Chapter # 4 US Wind Industry

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“A nation that can't control its energy sources can't control its future.”
- Barack Obama, US President
4.1 USA power market overview

A range of macroeconomic factors within the broader U.S. power market play an outsized role in the wind power market. Given that policy is the primary driver for wind power in the U.S. and the policy picture is shaky at best, the secondary macroeconomic drivers for wind power become all the more important. The Great Recession beginning in late 2008 has resulted in virtually no new electricity demand growth, lower average electricity prices due to cheap natural gas, and higher overall reserve margins, which is a measure of existing and planned generation capacity against current and projected demand. All are barriers to a sustainable build cycle for wind.

With respect to driving or not driving the wind power market, factors range from poor to average in the power sector. Electricity prices remain low and are not expected to increase appreciably over the next two years. Figure 4.1 give details of energy mix.

![Figure 4.1 Net Electricity Generation by (Billion kWh/day, % Share)](chart)

- Average U.S. residential electricity prices rose by 0.9% in the first quarter of 2012 and are expected to fall by 1.4% in 2013, according to the U.S. Energy Information Administration (EIA)
- Actual total consumption of electricity is slightly more positive, having dropped slightly in early 2012, but expected to grow 2.3% through 2013 as the U.S. economy continues to recover
4.1.1 Natural gas

No single commodity has had and continues to have a bigger impact on the U.S. power sector than natural gas. The boom in natural gas derived from the advanced drilling technique of shale rock deposits called hydraulic fracturing, resulting in the lowest gas prices seen in a decade. The price of natural gas delivered to electric generators averaged USD 3.67 per MMBtu in January. Spot prices, showed gas spot prices averaging USD 2.18 per MMBtu, down USD 0.32 per MMBtu from the February 2012 average and the lowest average monthly price since April 1999. The warmer-than-normal weather this past winter also contributed to high natural gas working inventories. Figure 4.2 displays power generation mix in US in 2011.

![Figure 4.2- US power generation Mix 2011.](image)

This has had the direct effect of rendering wind far costlier by comparison, resulting in reduced utility demand for new wind generation. Given projections on available gas and related price expectations, this dynamic will continue to plague the wind industry. Over 10GW of Natural Gas Combined Cycle (NGCC) plants are expected to be commissioned in 2013, up from around 7GW expected in 2012 and the 6.5GW commissioned in 2011. NGCC plants operate as base load plants, versus smaller gas peaking plants that run only to satisfy temporary peak demand.

Gas boom is presently at a trough – albeit a very low trough with much price climbing required before wind plants are again competitive to the degree they were before the recent gas boom. The oil and gas companies drilling for gas based their business model assumptions and drilling deployments around expectations of a market price
for gas in the USD 5–6 per MMBtu range and have gone on record saying that current prices are unsustainable for their businesses. Drilling rig counts have dropped substantially as a result. The EIA expects that Henry Hub spot prices will average USD 3.40 per MMBtu in 2013.

A potential headwind for natural gas lies in the environmental impact of shale gas. The average well requires 6 million gallons of water through its full extraction phase, which is injected deep into shale rock formations in order to dislodge pockets of natural gas. Water represents 94.62% of the fluid injection, with 5.24% sand and 0.14% chemicals filling the balance. The chemical component, although small, has led to concerns over its impact on groundwater supplies and led to a fast-moving reactionary regulatory climate. Because shale gas fracturing was specifically exempted from Environmental Protection Agency (EPA) regulation in a 2005 energy bill, a regulatory vacuum was left to be filled by individual states and municipalities. Numerous state moratoria have been enacted, and vocal opposition from the public may eventually increase regulation of the process. New York and New Jersey both enacted temporary moratoria while they assess environmental impact.

4.1.2 Thermal Power (Coal)

Natural gas has also had a transformational impact on the coal industry. Coal is typically responsible for around 43% of electricity generation due to its abundance and low cost. Gas is increasingly viewed as an alternative to coal for base load power generation. Long-term resource planning by utilities is strongly favouring gas plants for new generation and to replace existing retiring generation. Notably, even current coal plants are running at lower capacity as gas generation is dispatched in their place. Most coal is shipped by rail, with over 60% of all freight on U.S. railways comprised of coal. Coal shipments have declined of late which is a direct result of the competitive pressure from natural gas and indicative of continuing trends. Electricity generation from coal is likely to decline by 10% in 2012 as generation from natural gas increases by about 17%, according to the EIA. The construction of new coal plants has not stopped, however, with five new plants coming online in 2011 totalling 2,343MW. This is a relatively larger build cycle than in a typical year but partly reflects plans put into motion years ago. Compared to previous years, fewer projects are being announced. Last year, 1,599MW were announced, but a further 2,890MW projects in announced or planned phases were cancelled, partly as a result of a more competitive gas industry.
Coal plants also face increased regulation by the Environment Protection Authority (EPA). The EPA is in the process of promulgating four regulations that will have a negative impact on the fossil fuel sector:

- Proposed Coal Combustion Residuals rule (CCR rule)
- Proposed Mercury and Air Toxics Standards for Utilities (Utility Air Toxics rule)
- Proposed Cooling Water Intake Structures rule
- Final Cross-State Air Pollution Rule (CSAPR)

NERC states that these rules are likely to drive significant retrofit efforts and the decommissioning of coal plants. In NERC’s moderate forecast assumptions, the agency posits that between 576 and 677 coal plants will require retrofits by the end of 2015, totaling 234–258GW of capacity. NERC identifies 38GW of generation capacity (23GW of coal and 15GW of gas/oil units) that have committed and/or announced plans to retire.

Wind is not seen as a base-load replacement for coal. But decommissioning coal based thermal plants will tighten reserve margins, accelerate overall utility demand for new generation, and drive more gas-fired generation. Increasing reliance on gas will correspondingly motivate utilities to blend wind generation into their resource mix in order to hedge fuel costs and fuel supplies.

**4.1.3 Nuclear & Hydropower**

Reliance on other generation sources such as nuclear power and hydroelectric power are expected to remain largely unchanged. The U.S. has 104 nuclear reactors across the country, but concerns over the extremely high costs and challenges of storing nuclear waste have hindered most new development. One anomaly is in Georgia, which saw the first approval given by federal regulators in over three decades for construction of a new nuclear plant. Regulators in February 2012.

**4.2 A Brief History of the U.S. Wind Industry**

The U.S. wind industry got its start in California during the 1970s, when the oil shortage increased the price of electricity generated from oil. The California wind industry benefited from federal and state ITCs as well as state-mandated standard utility contracts that guaranteed a satisfactory market price for wind power. By 1986,
California had installed more than 1.2 GW of wind power, representing nearly 90% of global installations at that time.

Expiration of the federal ITC in 1985 and the California incentive in 1986 brought the growth of the U.S. wind energy industry to an abrupt halt in the mid-1980s. Europe took the lead in wind energy, propelled by aggressive renewable energy policies enacted between 1974 and 1985. As the global industry continued to grow into the 1990s, technological advances led to significant increases in turbine power and productivity. Turbines installed in 1998 had capacity 7 to 10 times greater than turbines installed in 1980s and prices of electricity generation dropped by nearly 80%. By 2000, Europe had more than 12,000 MW of installed wind power, versus only 2,500 MW in the United States, and Germany became the new international leader.


Nearly 700 MW of new wind generation were installed in the producers 1.5 cents (increased annually with last year before the credit expired—more than in any previous inflation) for every 12-month period since 1985. After the PTC expired in 1999, kilowatt-hour (kWh) of it was extended for two brief periods, ending in 2003. It was then reinstated in late 2004. Although this from wind during the intermittent policy support led to sporadic growth, business first 10 years of inefficiencies inherent in serving this choppy market operation, inhibited investment and restrained market growth.

To promote renewable energy systems, many states began requiring electricity suppliers to obtain a small percentage of their supply from renewable energy sources, with percentages typically increasing over time. With Iowa and Texas leading the way, more than 20 states have followed suit with Renewable Portfolio Standard’s (RPS), creating an environment for stable growth.

After a decade of trailing Germany and Spain, the United States re-established itself as the world leader in new wind energy in 2005. This resurgence is attributed to increasingly supportive policies, growing interest in renewable energy, and continued improvements in wind technology and performance. The United States retained its
leadership of wind development in 2006 and, because of its very large wind resources, is likely to remain a major force in the highly competitive wind markets of the future.

4.3 Evolution of wind industry in USA

From the historical data available first municipal use of multiple wind-electric turbines in the USA was a group of five turbine system in Pettibone, North Dakota in 1940. The US government worked closely with industry to develop the wind industry and enable large scale commercial wind turbines from mid-1970 through mid-1980. United States Department of Energy promoted several experimental wind turbines designs and operations and it is this research and development program that helped pioneered many of the multi-MW turbine technologies in use today. Some noteworthy achievements of this R&D program include among others, steel tube towers, variable-speed generators, composite blade materials, partial-span pitch control, as well as aerodynamic, structural, and acoustic engineering design capabilities.

4.3.1 Growth phase of US wind Industry

In the 1980s, California state government provided tax rebates for wind power and these rebates funded the first major use of wind power for utility electricity. In 1985 half of the world’s wind energy was generated at Altamont Pass CA where by the end of 1986 about 6,700 wind turbines, mostly less than 100 kW, had been installed. Investment was in the ballpark of $1 billion, and these wind farms generated about 550 million kWh/year.

