maintenance, testing etc in locations in India/ Europe or other countries such as SAARC, Asia and Pacific, Europe etc for competitive packaged solutions. In the future years, wind projects would be becoming competitive and challenging justifying such collaborative arrangements to grab opportunities.

Facilitate re-powering existing old wind machines. There is substantial scope for enhancing the productivity of the existing installations by micro-siting, redesigning the wind machines, overcoming grid related problems and instituting a MIS/ energy audit program. This may be taken up jointly with Indian partners, as highlighted in 5.1.1 above.

b) O&M Contracts

O &M contracts (short and long term) may be useful for realising full potential and optimising the performance of wind farms. Though a few players like Tate Consulting Engineers (TCE) have offered these services (Annexure), there is a perceived need to develop several service providers in decentralized locations. EU partners may take up extensive capacity building activities through suitable programs. More details may have to be worked out by interaction with the Indian wind farms and professionals.

c) Up-scaling of Wind Turbines

The up-scaling of wind turbines in the last 10 years witnessed is unprecedented. This trend is likely to continue. This results in better-cost economics and other advantages as highlighted below:

- In 'line clusters' the generating capacity per kilometer is more than proportional to the rotor diameter, which favors large installations.

- Minimization of the cost of offshore installations, a significant proportion of which is the cost of foundations, justifies the installation of the largest possible capacity unit on each foundation unit. It also holds for grid transfer from offshore to the shore.

- More number of small machines is replaced by small number of large machines. Besides, large turbines rotate slower, and thus tend to be less intrusive visually.

EU partners with their cutting edge may collaborate with Indian manufacturers /test centers to develop and verify substantially improved models of the principle wind turbine components, which the industry needs for the design and manufacture of wind turbines for future very large-scale applications, e.g. offshore wind farms of several hundred MW. The wind turbines required will be very large (>8-10 MW and rotor diameter > 120 m). Present design methods and the available components and materials do not allow such up-scaling. In order to achieve the necessary up-scaling, full understanding of external design conditions, innovative materials with a sufficient strength to mass ratio, and advanced control and measuring systems are essential.

In order to achieve this up-scaling in the most efficient way the following critical areas have been identified to be addressed in this Integrated Project. Aerodynamics, aero-elasticity, structural and material design of rotors, critical analysis of drive train components, monitoring and measuring techniques, and control concepts and support structures (for offshore applications), are to be analysed, and new design approaches and concepts developed, as well as supporting technology.

The collaboration will improve those techniques with the focus on large wind turbine structures.

d) On-shore Wind Projects

Europe has been pursuing on-shore wind program for the past 10 years or so with the reasonable degree of success. There is substantial scope for such projects in Indian situation for meeting the widening demand- supply gap due to the inherent advantages such as more space, higher wind speed, less turbulence, less visible riding the project developer of the hassles of land development and procurement. As easy sites are exploited, Indian wind sector will have o eventually prepare for exploiting the vast coastal line. No doubt this needs to resolve several issues such as foundation, expensive grid connection, access, corrosion, environment investigations etc. in the recent years, there is spurt of ocean exploration activities. This should call for identifying partners, pre-feasibility and continuing dialogue. Indian partners may also provide support for similar project in other global location.

e) R &D activities

R&D activities in the wind power field have not been adequately addressed. This is crucial considering the vast growth witnessed in the sector in the past 8-10 years and the complexities attached to emerging technologies. A few topical areas that need urgent attention are:

- Better techniques for short term forecasting (8-48 hours) and power output prediction,
- Development of LIDAR, SODAR and satellite observations for wind resource characteristics,
- Understanding the wind flow in and around large wind farms,
- Development of risk assessment methodologies,
- Novel rotor concepts using intelligent materials,
- Design criteria for components and materials,
- Modeling and prediction of ocean currents, wind potential, sediment transport, operation and maintenance,
- Grid integration for dynamic grid management based on improved systems integration, system analysis and control technologies,
- Integration of standalone turbines with other power sources such as diesel engine generators,

- Standardization of O&M mechanisms,
- Techniques to reduce sound, potential ecological problems,
- Testing, standardization and certification,
- Reduction of costs and uncertainties,
- Up scaling wind power production.