This success in California inspired wind power revolution in other states where favorable policies and sustained R&D efforts on wind engineering advances started showing results.

The United States generates more electricity than either Germany or China, for the same installed capacity. Germany generated 10.6% of the world’s wind generation with 12.1% of the world’s installed wind capacity, in 2011. In 2011; the U.S. generated 121 TWh, 27.7% of the world's wind generation, with 19.7% of the world's installed wind capacity, while China generated 73.2 TWh (16.7% of the world's total with 26.1% of the world's installed wind capacity). However in terms of installed wind power capacity, the United States is currently second, first being China.
The United States installed 6,810 MW of new capacity across thirty states during 2011, a 31% increase from the 2010 level but still short of the record highs in 2008 and 2009. This growth accounted for a cumulative increase of 17% from 2010, with total wind installations now reaching 47,084 MW. This increase in growth can be attributed to an improving economic climate and growing urgency over the expiration of the Production Tax Credit and Investment Tax Credit. The 30% cash grant as an alternative to the ITC, which could be taken in lieu of the $.022/kWh PTC, applied to projects in operation before the end of 2012, with construction started before the end of 2011. With the future of the PTC uncertain, and the ITC expiring in December
2011, increased pressure was applied to begin projects before these incentives expired, resulting in ongoing construction numbers climbing to near-2008 levels.

The United States remains the second largest market in the world, trailing only China in total capacity installed. It represented 17% of new generation worldwide, second only to China’s 44% share. On a state by state basis California installed the most new capacity - 921.3 MW. Illinois came second with 692.5 MW of new capacity, propelling it to fourth largest state for cumulative installations, overtaking Minnesota, Washington and Oregon. Iowa came in third with 646.7 MW, Minnesota fourth with 541.9 MW and Oklahoma fifth with 525 MW. Ohio and Vermont experienced the fastest growth rates during the third quarter of 2011, but from a low starting point, with 112 MW in Ohio and 42 MW in Vermont. Texas remained the leader in cumulative capacity, with 10,377 MW installed, a position resulting from the state’s commitment to transmission grid expansion and streamlining approval processes. Iowa, second with 4,322 MW, has achieved its success primarily by selling its generated electricity in the form of renewable credits to other states to help them meet their renewable energy goals. California, with 3,927 MW of total capacity, missed its target for 20% renewables penetration by 2010, but has set an even more ambitious goal for 33% by 2020. Illinois sits in fourth place, with 2,743 MW total capacities, driven by its goal for 25% renewable penetration by 2025.

GE Energy continued to be the largest turbine manufacturer in the country, but its market share decreased from 43% in 2010 to 30% in 2011. Other wind turbine manufacturers with a double digit market share in the US market are Vestas (22%), Siemens (18%) and Gamesa (13%). It should also be noted that last year ten Asian turbine OEMs installed capacity in the US, of which eight were from China and South Korea. NextEra Energy Resources and Iberdrola were the two leading project developers in the US, followed by local developers Invenergy, E.On, MidAmerican and Edison Mission. By the end of 2011, the United States had installed 46,919 MW of wind power, and generated 94,652 GWh of electricity from wind power in 2010. Figure 4.5 gives yearly and cumulative generation using wind power in USA.

The annual production of a wind turbine is a product of the capacity rating, the capacity factor, and the number of hours in a year. A 200 MW wind farm at 35% capacity factor will generate approximately 613.2 GWh/year.
Top five states with the most wind capacity installed as of 31 Dec. 2012, are:

- Texas (12,212 MW)
- California (5,549 MW)
- Iowa (5,137 MW)
- Illinois (3,568 MW)
- Oregon (3,153 MW)

Wind energy generation by GWh and percentage of total electricity output. Data reflects annual totals for 2002 to 2012 and the current 12 month rolling average from June 2011 to May 2012 can be seen from the graph below.
According to percentage of generation by wind top five states in 2012 are:

- Iowa (24.5%)
- South Dakota (23.9%)
- North Dakota (14.7%)
- Minnesota (14.3%)
- Kansas (11.4%)

Wind energy has grown rapidly in last decade with an average increase of 29.7% year. World’s largest wind farm having installation capacity of 1320 megawatt (MW) is The Alta Wind Energy Center in California. It consists of 490 wind turbines manufactured by different wind turbine manufacturers such as General Electric, Vestas etc.

New wind farms can produce electricity in the 5-8 cents per kWh range, making wind power competitive with the cost of fossil fuel electricity generation in many markets. Fifteen states have each installed over 1,000 MW of wind capacity, and a total of 39 states and Puerto Rico now have installed at least some utility-scale wind power. Much of the new wind power capacity is being built in the Great Plains and Midwest regions of the United States, which have a favourable combination of characteristics: ample wind resources, an extensive rail and highway network for shipping outsized turbine components, flat topography which both improves the wind and makes turbine components easier to ship, and broad acceptance from local farmers and ranchers. New development in some locations, however, is being limited by lack of additional capacity to transmit power to locations where it can be used.

United States has wind generation potential that far exceeds demand. For commercial operation, a capacity factor of at least 35% is preferred. Except for Florida and Mississippi which have no commercially significant wind power potential all other states have huge wind power generation promise. There are no locations in either state that. North Dakota, the windiest state, has the capacity to install 200,000 MW at 50% capacity factor 100 meter high turbines. Texas, although not as windy, is larger, and has the capacity to install 250,000 MW at 50% capacity factor, and 1,757,355.6 MW of at least 35% capacity factor, capable of generating 6,696,500 GWh/year, more than all of the electricity generated in the United States in 2010.
The ten largest wind farms in the United States are:

<table>
<thead>
<tr>
<th>Project</th>
<th>Capacity (MW)</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alta Wind Energy Center</td>
<td>1320</td>
<td>California</td>
</tr>
<tr>
<td>Shepherds Flat Wind Farm</td>
<td>845</td>
<td>Oregon</td>
</tr>
<tr>
<td>Roscoe Wind Farm</td>
<td>781</td>
<td>Texas</td>
</tr>
<tr>
<td>Horse Hollow Wind Energy Center</td>
<td>736</td>
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<tr>
<td>Tehachapi Pass Wind Farm</td>
<td>705</td>
<td>California</td>
</tr>
<tr>
<td>Capricorn Ridge Wind Farm</td>
<td>662</td>
<td>Texas</td>
</tr>
<tr>
<td>San Gorgonio Pass Wind Farm</td>
<td>619</td>
<td>California</td>
</tr>
<tr>
<td>Fowler Ridge Wind Farm</td>
<td>600</td>
<td>Indiana</td>
</tr>
<tr>
<td>Sweetwater Wind Farm</td>
<td>585</td>
<td>Texas</td>
</tr>
<tr>
<td>Altamont Pass Wind Farm</td>
<td>576</td>
<td>California</td>
</tr>
</tbody>
</table>

Table 4.1 Installed Capacities in USA

4.5 Wind Potential in USA

In above figure estimated wind resources and existing power transmission lines are displayed. It is important to recognize that we need combination of potential wind sites and transmission network to be able to harness wind energy cost effectively.

Figure 4.7 USA Map Showing Wind Potential and Transmission Lines
According to the National Renewable Energy Laboratory, the contiguous United States has the potential for 10,459 GW of onshore wind power. The capacity could generate 37 petawatt-hours (PW·h) annually, an amount nine times larger than current total U.S. electricity consumption. The U.S. also has large wind resources in Alaska, and Hawaii.

The U.S. Department of Energy’s 2008 report 20% Wind Energy by 2030 envisioned that wind power could supply 20% of all U.S. electricity, which included a contribution of 4% to the nation’s total electricity from offshore wind power. In order to achieve this, however, significant advances in cost, performance and reliability are needed, based on a 2011 report from a coalition of researchers from universities, industry, and government, supported by the Atkinson centre for a Sustainable Future. Obtaining 20% from wind requires about 305 GW of wind turbines, an increase of 16 GW/year after 2018, or an average increase of 14.6%/year, and transmission line improvements.

4.6 Stakeholder Analysis- Customers (Developer)

A typical large wind project involves many, many players. The main responsibility for the project lies with the developer. He is the one who has conceived the project and he ties-up various stakeholders to make realize wind power projects. Developers may continue in the project as equity investor or at some point they may sell off the project for attractive returns to buyer (equity investor) and take up development of another project.

The role of major investors in the wind power market has gained greater prominence over the past five to six years, mainly as a result of the interest shown in wind energy by large utilities, independent power producers (IPPs) and oil companies. These larger players are taking an increasingly important share of the available business. In terms of cumulative capacity, the market share of the Top 15 operators has increased from 23% of total global installations in 2003 to 33% in 2011.

Wind farm Owner are promoters or equity investors of the proposed wind power projects and just like banks & FIs they have their own evaluation criteria and other than IRR & NPV mentioned earlier they may be interested in return on Equity (RoE) or at times project IRR. Depending on what stage equity investors enter the project – conceptual phase which is high risk low visibility or mature phase low risk high visibility the valuation and therefore returns vary from very attractive to moderate.
Profile of wind farm owners vary from oil & gas companies, utilities, industries etc. who may have their own objective in terms of green energy portfolio, green branding, captive use, tax relief etc.

Following is a closer look at some of key customer Profiles.

4.6.1 Utilities

In a globalized market no sector has been insulated from the effects of the economic recession. The wind industry is no exception. As a consequence, assets and project pipelines owned by some financially troubled small and medium-sized IPPs have been acquired by large utilities, oil companies or players with deeper pockets. This has reinforced the trend for energy utilities to become even bigger players in the three leading global wind power markets - Europe, the US and China.

Several of the largest European utilities have been playing a leading role in wind power development. To optimize their future stake and increase their opportunities for investment in a booming market, they are more and more active outside their domestic bases. Companies like Iberdrola, EDP, EDF, ENEL, E.ON and GDF Suez have established bases in North America by buying up local wind power developers. During the past two years some of these have also entered Central and South America and most recently the emerging African markets. Last year also saw leading Chinese utilities such as Longyuan Power Group, Datang Corporation and China Three Gorges Corporation make their first moves into overseas markets. This trend for Chinese players to seek opportunities outside their crowded home base is expected to continue.

The shift in the ownership structure of wind projects has continued worldwide over the past several years. In the US there has been a shift in ownership from independent power producers towards a more utility driven market. The increasingly important role of utilities in wind power development is mainly encouraged by three factors:

- Wind now plays an essential role in developers’ overall energy portfolios. There is also increasing pressure on utilities to incorporate renewable energy sources into their generation portfolio as a result of mandates laid down by international, regional and country/state-based targets. In the US, the model of mandating a rising share of renewables in the generation portfolio, known as an RPS (Renewable Portfolio Standard), is now in operation in 33 states, despite the fact
that climate change legislation which would have set a national renewable energy standard (RES) was not approved eventually by the US Senate in 2010.

- The large capital requirement of wind projects, especially offshore wind, has turned the sector into a marketplace for cash-rich utilities. This shift was encouraged by the previous extremely tight situation for turbine supply, when utility-scale projects tended to be favored by wind turbine suppliers. In today’s financial climate, only utilities are likely to be able to side-step the debt financing market and make the investment required for large projects based on their balance sheet. At the same time, investors in the public markets have felt safer putting their money into projects with utility sponsorship than those backed by small and medium-sized IPPs.

- With an increase in the general public’s awareness of climate issues, utilities are also trying to promote a green image, moving away from their characterization as "polluters". To signify their commitment to clean energy development, the large utilities, have now set up separate renewables business units or subsidiaries. Encouraged by the current market, utilities prefer to do the development work on projects themselves, not just acquiring already committed projects from the developers or following the traditional route of contracting out the work. The competence to carry out development work will therefore increasingly be taken on board by the utilities themselves.

Independent power producers (IPPs), and ultimately, the utility sector are the end-users that drive demand for the vast supply chain of components and services across the wind energy value chain. IPPs develop, construct, and operate power projects and primarily sell the output directly to utilities, which in turn manage retail electricity sales to all rate-payers of electricity. IPPs also sell electricity in the competitive wholesale power markets (RTO/ISO) at fluctuating rates driven by a range of market conditions. U.S. utilities generate electricity through a mix of owned generation – typically fossil fuel–burning, hydroelectric, and nuclear for base-load generation – and further contract for additional electricity delivery from IPPs. Natural gas and wind are the most popular sources for adding generation to large existing base-load generation. Wind projects originate from the development arms of an IPP, or in many cases, IPPs buy wind projects in late-stage development from small developers that focus solely on bringing a project to late-stage development for sale to an IPP or utility.
Wind projects typically sell power to utilities under long-term contracts – 20 years is the most common – that provide fixed income for the IPP and a fixed range of expected generation to the utility. Utilities generally solicit new wind power through a competitive request for proposal (RFP), which seeks competing bids from multiple IPPs. Alternatively, if a utility wants to avoid the application review process, it can identify and contract directly with a wind power developer or an IPP. The U.S. market leader for wind power procurement for multiple years has been Midwest-based Xcel Energy, which purchases nearly 3.8GW of wind power from IPPs for its customers.

4.6.2 Oil & Gas Companies

Utilities and IPPs are not the only players currently active in the wind market, however. Global oil companies such as BP, Shell and Statoil have already indicated their interest in the wind industry several years ago, although both BP and Shell, with their focus on the North American onshore market, slowed down their development due to the financial crisis. The decision by Spanish oil company Repsol to invest in offshore wind by acquiring SeaEnergy Renewables Ltd in June 2011 followed Statoil’s moves to utilize its offshore experience from oil and gas in the offshore wind industry.

4.6.3 Pension Funds

2010 saw pension funds entering the offshore wind market for the first time, an important benchmark for the attractions of wind power investment.

4.6.4 Private Equity Companies

Private equity companies are also looking to increase their spending on wind energy. First Reserve, for example, a global energy-focused private equity and infrastructure investment firm, bought into its first wind energy projects in North America and Europe in December 2011 through a joint venture with global developer Renova. In the same month, Bridge point, an international private equity firm, acquired a portfolio of wind energy assets totaling 443 MW from Spanish construction conglomerate Auxiliary de Construction Servicios.

4.6.5 Corporate Sector

Other customers entering the market recently have included a number of consumer brands. Large retailers like IKEA and Wal-Mart and search engine Google have provided fresh impetus for wind energy development in Europe and the US.
4.6.6 Community Ownership

At the other end of the spectrum it should be noted that community-based (citizen-owned) wind projects has recently been given new potential by the cash grants being made available under a federal program included in the US government’s economic stimulus package and by the passage of green energy legislation in Canada. Nonetheless, these models now represent a small proportion of total wind power investment.

With wind turbine projects increasing in size and a shift towards more utilities entering the wind business, a group of larger utilities and IPPs are leading the development of wind projects worldwide.

4.6.7 Developers, operators and owners – brief description

Below is a short description of some of the world’s major wind farm developers/operators and owners

**NextEra Energy Resources** (formerly FPL Energy LLC), headquartered in Juno Beach, Florida, is the largest owner of wind generation in the United States, with an operational capacity of about 8,560 MW. A subsidiary of the FPL Group, the company came into the wind energy business through partnerships in wind farms in California in the 1990s. With more than 50% of its total installation being wind power, it has a pipeline of wind projects in North America of more than 10 GW.

**MidAmerican Energy Company** is an Iowa-based utility with a large ownership of wind generation assets. The company had more than 1,870 MW wind power in operation and 400 MW under construction by the end of 2011, which makes it one of the US leaders in wind power ownership among regulated utilities.

**AES**, a Fortune 500 global power company with both generation and distribution businesses, is a leading US developer and operator of utility scale wind plants. Through AES Wind Generation, formed in 2005, it has nearly 1,500 MW of operational wind power capacity under its ownership and a further 6,000 MW of projects at various stages of development in some of the fastest growing world markets, including Bulgaria, Chile, France, the UK and China.

**Invenergy** is the largest independent wind developer in the United States. More than 20 wind parks, representing a generation capacity of over 2,300 MW, have been developed by the company and are now operating in North America and Europe. A
further 1,500 MW is currently under contract or under construction, and expected to be in operation by the end of 2013.

**Edison Mission Energy**, a subsidiary of Edison Mission Group, based in Irvine, California, is an independent power producer engaged in the business of owning, leasing, operating and selling energy and capacity from electric power generation facilities. The company operates more than 1,800 MW of wind parks and has over 30 projects with a capacity of 4,000 MW under construction or in the project pipeline, one of the largest in the US.

**Cielo Wind Power** is a private company based in Austin, Texas whose sole business is the development and operation of wind power facilities. Cielo is one of the largest independently-owned wind companies in the U.S. Cielo has developed 1,395 MW of projects in New Mexico and Texas over the past 11 years.

**TransAlta**, with facilities from Alberta to New Brunswick, is Canada’s largest producer of wind power, operating more than 20% of Canada’s total wind power installation by the end of 2011. In October 2009, TransAlta reached an agreement with Canadian Hydro to acquire all of its issued and outstanding common shares. The acquisition nearly doubled its wind development pipeline to 2,620 MW, with more than 400 MW at an advanced stage.

**Iberdrola**, the world’s largest wind farm developer, is a Spanish utility highly committed to the use of clean energy, in particular wind, hydroelectric and combined-cycle natural gas generation. The company had more than 13 GW of wind power capacity in operation at the end of 2011 and has a portfolio of projects totaling about 62 GW, over half the company’s growth is expected to come from the US market.

**Acciona Energy**, one of the biggest renewable energy operators in the world, has installed a total of 8,392 MW of wind power, including turnkey projects for third parties in 15 countries. Of its renewable portfolio, more than 80% is wind power. With more than 70% of its wind turbines installed in Spain, the Spanish company currently has over 18,000 MW in development around the world.

**E.ON** is one of the largest utilities in Europe, with around 23 GW of wind projects in its development pipeline. The purchase of Airtricity North America at the end of 2007 marked the biggest jump in E.ON’s wind assets. Its renewables unit, E.ON Climate and Renewables, founded in 2008, identified the US as a key market for expansion.
The company is also the third largest offshore wind operator in the world, with an offshore pipeline of more than 4.3 GW.

RWE Innogy, the German utility RWE’s renewables business, was launched again as a separate division in 2008. The company paved the way for further expansion by completing a friendly acquisition of Dutch energy group Essent’s commercial energy activities in 2009. RWE Innogy is also a major offshore developer, with over 6 GW of projects planned in Northern Europe. By 2025, RWE intends to have 30% of its power generation from renewables.