Though setting up of C- WET in 2000 is a positive development, vigorous efforts to intensify R&D apparatus is needed, keeping in view the wide spread of existing and forthcoming wind power generation sites. EU may strengthen C-WET or assist other institutions such as NAL , IITs, etc for the R&D activities

f) Small Wind Farms

Despite sporadic applications for water pumping, grain milling, battery charging etc in decentralized locations, small wind mill program is yet to take off for complimenting the massive Govt of India initiative in providing power to all villages by 2012. Tried and tested technologies for such small applications is under developed due to this mismatch, bad project design, lack of trouble shooting skills and barriers in commercial operations. The Small Wind Industry Implementation Strategy (SWIIS) Project, co-coordinated by Socie'te' d' Etudes Et de Development (SEED) to increase the sector's impact and through provision of tools such as sectoral market analysis, a catalogue of manufacturers, comprehensive listing of available turbines and their applications, and detailed information on hybrid technologies such as wind- diesel and wind- PV. Similar initiatives are needed in the Indian context, which develops useful user guides for Indian audience. The past programs have not succeeded due to technical and financial constraints. Going by the experience of Europe, Indian users, especially small farmers or entrepreneurs, can design appropriate small wind programs. It would be useful for Indian NGO's/ entrepreneurs to closely associate with EU counterparts in designing suitable projects and trouble shooting the existing installations.

g) CDM

Indian wind projects offer ready market to EU nations for meeting the EU member nations Kyoto obligations for green house emissions reductions.

i) Procurement of Components/ Plant and Machinery

There is substantial scope to supply components, plants and machinery from Europe to Indian wind project developers and equipment suppliers on the basis of reliability and quality and cost- competitiveness.
An unwanted effect may arise from the repowering activities in Europe. In some countries relatively small wind turbines which have reached the end of their economic life time are being replaced by larger units at a significant rate. As the decommissioned machines have significant value, a market for used machines is developing. As no quality system is in place for used machines the danger exists of implementing low quality machines on a large scale. It is therefore recommended to introduce a registration system for used wind turbines. The origin of the machine in terms of

manufacturer, owner, history of operation and maintenance need to be recorder in order to stimulate a sound market for these products.

ii) Policy Research

There is vast potential through EU-India co-operation for technological up-gradation of wind turbines and balance-of-systems. A collaborative approach would also be beneficial in imbibing best practices of wind farm management in the Indian context. The technology related priority areas where further developmental work is required are as follows:

- MW size wind power systems
- Wind machines for low wind regimes
- Improved rotor blades and gear boxes
- Advanced control systems
- Development of cheaper materials
- Integration of wind farms with weak grids
- Power quality improvement

On the policy front, India has a lot to learn from the European countries, where innovative policy and regulatory frameworks have been designed to give the much-needed push to renewables based electricity. Also, the promotion of wind power is expected to make a huge impact on carbon emissions and provide a respite to environmental challenges.

Thus, a meaningful exchange could occur, for instance, with the Netherlands concerning 'Green Power Certificates' and 'Regulatory Energy Tax', with Denmark on 'Electricity Supply Act' and the 'CO2 Quota Act', with Germany on 'Renewable Energy Sources Act' and the 'Green Pricing Scheme', and with UK concerning 'The Renewables Obligation' and 'Climate Change Levy'.

3. Opportunities for Indian Wind Energy Companies in EU Wind Energy Sector

India has picked up in the field of wind energy sector and can offer activities with European member nations in the following areas:

a) Skilled Technical Manpower

Indian manpower is fairly educated and proficient and can team up with European counterparts by taking up wind energy projects in Europe. This would often provide an edge in taking up global projects. Indian technicians can be outsourced for project design, engineering and erection and testing assignments. Indian generic technical prowess in the areas of aerodynamics, aero-elasticity, meteorology and other related fields would need to be made more application oriented to suit the need for wind energy sector.

b) Supply of Equipment (Indian Supplier to Europe)

Reputed equipment suppliers from India can offer the components, plant and machinery to European project developers for sites in Europe and other locations in competitive terms. Some of Indian SMEs in wind energy related component manufacturing now offer cutting-edge products with competitive prices. These companies can become global supplier of select components and can help reduce cost of wind energy projects world-wide.

c) Indian Investors in Wind Power Projects

Indian investors may find it appropriate to invest in upcoming wind projects due to the following:

- Several Indian companies are now internationalizing and seem to have adequate financial resources to invest overseas along with managerial ability to handle project abroad.