Vattenfall, the EU’s sixth largest electricity generator and the largest producer of heat, is also the world’s largest operator of offshore wind capacity and has an offshore project pipeline of around 4 GW. A deal with Nuon in 2009 gave Vattenfall a 49% share in the Dutch company, as well as operational control, and created Europe’s largest provider of offshore wind power. The company’s total wind installation by the end of 2011 was more than 1,400 MW, of which nearly 56% is offshore.

DONG Energy, a leading energy group in the Nordic region with 30 years’ experience in the wind industry, particularly in the operation and maintenance of offshore wind farms, is one of Europe’s major wind power developers. Dong has been the world’s No.1 offshore wind operator for many years, but it drops to No.2 after shares in some of its offshore projects were sold out recently. With a project pipeline of more than 3,500 MW, mainly offshore in the UK, Denmark and Germany, the Danish utility aims to reach its target of at least 3 GW of wind capacity by 2020.

Shell Renewables, based in the Netherlands, focuses on the development and operation of utility-scale wind farms. The company recently shifted its sights from offshore in Europe, however, to a large tract of land stretching from Alberta to Texas in the US, where eight of its 11 wind project operations are located.

BP Wind Energy, oil company BP’s wind power business, is one of the leading wind farm developers, with more than 1,700 MW in operation by the end of 2011. The company continues to focus on its major development portfolio in the US, where it installed more than 400 MW in 2011 and with a further 1,000 MW at an advanced stage of development.

Scottish and Southern Energy is the UK’s largest generator of renewable energy, with more than 4,000 MW of capacity in operation, under construction or with consent
in the UK and Ireland. SSE Renewables is responsible for the development and construction of SSE Group’s European portfolio of renewable energy projects, including onshore and offshore wind, hydro, marine, biomass and solar. The company bought wind energy developer Airtricity in 2008 and has a development pipeline of over 15 GW, of which more than 8 GW is offshore.

**EDP Renewables** is one of the world leaders in the renewable energy sector, with its major shares controlled by EDP, Portugal’s largest industrial group and Energy Company and 21.35% stake controlled by China Three Gorges Corporation. The company’s projects under development have reached a total of 29 GW in Europe, North America and Brazil, of which more than 50% is in the US. The North American market will be one of the company’s major drivers of growth over the next four years.

**Enel Green Power**, established in December 2008, is the arm of the Italian Enel utility dedicated to developing and managing energy generation from renewable sources at an international level, with a presence in Europe and the American continent. As one of the global leaders in wind power development, with a total installed capacity of more than 3,500 MW, the company took over US-based NRG Energy’s wind development company, Padoma and also acquired a 60% controlling interest in Endesa Generacion y Renovables from the Spanish Endesa Generacion in 2010. Enel Green Power started trading on both the Italian and Spanish stock markets from November 2010.

**EDF Energies Nouvelles** became a wholly-owned subsidiary of the Electricite De France group (EDF) after the French utility bought out the remaining 50% share in EDF EN in 2011. Following this acquisition, EDF EN was delisted from the Euronext Paris stock listing. The company is one of the largest wind power operators in the world, with a project portfolio of more than 14 GW at the end of 2009.

**GDF Suez** was created by the merger of Suez and Gaz de France in July 2008. This deal enhanced the renewables status of Suez, which had already made a commitment to wind power through its subsidiary Electrabel. The recent combination of GDF Suez’s Energy International Business Areas (outside Europe) and certain assets in the UK and Turkey has further strengthened its position in the wind sector. With around 15% of the group’s generation capacity being renewable by the end of 2011, it is the largest wind project operator in France and plans to be a major offshore developer there as well.
Eole-RES, a major player in the French wind energy sector, has a portfolio of 485 MW across the country. The company is a subsidiary of RES Group, a leading UK-based renewable energy company which has successfully developed and/or built more than 5,000 MW of wind energy capacity worldwide, including projects in the UK, Ireland, France, Portugal, the Caribbean, Sweden and the USA.

Infigen Energy was formed in 2008 by Babcock Brown Wind partners after its separation from its parent company, Babcock Brown, and the sale of its Spanish and Portuguese assets. As one of the world’s largest IPPs, listed on the Australian Securities Exchange, the company now only owns and operates wind farms in Australia, the United States after it sold its portfolio of Germany wind energy assets in 2011.

Eurus Energy Holdings Corporation is the largest wind power developer in Japan. Its activities are managed through worldwide offices in Japan, the United States and Europe. The company was formed through a joint venture between Tomen Corporation and Tokyo Electric Power Company (TEPCO) in 2002. After a rearrangement of shareholdings in 2012, TEPCO and Toyota Tsusho hold 40% and 60% stakes respectively.

Bar chart below gives clear idea about top 15 owners of wind power capacities in USA with annual capacity additions in last 3 years of research i.e. till 2011.

Figure 4.8 Top 15 Owners of Installed Capacity in the U.S. (YE/2011)
4.7 Stakeholder Analysis- Key Component Suppliers

As mentioned earlier wind industry supply chain is not as matured as an automobile or aviation industry as the whole sector is merely just over 2 decades old. As a result standardization of key components and volumes of scale are yet to be achieved since designs of key components are unique to OEMs. It also stated earlier that supply chain is scattered globally as expertise of key components is localized or not available everywhere.

Production capabilities and capacities of key component suppliers therefore is a major consideration for the growth of industry, as there are not many options available. Given the nature of industry OEMs and importantly investors insist for tried and tested names of component suppliers rather than experimenting with a new entrant in wind industry.

Following is a brief profile and description of key component suppliers active in US wind industry, who are important stakeholders.

4.7.1 Blades

Blades are one of the most critical components of wind turbine generator as it helps harness every single unit of electricity from available wind. Moreover blade design of each OEM is unique and research work on blade profile, newer raw material etc. continues to evolve.

Following are lead lights in manufacturing of blades.

**LM Wind Power** is the world’s leading manufacturer of wind turbine blades and the only supplier with a global footprint. Achieving this strong position is the result of a constant focus on research, product development, quality and excellent customer partnership where each development is aimed at reducing the cost of energy. Building on in-house state-of-the-art wind tunnel technology LM Wind Power pushes the limits of blade design by developing and verifying its own blade profiles. The company offers a full range of blades for turbines from 1500 kW to 6000 kW with lengths from 34 to 73.5 meters. In more than 30 years, LM Wind Power has produced over 140,000 blades, corresponding to one in every three turbines currently in operation.
**Tecsis Technology** has been supplying blades to the wind turbine industry for over a decade. Today there are more than 12,000 Tecsis blades in operation in over ten countries, of which more than 10,000 operate in turbines with a power rating of 1 MW or more. Located in São Paulo, Brazil, Tecsis can readily supply the North American, European and Asian Pacific markets. Tecsis develops blades for turbines up to 3 MW capacity and is capable of delivering more than 3,000 MW/year.

### 4.7.2 Gearboxes

Gearbox is yet another vital component in the design of wind turbine generator. Although gearless wind turbines using direct drive application are on the horizon, more than 98% of wind turbines operational today use gear box and till the foreseeable future this dominance will continue. Gearbox makes possible to connect slow speed revolving rotor with high speed revolving generator thus transforming kinetic energy of wind in the electrical energy. Once perceived as weakest link in the turbine design and a limitation on life cycle of wind turbine generators, gear box design and technology has evolved with dramatic improvement in performance and reliability.

Following are few leading manufacturers in wind turbine gear box.

**Winergy AG** (formerly Flender), one of the world’s oldest and largest power transmission manufacturers, is the only worldwide supplier of complete drive systems for wind turbines. More than 50% of turbines installed globally operate with at least one Winergy component. The company has a manufacturing presence in Europe, the US, India and China. Most recently it has supplied gearboxes for REpower’s 6M offshore turbine and BARD’s 6.5 MW machine. Its new test rig offers a test output of 14 MW, which is a world record.

**Hansen Transmissions** is a long-standing supplier of gearboxes for wind turbines, with manufacturing facilities in Belgium, India and a gearbox testing and assembly facility in China with a combined output of 7.6 GW. Hansen produces gearboxes ranging from 1.5 to 6.15 MW, including offshore. The company has undergone a number of previous ownerships, but most recently (in March 2011) it separated off its industrial gearbox manufacturing operations and sold them to Sumitomo Heavy Industries. This arm of the company has been rebranded as Hansen Industrial Gearboxes. Later in 2011, Suzlon sold its 26% share in Hansen to German
manufacture ZF Friedrichshafen AG. ZF then purchased the remaining shares in November 2011. www.hansentransmissions.com

**Moventas** (formerly Metso Drives) is one of the world's leading suppliers of mechanical power transmission equipment for energy and process industries. Manufacturing wind gears is one of the company's core businesses. The company's wind gearbox business is focused on the leading European turbine suppliers, providing gearboxes ranging from 660 kW up to 3 MW, including offshore. Based in Finland, Moventas has a total production capacity of 5,000 MW. In November 2011, Clyde Blowers acquired Moventas, making it one of the largest gear manufacturing groups in the world. www.moventas.com

### 4.7.3. Generators

Wind turbine generators do not use conventional generators but design and technology is specially made to suit harsh application of wind industry requirements. Generators like other equipment's of wind turbines, have to perform at remote locations, among adverse weather and site conditions 24 x 7 for lifecycle of wind turbine. Load is seldom steady as wind conditions and grid conditions are always posing challenges. Reliability and efficiency are often the most important considerations in selection of generators, designs of which change as per OEM requirements.

Following are leading manufacturers of generators for wind turbine applications.