- In wind energy sector, Indian companies and project developers are already familiar with global best practices. With the help of in-house manufacturing they can be extremely cost competitive.

d) Dedicated Outsourcing

India is fast becoming a global manufacturing hub in wind energy sector. Wind component/turbine manufacturing can be outsourced to India. This could be done as captive manufacturing units of major wind companies located in India serving their parent company or by enabling local manufacturers supplying to big wind energy companies on the basis of firm supply contract. This is particularly relevant in the context of upcoming renewable energy-based SEZs in India, which promises to provide numerous tax benefits for export based renewable energy manufacturing units in India.

e) Design and IT Integration

Taking advantage of India's already proven cost-competitive and cutting edge IT skills, Machine/component designing and IT integration can be done in India very cost effectively.

f) Testing and Certification

India is well-positioned to become world's wind energy R&D, testing and certification lab of the world owing to its high-skilled, low cost technical manpower. This is further justified by the fact that India also has a robust domestic market, which can support expansion of testing, certification and R&D facilities in the country. Existing international laboratories in the wind energy sector can consider setting bases in India. Similarly, Indian agency - CWET- can go for major capacity building and aligning its standards/procedures in line with IEC standards and MEASNET procedures to tap the opportunity.

4. Table: Opportunities for Joint Activities between of Indian and EU Wind Industry

STAKEHOLDER	ENGAGEMENT	BRIEF
Equipment suppliers	Develop certified versions and allied services	Price negotiations, terms, warranties, spares, drawings, manuals, customer satisfaction
Government	Initiate policy and measures	Macro review based on evaluation seeking expert advise
Power distribution companies	Facilitate exchange of power, distribution upgrade, install metering, control and safety equipment	Guidelines/terms for power exchange, PPAs, wheeling and banking, reactive power penalty, securitization, timely payment
Financier- bank/ intermediary	Appraise DPR, fund and monitor.	Legal contract, track the project as per contract
End Consumer	DSM, monitoring and evaluation, 'green tag'	Objective assessment, credits, pinpoint deficiencies, rectify/ decision for contract variations
Farmers in adjoining areas	Feedback on the environmental concerns	Interact with the wind farm operator, end consumer and concerned agencies on environmental and safety concerns.

It is also essential for all stakeholders – including local population – to be involved in any project from the very beginning. Synergy is the key to result-oriented business-like models and requires concerted efforts on the part of all those who matter.

V. Conclusions

Both EU and India having experienced the rapid growth in wind energy sector will have to make huge efforts in sustaining the high growth rate and market their expertise in new and difficult territories including overseas and on shore locations. The old generation wind farms need to be re-powered correcting the deficiencies with respect to existing installations. It is a fine job needing competitive skills and teamwork amongst specialists. There is good room for collaboration between European and Indian counter parts.

EU-India partnership in wind sector is not all that new. Quite a few of the past activities such as manufacturing and supply of components, forecasting and modeling, certification and field-testing have been implemented to facilitate larger market penetration of wind power. Collaborations have also to address grid improvement matters, technology innovations including feasibility of on shore, re-powering and capacity building issues for small-decentralized markets.

Learning lessons for capacity building and advocacy of the concept amongst political and regulatory establishments, power utilities and potential users is another area for developing global solutions as wind energy has emerged as a powerful option for meeting energy needs. This will facilitate wind energy professionals to develop comprehensive solutions, which are useful, well packaged and marketed to prospective decision makers.

Joint activities by India and EU to tap the emerging market, in India (off-shore and on-shore) and other locations may work out quite favourably based on respective strengths of the partners. Synergy between EU and Indian players may open several opportunities for joint working as revealed in the table below:

Bibliography

TERI, Energy Data Directory & Yearbook 2001-02

IREDA, Brochure

Ministry of Non-conventional Energy Sources (MNES), Annual Report, 2001/02, New Delhi
MNES, Renewable Energy in India: Business Opportunities, 2001, New Delhi.
Website: www.mnes,

"Down To Earth", Vol 18 No3 June 1999
http://www.cseindia.org/html/dte/dte990630/dte_cover.htm

European Wind Energy Association and Greenpeace, Wind Force 12: A blueprint to achieve 12% of the world's electricity from wind by 2020.