**ABB** is a global player in power and automation technologies which enable utility and industrial customers to improve their performance while lowering environmental impact. With 25 years’ experience in wind energy, ABB is the leading supplier of components for wind power production, offering a comprehensive range of high technology products and systems, such as generators, power converters, transformers, low voltage products and cable systems.

**Siemens LDSPW VMMD**, (formerly part of Winergy) is the long-standing generator and converter business now rebranded as Siemens and supplying large drives, sustainable power conversion and products for the wind industry. With 25 years’ experience in the design and development of asynchronous generators for wind turbines, this is one of the world’s leading suppliers of generators up to a capacity of 6,000 kW. The German company has in-depth knowledge across the complete range of power transmission systems used in the wind industry.
Ingeteam is a market leader in the development of electrical equipment for the energy, industrial, marine and rail traction sectors. With more than 15 years’ experience in wind energy and installed capacity of 18 GW worldwide, the company’s philosophy is based on innovation and commitment to provide the best service and support. It supplies electric generators with a power range from 660 kW to 8 MW, low voltage power converters up to 7.5 MW and medium voltage power converters up to 10 MW, control electronics, pitch control systems, wind farm management systems and a comprehensive range of after-market support services. The company has manufacturing facilities and service centers strategically located in Europe, Asia, North and South America.

Elin Motoren is an Austrian manufacturer of generators with a power range from 750 kW to 6,000 kW currently, including conventional, double fed asynchronous induction and synchronous generators with both electrical and permanent magnet excitation. Elin Motoren has established a manufacturing facility in India in conjunction with turbine supplier Suzlon and supports its global customers by offering local generator supply in the main markets. Since the mid-1980s more than 8,000 wind power generators have been supplied from the Elin factory in Austria alone (not including joint ventures and licensed production).

4.7.4 Bearings

Bearing is a critical component of wind turbine design and has a very key role to play, be it as a part of rotor, rotating gigantic blades or a part of nacelle helping monstrous structure rotate to align with changing wind direction. Bearing application for wind turbine is a special and this design is not seen in any other industry except of some military application. As a result standardization and economies of scale are still a distant reality.

Following are leading bearing manufacturers.

SKF is a leading supplier and development partner to the wind energy industry. With over 100 years of knowledge and experience from five competence platforms; Bearings, Sealing solutions, Lubrication systems, Mechatronics and Service solutions, SKF supplies to a majority of the wind turbine manufacturers globally. They have a manufacturing footprint in Sweden, Germany, France, Austria, USA, India and China and local sales and engineering support in most of the countries across the world, capable of providing support to the wind industry. SKF is well equipped to find
solutions to logistic needs in the globalization of the industry. Several industry specific products, like the Nautilus main-shaft solution, the WindCon condition monitoring system, the XL-hybrid bearing for generator insulation and the High Capacity CRB for wind-gearboxes etc. are recent developments from SKF to support the technology development in the wind energy industry.

**Schaeffler** ranks among the world’s leading manufacturers of rolling bearings. As a development partner for the wind power sectors it has been producing bearings for wind turbines for over 30 years. With the INA and FAG brands, Schaeffler offers a solution for every bearing location, including rotor shafts, gearboxes, generators and nacelle and blade adjustment. The company also supplies rotor bearing housings, special greases, advanced simulation and calculation methods as well as services and products for all aspects of maintenance and condition monitoring.

**Timken** offers a full range of products and services for wind energy applications, and has recently expanded by setting up bearing manufacturing facilities in both India and China. Timken is also a producer of high alloy and ultraclean steels used for bearings but also a wide variety of demanding industrial applications, among them wind energy gear drives. In addition to bearing products, Timken also provides lubricants, seals and condition monitoring for the wind industry.

**NSK** inaugurated its bearing business in 1916, has supplied large bearings to the European market since the 1990s and has since developed a worldwide market. The company entered the Chinese market by opening NSK Hefei, a bearing manufacturing subsidiary, in 2011. NSK offers the full range of bearings for wind turbines up to 6.5 MW and supplies some of the world’s top ten turbine manufacturers.

**Liebherr** provides entire systems for electromechanical pitch, hydraulic pitch and also yaw adjustment, in wind turbines. This also includes large diameter bearings, slewing gearboxes, electric motors and hydraulic cylinders. Since the mid-1990s Liebherr has equipped more than 13,000 wind turbines, among them many offshore machines in the multi-megawatt class. Factories for bearings, gearboxes, electric motors and cylinders are located in Germany, Mexico and China.

### 4.7.5 Towers

In the entire wind turbine generator tower is one of the heaviest components and it is firmly grounded on a foundation using flanges and bolts. Towers made of steel plates
are designed to sustain all the static and dynamic load of wind turbine while in operation. As the turbine capacities and hub heights increase, concrete tower or a mix of concrete and steel – hybrid structures are also evolving.

Following are leading manufacturers of wind turbine towers.

**DMI Industries**, a US company located in West Fargo, North Dakota, is a heavy steel manufacturer specializing in wind turbine towers, including the full range of tower production, tower internals as well as full steel plate preparation. The company was founded in 1978, and has been making towers since 1999. It is one of the world’s largest wind tower suppliers.

**DS SM**, owned by DS Gruppen, is a Danish manufacturer which began production in 1998 and has a current capacity of 2,400 MW per year. Manufacturing tower sections with a unit weight of up to 160 tons, the company builds towers, foundations and machine frames for the major Danish, German and US turbine manufacturers.

**Bladt Industry** is a Danish tower manufacturer with over a decade of experience in complex steel structures for the renewables sector. It supplies the major Danish, German and US turbine manufacturers and has been fabricating towers for offshore wind farms since 2003. New facilities under construction will double its capacity. The company also fabricates offshore substations and foundations.

**SIAG Schaaf Industrie** has developed from a classic steel constructor to become a leading supplier to the wind energy sector, with plants in Europe, Egypt and the US. With an annual output of over 900 towers and a potential for up to 2,600 towers, the German company can supply towers for wind turbines greater than 5 MW.

**Trinity Structural Towers**, a wholly-owned subsidiary of Trinity Industries, is one of the largest wind towers suppliers in the US. Through its parent and affiliated companies, Trinity is able to provide a number of steel turbine components, concrete and aggregates, product transportation and specialized coatings. Trinity has the capacity to produce towers for turbines as large as 2.5 MW and can supply more than 2,650 per year.

**Titan Group** (Titan Wind Energy (Suzhou) Co. Ltd) specializes in the manufacture of wind towers, with facilities in Suzhou, Baotou, Lianyungang and Shenyang producing a maximum of 1,600 towers annually. Titan towers can support turbines up to 3 MW and is an approved supplier to Vestas and GE, exporting its products worldwide.
4.7.6 Other Components

Apart from the major components mentioned above in terms of size and value, wind turbine generators comprise of hundreds of components that are critical to its functioning. Some of these key components have been introduced in the earlier chapter of research.

Leading key component vendors are as below.

**GE Energy's Power Conversion** business, formerly Converteam, provides the wind industry with converters, generators, power collection and connection to the grid. Power Conversion is a leader in wind converters with an installed base of 26 GW and has also delivered many permanent magnet generators for configurations, including direct drive, medium and standard speed.

**The Switch** evolved in 2006 from three companies - Rotatek Finland, Verteco and Youtility – with a combined experience of 25 years’ innovation and expertise. The company is a leading supplier of megawatt-class permanent magnet generators and full-power converter packages for the wind industry. It provides generator and converter solutions up to 6 MW capacity and with an annual output of 5.5 GW. The Switch has manufacturing facilities in Europe, China and the USA.

**Brevini**, with 50 years of experience in gear technology, maintenance and service, manufactures main gearbox and pitch and yaw systems for wind turbines. Brevini has facilities in Italy, China, India and Brazil and develops gearboxes for wind turbines between 900 kW and 3.5 MW capacity. Brevini Power Transmission has also installed over 70,000 pitch and yaw systems for global wind industry players.

**Bonfiglioli**, established in 1956 in Bologna, Italy, has developed into the world’s top name in power transmission and control solutions. The company designs, manufactures and distributes a complete range of gear motors, drive systems and planetary gearboxes. Leveraging its know-how in power transmission, it has developed complete pitch and yaw drive systems for turbines up to 6 MW. Bonfiglioli has manufacturing facilities in Italy and China and one out of every three wind turbines globally now uses one of its gearboxes.

**Comer Industries**, is a global leader in the design and production of advanced engineering systems and mechatronic solutions for power transmission. Comer offers complete pitch control and yaw drive systems and is one of the largest suppliers of
main pitch systems in the world. The company has manufacturing facilities in Europe, the USA and China. Comer’s headquarters are in Reggiano, Italy.

**kk-electronic** is a Danish company producing wind power control systems for the major turbine manufacturers for more than three decades. In 2008, it established a joint venture in China with CSIC Chongqing Qianwei Instrument & Metering Factory. More than 15,000 kk-electronic control systems are now in operation in both onshore and offshore wind farms.

**CG (formerly Pauwels)** acquired the Belgium-based Pauwels Group in 2005 and is one of the leading manufacturers of power transformers for the wind industry. CG is an engineering conglomerate with a large portfolio of products, solutions and services. The company has manufacturing plants on three continents, producing more than 30,000 transformers each year and is a leading supplier for the offshore wind sector.