Department of Trade and Industry, United Kingdom, New and Renewable Energy Prospects for the 21st Century, conclusions in response to the public consultation,
http://www.dti.gov.uk/renew/condoc/policy.pdf

European Wind Energy Association (EWEA), (2003), Wind Energy: The Facts, Volume 3: Industry and Employment.

International Energy Agency (IEA), (2004:1), Wind Energy Annual Report 2003, April
http://www.ieawind.org/iea_wind_pdf/PDF_2003_IEA_Annual_Report/2003IEA_WindAR.pdf.
IEA, (2004:2), Renewable Energy: Market and Policy Trends in IEA countries
IEA, (2004:3), Energy Statistics R&D Database.
http://www.iea.org/dbtw-wpd/Textbase/stats/rd.asp

Suzlon (2004) http://www.suzlon.com.

www.windpowerindia.com

Indian Wind Turbine Manufacturers Association, http://www.indianwindpower.com.

GE Wind Website. (2004) "GE to Supply 990 Megawatts of Wind Turbines for Milestone Wind Solicitation Award in Quebec--Largest Solicitation Award of Wind Generation Capacity in Industry History." Press Release Montreal, Quebec, October 4, 2004.

Gipe, Paul. (2004) Presentation to the Oregon Sustainable Energy Association (OSEA), http://www.energy.state.or.us/renew/Wind/OWWG/Pubs/Gipe_show.htm

Dr G. R. D. College of Science, prepared for IREDA. "A Comprehensive Study on Socio-economic and Environmental Implications of Wind Energy Generation in Coimbatore, Tirunelveli and Kanyakumari districts of Tamil Nadu." 2001

Bhatiani, G and K. Ramanathan. "The Power Sector in Transition to a Liberalized Economy." Background paper, TERI, 1999.

Mangotra A. K. "Opportunities for CDM Projects in Indian Renewable Energy Sector." Paper presented in Indo-Australian Bilateral Meet on Clean Development Mechanism, New Delhi, September 11-12, 2001.

Kamp, Linda M, Dissertation. (2002) "Learning in Wind Turbine Development: A Comparison between the Netherlands and Denmark." Utrecht University, Netherlands.

Sawin, Janet Laughlin. (2001) "The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Wind Power in the United States, California, Denmark and Germany." *1970-2000,* Ph.D. Thesis, Fletcher School of Law and Diplomacy, September.

SYNOVA International Business Development, (2004), "Manufacturing and Service Opportunities from large Wind Turbines." Presented to CanWEA Conference, October 17, 2004, Updated November 5, 2004.
Mansfield, Edwin. (1994). "Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer." International Finance Corporation Discussion Paper

Taylor, R. P. and Bogach, S. "China: A Strategy for International Assistance to Accelerate Renewable Energy Development." (1998), World Bank Discussion Paper Number 388.

Clean Energy Factsheet: Renewable Electricity Standards at Work in the States, Union of Concerned Scientists. (2004)

DHV Environment and Infrastructure, The Netherlands Country Report, Ener-lure Project Phase III, http://www.jrc.es/cfapp/eneriure/analysis.htm

Lorenzen K. Report on Electricity Legislation In Denmark, Ener-lure Project Phase III, http://www.jrc.es/cfapp/eneriure/analysis.htm

Ruchser M, Report on Electricity In Germany, Ener-lure Project Phase III, http://www.jrc.es/cfapp/eneriure/analysis.htm

Little, Arthur D., "The Wind Energy Production Tax Credit: A User's Guide", AWEA International Wind Power Markets.

AWEA, Renewable Energy for New York State--Policy Options for a Clean Energy Future.

Kohler, Judith. (2004) "Colorado Voters Backing Renewable Energy Standard." Denver: Associated Press State and Local Wire, November 3, 2004.

Victor K. Mallet. “The Use of Wind Energy in India – Lessons Learned.” Term Paper, Sustainable Energy, 10.391J, Spring 2001

Rajsekhar, B., F. Van Hulle, and J.C Hansen. “Indian Wind Energy Programme; Performance and Future Directions.” Energy Policy 27, 1999, 669-678.

Jagdeesh, A. “Wind Energy Development in Tamil Nadu and Andhra Pradesh, India Institutional Dynamics and Barriers.” Energy Policy 28, 2000, 157-168.