### 4.8. Stakeholder Analysis - Original Equipment Manufacturers (OEMs)

Since US wind industry has huge business potential in store it has over the years attracted wind turbine generator manufacturers or OEMs from around the world, mainly Europe, where wind power industry has been conceived, nurtured and commercialized.

![2011 Market Share in the USA](image)

Figure 4.9 US wind industry Market share of major OEM in 2011.

Presence of large number of OEMs makes US wind industry a very competitive in terms of technology, pricing etc. as customer have ample of choice. Most of OEM
suppliers refer to ship wind turbine generators from outside of US as volumes do not justify local manufacturing. There are however early signs of changing trends as freight costs, time and logistics pose bigger problems for imports in to US. Leading names that feature in OEM space are GE, Siemens, Vestas, Mitsubishi, Nordex, Suzlon etc Following is a brief profile of major leading OEMs active in US wind Industry.

Vestas Wind Systems (Denmark): Vestas is the world’s largest manufacturer of wind technology, with its core business including the development, manufacture, sale, marketing and maintenance of installations. The company supplies a full range of products, from individual turbines to the delivery of turnkey wind power systems. Vestas does not participate in the development, financing or ownership of projects, but does supply support and guidance in these areas. The company began wind turbine manufacturing in 1979 and has played a major role in the fast-moving wind power industry ever since. Vestas has installed over 50,000 wind turbines in 69 countries on six continents and has also delivered turbines to more than 34% of the world’s offshore installations. It has built up a wealth of experience and expertise, which are used to the benefit of customers all over the world.

Goldwind (China): Listed on the Shenzhen Stock Exchange in 2007 and Hong Kong Stock Exchange in 2010, Goldwind was the second largest manufacturer in the world in 2011. The company manufactures and markets wind turbines which have been specially designed for regions with varying weather conditions. Its products range from 600 kW up to 3.0 MW. Goldwind co-designed its 1.5 MW direct drive machine with German turbine manufacturer Vensys, which it acquired in 2008, and is the world’s largest supplier of permanent magnet direct drive turbine. Goldwind plans to install the first 6 MW direct drive offshore turbine by the end of June 2012, scheduled to be the first of its kind in Asia. The company is the first Chinese turbine manufacturer to have installed utility-scale wind projects on US soil and is currently installing turbines in Ecuador, Chile, Pakistan, Australia and Ethiopia.

GE Energy (US): GE is the third largest supplier of wind turbines in the world, with manufacturing and assembly facilities in Germany, Norway, China, India, Brazil, Canada and the United States. Its current product portfolio includes turbines with rated capacities from 1.5 to 4.1 MW and support services ranging from development assistance to operation and maintenance. Its 1.6 MW machine received new traction in 2011, with over 1,200 MW of orders and more than 2 GW operating to date. GE also installed the first of its 4.1 MW direct drive offshore wind turbines in Gothenburg,
Sweden, marking its re-entry to the offshore market. GE also announced plans to develop an entirely new scale of turbines, aiming for a 15 MW capacity machine.

Gamesa (Spain): Gamesa specializes in sustainable energy technologies, mainly wind power. It is the market leader in Spain and was the fourth largest manufacturer in the world in 2011. Gamesa has more than twenty production facilities in Spain (supplying mainly the European market), the US, Asia (China and India) and Brazil (since mid-2011). Its sales network, distributed across eight regions and 24 sales offices worldwide, covers many European countries (Bulgaria, Denmark, France, Germany, Greece, Italy, Poland, Portugal, Romania, Turkey and the United Kingdom), North America (USA and Mexico), Brazil, China, India, Japan, Singapore and several North African countries such as Morocco and Egypt. Gamesa offers a product range with a rated power from 850 kW up to 4.5 MW. For the offshore market, Gamesa is currently designing and developing two families of turbines: the G11X- 5.0 MW, set to launch in 2012, and the G14X with a capacity of 6-7 MW, set to debut in 2015.

Enercon (Germany): For more than 25 years Enercon has been setting new standards with its technical innovations in the field of wind energy, and now ranks as the fifth largest wind turbine supplier in the world. Over 19,000 of its turbines have now been installed in 30 countries, making it one of the leading manufacturers in the international market. Research and development, as well as production and sales, are constantly being extended. The largest supplier in Germany, Enercon has production facilities in Germany, Brazil, Sweden, Turkey, Portugal and Canada as well as sales offices in 16 countries. Its product portfolio was extended in 2010 with three new models - the E-82/2.3 MW, E-82/3 MW and E- 101/3 MW. In December 2010, the company installed what is currently the world’s most powerful wind energy converter, an E-126/7.5 MW, at its site in Magdeburg-Rothensee in Germany. This was an upgrade of the 6.0 MW turbine already installed in Belgium and Germany.

Suzlon Group (India): Suzlon, established in 1995, ranked as the world’s fifth largest wind turbine supplier in terms of the group’s cumulative market share at the end of 2011. The company’s global spread extends across Asia, Australia, Europe, Africa and North and South America. Suzlon is a vertically integrated manufacturer with capability across the full value chain – from components to complete wind turbine systems. The group has installed over 20,000 MW of capacity in 28 countries, and has established operations across 32 countries. Maintaining market leadership in India for the past 14 years in a row, the company is listed on the Indian Stock
Exchange. Suzlon completed the acquisition of REpower in 2011 and now has complete control of the company.

REpower is the third largest German manufacturer of wind turbines, with a product portfolio ranging from 1.5 up to 6.15 MW. Headquartered in Hamburg, the company focuses on the development, production and installation of multi-megawatt wind turbines. The REpower 6M 6.15 MW turbine is currently the largest commercial machine in the world for offshore wind projects. REpower is represented by distribution partners, subsidiaries and participations in European markets as well as at a global level in the USA, China, Australia and Canada.

**Sinovel Wind (China):** The second largest wind turbine manufacturer in China, Sinovel fell from its position as the second largest supplier in 2010 to seventh in 2011. With headquarters in Beijing, the company's manufacturing bases are located in Dalian, Baotou, Jiuquan, Yancheng, Shanghai and Hami. In January 2011, Sinovel Wind Group Co. Ltd was successfully listed on the A-Share Main Board of the Shanghai Stock Exchange. Its current product portfolio includes wind turbines with rated capacities ranging from 1.5 to 6.0 MW. Sinovel installed its 5 and 6 MW turbine prototypes in September and October 2011, the first of their kind outside Europe.

**Siemens Wind Power (Denmark):** Formerly Bonus Energy, the oldest manufacturer in Denmark has produced more than 10,600 turbines for clients around the world since 1979. Known in the wind industry for its solid financial basis, Siemens’ turbines are noted for their high reliability under extreme environmental conditions. Commercial turbine sizes include 2.3, 3.0 and 3.6 MW. Bonus turbines were supplied to the world’s first offshore wind farm at Vindeby, Denmark in 1991, and based on this experience the company has become a leading supplier of offshore turbines, with more than 50% of the global market. The company’s first direct drive systems were developed in 2008, followed by the launch of the SWT-3.0-101 3 MW and SWT-2.3-113 2.3 MW direct drive gearless turbines in 2010 and 2011 respectively. Most recently it installed a SWT-6.0-120 6 MW direct drive prototype in Denmark, the first of its kind in the world.

**Nordex (Germany):** Nordex AG has been listed on the Frankfurt stock exchange since April 2001 and is among the leaders in the megawatt size category, particularly benefiting from the trend towards larger capacity turbines. Its range includes what is currently one of the world’s largest series turbines, the N80, N90 and N100/2.5 MW machines. With manufacturing facilities in Germany, China and the US, the company
has offices and subsidiaries in 19 countries. As the 11th largest manufacturer, Nordex plays a key role in international high growth regions. By the end of 2011, nearly 5,000 of its turbines, with a total rated output of more than 7,900 MW, were rotating in more than 30 countries. The company introduced its new N117/2400 model in 2011 and also announced plans to enter the offshore market with the N150/6000 direct drive turbine design.

**Acciona Windpower (Spain):** An Acciona Group Company dedicated to the design and production of wind turbines. Acciona Windpower currently produces AW 1,500 kW machines of different classes and rotor diameters. These are designed by an engineering team with considerable experience in the sector. The company was originally formed to solve the problems arising in the wind farms operated by Spanish developer EHN, where 2,600 wind turbines of six different technologies and 20 different models had been installed. More recently, the company introduced the new AW-3000 design and four units have been installed over the last three years. Acciona has three production plants around the world - two in Spain and one in the United States. By the end of 2011 it had nearly 2,600 turbines installed in 12 countries.

**Mitsubishi Heavy Industries (Japan):** MHI is the oldest wind turbine manufacturer in Asia. Since 1980 it has completed almost 4,000 installations in over ten countries with a total capacity of more than 3,900 MW. The company produces induction type and variable speed machines from 250 kW up to 2.4 MW capacity. Its main products are the MWT 1.0 MW and MWT 2.4 MW turbines. MHI started building its manufacturing plant in Fort Smith, Arkansas, in 2010, the company's first nacelle production plant located outside Japan. The company unveiled the blueprint of its 7 MW hydraulic drive offshore turbine in 2011 and full-scale prototype testing is expected to take place in 2013.

**Alstom Wind (Spain):** A new turbine manufacturer created in 2007 by linking the French engineering company Alstom and Spanish supplier Ecotécnia. The latter started working with renewable energy in the late 1970s and was one of the pioneers of the industry in Spain. Ecotécnia designs, assembles and installs a wide range of onshore wind turbines from 1.3 MW to 3 MW and is also involved in project development, including turnkey deliveries. The company has five manufacturing facilities in Spain and has recently built assembly facilities in the US and Brazil. In 2011 it unveiled a 6.0 MW permanent magnet direct drive offshore turbine. A prototype will be installed this year, with series production in 2014.
Clipper Windpower (US): Clipper started manufacture of wind turbines in 2004, when the company introduced a novel design concept based on four separate drivetrains (gearbox and generator). The first projects with this new design were completed in 2007. Clipper’s patented Liberty turbine has a capacity of 2.5 MW and three options for rotor diameter, ranging from 89 to 99 meters. In December 2009, Clipper sold a stake of roughly 39.3% to United Technologies Corp (UTC), and one year later UTC completed its purchase by acquiring all remaining shares. In 2008, the company started the Britannia project to deliver a 10 MW turbine for the UK’s offshore market, but UTC terminated the plans in 2011.

While we have now already seen who are leading OEMs present in US wind industry, let’s take a closer look at the product portfolio of these OEMs.

![Figure 4.10 Top OEM Product Portfolio overview](image)

One can clearly see from above figure that most OEMs are promoting 2MW rated wind turbine generators in the US market. This clearly demonstrates that Wind turbines rated between 1MW to 2MW is a thing of past and leading OEMs are pitching wind turbines of 2MW and higher rating to maximize returns from the good wind sites.

4.9 Stakeholder Analysis - OMS providers

Wind turbine generators work 24 x 7 in the harsh weather conditions and they have to continue to do so for their life which is estimated at 20 years. Advances in
computer and IT sciences have made sure that remote monitoring and control from a distantly located central monitoring station is possible. However several scheduled maintenance procedure, replacements, break-down, troubleshooting etc. has to be done at site by certified professionals to ensure that turbine availability and generation stays in as per contractual commitment. Specialized OMS service providers make it possible as for OEM it is not always possible to deploy its resources at every project site across such a vast country. Moreover necessary equipment such as cranes needs to be mobilized from time to time over long distances and its way costly for OEM to spend energies in maintaining inventory and manage crane, technical resource expertise. OMS providers therefor contribute to helping achieve necessary project performance and thus are critical partners in entire delivery value chain.

A turbine shutdown for just one day can cost USD 2,000–5,000 in lost revenue, depending on turbine make and model. Annual costs can range from USD 25,000 to 75,000 per turbine per year, depending on a myriad of factors. As higher priced full service agreements and yield based guarantees are still in their infancy, actual operational expenditures (OPEX) budgets across the U.S. fleet are on the lower end of the range, roughly USD 25,000–35,000 per turbine per year, averaged over its expected lifespan. Full-service O&M providers providing scheduled maintenance services have close relationships with the end-users they serve and are in a position to pull through higher-margin spare part agreements and turbine upgrade solutions.

Turbine OEMs are leveraging substantial engineering resources to cement their competitive advantage in the marketplace while providing asset owners added value by enhancing turbine availability, extending component life, and better predicting and managing failures. This added value is realized through a new wave of advanced diagnostics employing the latest trend analysis software to analyzes extensive SCADA data and condition-based monitoring system output.

The Independent Service Providers (ISPs) community is made up of a wide array of service providers, ranging from full service providers such as enXco to groups such as Run Energy who tend to serve as contract labor for turbine OEMs. Irrespective of the group’s suite of services, the ISP competitive advantage resides in their lower costs and ability to serve as an unbiased advocate for the asset owner. ISPs are free to point out any and all concerns regarding a turbine’s operation without the worry of serial defect litigation or triggering of equipment warranty claims. As a consequence of this competitive advantage, the ISP community has benefitted from a glut of ISP
end-of-warranty inspections, which aside from their transactional value can be an effective springboard of trust to secure additional service work.

ISPs can also freely service any turbine within an available market, which represents a strong advantage with end-users owning multiple turbine technologies. This inherent strength of the ISP model must be validated in practice, as to date most ISPs have opted to focus on a limited portfolio of turbine products. The technical training, asset management and supply chain mapping for multiple turbine vendors and multiple turbine vendor models can be extremely costly, especially if taken on with a small fleet. Nevertheless, turbine OEMs have still not taken the leap of servicing competitor turbines in the U.S., and as such this cross-platform capability provides an excellent channel from which to court end-users that are unable or unwilling to execute a self-supply O&M model.

Most asset owners welcome the presence of ISPs with the same competence and capabilities as leading turbine suppliers, if only for enabling competition and an objective viewpoint in the post warranty service segment. The central impediment for increased adoption of the ISP service model has been that ISPs are ill equipped financially to backstop the availability guarantees and warranties typically associated with turbine vendor contracts. This is one of the primary reasons why a vast majority of the smaller ISPs and specialty repair shops in the U.S. have failed to cultivate a viable full-service O&M offering. The other major reason is an inability to invest in the backroom support functions necessary to develop value added services such as procurement support and engineering groups. In essence, most ISPs are functioning as contract labor organizations, or concentrating on regional unscheduled service opportunities such as blade repair, gearbox replacement, and generator service. Therefore, no ISP has yet emerged with the right combination of size, parts management, technical expertise, and financial backing to counterbalance effectively either OEM service or self-perform models. enXco reflects this description, however their unique positioning as one of the U.S.' largest wind asset owners provides them a distinct advantage within the market. The U.S. ISP market is very fragmented, and represents a tremendous opportunity for consolidation with an eye towards the formation of at least one major ISP to compete with OEMs on financial strength, operating scale, technical capability and outsourcing flexibility.

In the absence of such an ISP player in the market, high turbine OEM service costs and the increasing operational scale of wind asset owners have prompted the
development of the self-perform maintenance segment to help lower operating expenditures. This trend is being driven by a number of factors:

- Increasing size of the asset base of IPPs below the big two that self-perform (NextEra Energy and Iberdrola)
- Greater experience with deployed turbine technology
- A larger and more fluid base of turbine technicians
- A wide array of specialty repair shops that can be engaged on an as-needed basis

Despite the need for basic training, supporting documentation and remote monitoring services, basic wind turbine maintenance is still not deemed a specialty skill set and therefore is increasingly commoditized. As such, asset owners with a large-enough fleet are comfortable bringing service in house in order to reduce costs. Asset owners with a relatively uniform turbine fleet and limited regional spread are particularly well suited to operate a self-perform service model because a common turbine platform minimizes training and technology expertise required for field technicians and field support services, while also allowing for more technician flexibility between wind farms. Spare parts can also be more efficiently managed.

4.10 Stakeholder Analysis - Insurance Companies

Unlike in India, insurance companies have number of products that they offer to wind industry in USA. Not just product and project insurance but also performance insurance. These are relatively new concepts for Indian new entrant, however they need to be learnt and deployed as customers want them. Wind turbine performance insurance gives financers comfort as a fall back arrangement just in case wind turbine performance falls short of committed benchmarks. Insurance premium is an integral element of project costing. Leading companies offering this product are American insurance Group (AIG), Credit Susie etc.

There are several types of insurance policies undertaken during wind power project cycle and major ones are as follows:

- **Marine Cargo insurance**: This covers goods from works where turbines are manufactured all the way to project sites where installation is planned. This includes transshipments
- **Erection all risk Insurance**: Classical scope of this insurance policy covers among others following, Erection and dismantling (repowering) of WTGs. Erection and dismantling (repowering) of WTGs on a turnkey basis and/or as supervisor. All work included in the project, whether permanent or temporary, including any materials used or to be used in connection with the erection which belong to the insured or which the insured carries the risk while the materials are situated at the building site. Service and warranty work

- **Warranty Insurance – WTG**: Typical scope of the warrantee insurance policy covers among others following, Machinery and electrical breakdown, Lightning, Ice, Fire, Expediting expenses, Pollution due to a indemnified claim, Series of losses: 25% of the total Wind Turbine park, business interruption-indemnity period of 8 months.

- **General and Products Liability**: All activities of the insured, which is principally, but not limited to Sale, Repair, Assembly, Service and guarantee work, Trading with wind turbines, products related to wind power industry, Turn Key projects

**4.11 Stakeholder Analysis- Technology Institutions**

Overall growth of wind power on sustainable basis is possible only by continued by technology innovation is something private as well as Govt. sector in USA recognize. Therefore a lot of emphasize is paid to exploring new technology frontiers in various aspects of wind power such as wind resource assessment, raw material advances and wind turbine generator itself. Adapting to advancements in allied industry by way of components, processes and practices is how wind industry in US is leveraging technology. No wonder then wind turbine performance is improving, reliability is on rise and costs are declining. Some key names such as National renewable energy Laboratory (NREL), US Govt. and Department of Energy (DoE) on govt. side where as DNV, GL and GH on private side are leading this initiative.

**National Wind Technology Centre (NWTC):** National renewable Energy laboratory’s (NREL), NWTC is the nation’s premier wind energy technology research facility. The NWTC advances the development of innovative land-based and offshore wind energy technologies through its research and testing facilities. NWTC’s vision is to be an essential partner for the technical development and large-scale deployment of wind power. The goals are to:

- Improve wind-plant power production
- Reduce wind-plant capital cost
- Improve wind-plant reliability and lower operation and maintenance costs
- Eliminate barriers to large-scale deployment.

The NWTC's wind energy research capabilities are ahead of the curve. The centre's experienced staff, unique research capabilities, and specialized state-of-the-art equipment provide industry partners and stakeholders with technical support from the design table to the marketplace. NREL's R&D projects are funded in part by the U.S. Department of Energy's Wind Program.