Ackermann, Thomas and Lennart Soeder. “Wind Energy Technology and Current Status: A
Review.” Renewable and Sustainable Energy Review 4, 2000, 315-374.

Abrutat, R. “Unleashing Business Opportunities for Wind Energy.” Renewable Energy, 22, (2001), 403-410.

Trivedi, M.F. “Environmental Factors Affecting Wind Energy Generation in Western Coastal Region of India.” Renewable Energy 16, (1999), 894-898.

Kumar, S. “Wind Energy – India Overview” Renewable Energy 16, (1999), 961-964.

Iniyani, S, L. Suganthi, and R Jagdeesan. “Critical Analysis of Wind Farms for Sustainable Generation.” Solar Energy Vol 64, Nos 4-6, 141-149, 1998.

Chetri, Mridula. “Gone with the Wind.” Down to Earth, Vol 8, No3, June 30, 1999.

Dinica, Valentina. (2003) “Sustained Diffusion of Renewable Energy: Politically Defined Investment Contexts for the Diffusion of Renewable Electricity Technologies in Spain, the Netherlands, and the United Kingdom.” University of Twente, Netherlands.

Goldemberg, Jose, Suani Teixeira Coelho, and Oswaldo Lucon. (2004) “How Adequate Policies can Push Renewables.” Energy Policy, Volume 32, Issue 9, June, 1141-1146.

Johnson, A. and S. Jacobsson. (2003) “The Emergence of a Growth Industry: A Comparative Analysis of the German, Dutch and Swedish Wind Turbine Industries”

Metcalfe, J. S and U. Cantner, Springer, “Change, Transformation and Development”.

Kamp, Linda M., Ruud E.H.M. Smits, and Cornelis D. Andriesse. (2004) “Notions on Learning applied to Wind Turbine Development in the Netherlands and Denmark.” Energy Policy, Volume 32, Issue 14, September, 1625-1637.

Karnoe, Peter. (1990) “Technological Innovation and Industrial Organization in the Danish Wind Industry, Entrepreneurship and Regional Development.” Volume 2, 105-123.

Klaassen, Ger, Asami Miketa, Katarina Larsen, and Leo Schrattenholzer. (2003) Public R&D and Innovation: The Case of Wind Energy in Denmark, Germany and the United Kingdom. International Institute for Applied Systems Analysis, Environmentally Compatible Energy Strategies Project, May 9, 2003.

Krohn, Soren. (1998) “Creating a Local Wind Industry: Experience from Four European Countries.” Helios Center for Sustainable Energy Strategies. May 4, 1998.

Langniss, Ole and Ryan Wiser. (2003) “The Renewables Portfolio Standard in Texas: An Early Assessment.” *Energy Policy* 31, 527–535.

Lemming, J. and Anderson, P.D. (1999) “Wind Power in Denmark: Technology, Policies and Results.” Danish Energy Agency Copenhagen, Denmark September.

Lew, Debra J. (2000) “Alternatives to Coal and Candles: Wind Power in China.” *Energy Policy,* 28, 271-286.

Lewis, Joanna I. (2005) Foreign Technology and Local Enterprise: Technology Transfer and Local Manufacturing in China’s Wind Power Industry. Draft. University of California, Berkeley.

Liu Wen-Qiang, Lin Gan, Xi-Liang Zhang. (2002) “Cost-competitive incentives for wind energy development in China: institutional dynamics and policy changes.” *Energy Policy* 30, 753–765.

Rajsekhar, B., F. Van Hulle, and J.C. Jansen. (1999) “Indian Wind Energy Programme: Performance and Future Directions.” *Energy Policy* 27, 669-678.

DeWind Website. (2004) “FKI plc withdraws from the wind turbine business.” Press Release, November 8, 2004. http://www.dewind.de/en/news/index.htm.

International Conference on Accelerating Grid-Based Renewable Energy Power Generation for a Clean Environment. Panel 3: Policies for Accelerating Renewable Energy Policy Approaches: The Indian Experience By Ajit K. Gupta, Adviser & Head, Power Group.

Ministry Of Non-Conventional Energy Sources, Government Of India, New Delhi, India,March 7-8, 2000 At The World Bank, Washington, D.C.

European Union - India
Economic Cross Cultural Programme

ECCP

supporting innovative india - european union civil society partnerships

www.euindiawind.net