**University led research Programs in Wind:** The University of Massachusetts Wind Energy Center is a leading institution in wind energy engineering nationally and internationally. Since 1972 the Center has worked diligently to maintain and enhance its important wind energy education programs and research activities. Texas Tech University's newly-formed National Wind Institute (NWI) is based on a strong foundation of more than 40 years of research and education on the impact of wind on structures and human life. An Illinois Institute of Technology (IIT) led consortium for wind energy research facilities is expected to enhance the United States' leadership role in testing and producing the most advanced and efficient wind turbines in the world. Objective of this consortium is focused research on critical wind energy challenges identified in the "20% Wind Energy by 2030" report, including wind technology challenge, grid system integration, and workforce challenge. The university consortium's research and development plan includes advanced concepts for rotor control and drive train control, robust sensors for blades, and improved aeroelastic models to improve wind turbine performance and reliability.

4.12 Stakeholder Analysis- Others

Over and above leading industry stakeholders listed above, there are several niche players who play a vital role in overall development and growth of wind Industry in USA. Some of them are listed below.

**Wind Industry Associations:** These associations have a very valuable role to play which is to keep entire wind industry fraternity together and facilitate growth of wind industry. Associations organize trade shows and events round the year to bring various topics related to technology, policy, financing etc. to table and help evolve optimal solutions by way of exchange of ideas and practices. They represent industry voice to law-makers for requisite policy reforms and keep wind industry in USA going thus creating local jobs, expertise and obviously help achieve green energy targets.
**3rd party Consultants:** For established players as well as for new entrants, 3rd party consultants provide expert services on several fronts be it technology, quality, logistics insurance or for that matter financing. Consultants bring to table unique insights developed over years to study and exposure to best industry practices across the global wind industry besides invaluable network of professionals. Thus helping companies get jump started with their stated objectives. Most stakeholders rely on consultant service either for due diligences or techno-commercial feasibility & viability studies and thus bridge knowledge gaps effectively.

**Erection Contractors:** US wind industry has strict rules regulations and laws that authorize only registered licensed personnel participate in project construction e.g. master electrician. Also specialized erection equipment such as cranes having necessary boom length and weight bearing capacity has to be deployed. Expert erection contractors are available to fill this important piece value chain of delivery. Several compliance measures such as health, safety environment, weather permits etc. have to ensure. Leading players are companies like Pen power.

**Shipping & Freight Logistics companies:** Since wind turbine generators are huge in size and most components arrive from different parts of world, shipment and logistics is becomes critical component of supply chain management. USA being huge country and most of the wind farms location being internal onshore, away from coast, domestic transportation becomes vital. Several factors such as specialized trucks, equipment handing facilities at port, storage, stevedoring etc. have to be considered. This is clearly a job of local experts and their services should be hired. Few leading names are Northstar logistics, Wind logistic services Inc. etc.

**Landowners:** The developer negotiates with the landowner for the right to “harvest the wind” above the land and to place the turbine on a small plot of land – typically less than 1 acre is removed from normal use (farming, grazing, etc.) for each 50 acres of wind resource captured. These are typically farmers who lend a foot print for wind turbine installation more often than not on a leasing arrangement, though outright sale of land is also not uncommon. Land of course must have promising wind resource which is actually measured initially using secondary sources e.g. satellite data followed by primary sources e.g. actual wind measurement using wind masts.

**Banks & FIs:** When it comes to financial viability of any wind power project role of funding agencies that provide debt for the project comes in. Funding of any wind power project can be for financing, construction part, vendor part or for that matter a
realizing a project. Wind power Project no matter how good it looks on paper have to pass test of financial closure i.e. tying up debt and also equity before it hope to take off the ground. Banks and FIs have their own ways and means to evaluate merit of the project and often they engage services of sector experts for the purpose of due diligence. Only when they are convinced that project has requisite potential in terms of either Internal Rate of Return (IRR) or Net Present Value (NPV), each bank / FI may have their own ways of evaluation then only they sanction loan for the project. There are several banks/ FIs on Wall Street who have set aside funds for green or socially responsible investments.

Policy Makers: These are law-makers who constantly evaluate energy mix of the country, aspects such as energy security, tax issues while evaluating various policy regulatory mechanisms prevailing in different part of the world. Law-makers deploy sector experts in technology and finance to create various scenarios in terms of overall impact on country, society as a whole. Lobby groups often present law-makers all the fodder required to make a strong business case that could pass test of senate & congress at federal and state level. In the research period we have seen that wind energy incentives have at times been tied to tax bill on occasions attached to energy bill.

4.13 Policy mechanism in US wind Industry

Wind industry worldwide survives and thrives on the basis of strong supportive policy and regulatory mechanism and US wind industry is no exception. Worldwide there is divergent policy mechanisms observed from soft funding support, tax holidays, and incentives for green energy, premium tariffs or a combination thereof. Every country has formulated policies as per their market dynamics, energy mix, financial situation etc. Some countries apply policy compliance on demand side where are there are others who impose it on supply side. In either eventuality cascade effect is seen across the value chain.

Following is a policy mechanism that is prevalent in US wind industry.

4.13.1. Renewables Portfolio Standards (RPS)

State-based RPS has contributed significantly to sustaining wind power development in the U.S. An RES requires that a specific and typically rising percentage of a utility’s generation portfolio be generated from renewable energy sources such as wind power. This has spurred new clean energy development as well as advanced utility
wind procurement strategies, evident in the growth in utility ownership and activity along the value chain (sees section 5.5, figure 38). In lieu of a national RES and a stable federal incentive mechanism, state-level RES policies provide a consistent and critical demand-driver for the wind power industry. At the time of publication, 29 states plus the District of Columbia had adopted mandatory RES policies. Moreover, there are renewable energy goals in an additional eight states. Although the mandates do not have to be satisfied exclusively by wind power, wind is typically used for compliance more than other renewable. These state policies could yield over 100GW of new renewable energy capacity by 2020. State RES policies have one commonality – each one is different. This has contributed to extreme difficulty in crafting a federal RES for the entire U.S. Currently, state RES policies differ on items such as qualifying renewable energy sources, penalties for noncompliance, deadlines, energy efficiency, and RECs. Compliance with state RES mandates could be challenged by a number of factors, including saturation of quality development sites, transmission bottlenecks, cost, or a lack of in-state resources.

RPS language can allow utilities to purchase renewable energy credits (RECs) in order to satisfy compliance obligations under an RPS. A REC is a tradable certificate that represents the renewable energy attributes of one megawatt-hour of renewable energy. Essentially, the renewable attribute is decoupled from the unit of energy and sold independently. Many deals also bundle RECs and generation together, but most decouple or unbundle the RECs for separate sale. For many utilities, purchasing RECs can be more cost-effective than generating the clean energy or buying the necessary MWhs from an independent power producer (IPP). Some states require that an eligible REC be generated from an in-state clean energy generator as a means to keep the economic benefits local. Illinois’s RES, for example, includes a stipulation that eligible resources had to be located in-state through 2011. Other states, such as in the Northeast, recognize RECs generated by out-of-state renewable energy projects. Interstate REC markets enable RECs to be distributed more widely and possibly at a lower cost, and give utilities significantly more flexibility in meeting clean energy mandate.

At a time when many states face significant budgetary shortfalls and RES compliance has been targeted as an unnecessary nuisance to struggling rate-payers, there have been isolated cases of RES policies coming under attack. Legislation has been proposed in several states, to relax compliance deadlines or remove the obligation altogether a weakening or removal of a state RES, therefore, would not
only have a negative impact on the economy and clean energy generation in-state, but it could also be deleterious to a neighboring state as well.

There are reports that detail the positive economic results from renewable energy development and how the policy helped to bring down the price of renewable energy to levels cheaper than coal, not to mention the creation of millions of dollars in new economic development. The findings have resulted in discussions over strengthening the state’s RPS policy despite countering efforts to repeal the standard without a federal RPS in place, industry growth depends on states strengthening existing clean energy mandates, particularly as compliance schedules have largely been met. States without existing RES mandates that enact new policies will offer further market predictability and a more stable investment environment for the industry.

Many utilities have banked RECs during the last few years of industry growth as a means to hedge against higher prices. A banked REC is a REC that is not used by a utility to comply with a RPS in the calendar year during which it is generated. It can be held (i.e. banked) and used at a later date for the purposes of compliance. As utilities have come into compliance, and REC volume has increased due to strong build years, the value of RECs has generally decreased. The potential record year in 2012 will generate even more RECs, further flooding the market, and enable utilities to bank credits at a very competitive price. Different states have provisions outlining the use of banked RECs to comply with a RPS. Different state provisions for RECs and banked RECs make it very difficult to track the issuance and ownership of RECs effectively.

Many of the top states have supplemented RPS mandates with other wind-friendly policies such as tax exemptions, transmission expansion plans, and GHG emission reduction strategies. The proactive efforts of policymakers and regulators in these states have yielded considerable wind power development.

States with RPS mandates accounted for approximately 82% of cumulative installed capacity through 2011. Over the last several years, states without RPS policies have begun to add capacity and have slowly risen up the ranks of total installed capacity, such as North Dakota, Indiana, Oklahoma, and Wyoming, which all rank among the top 15 for cumulative capacity. This is largely due to new wind plants in these states satisfying RPS demand in other states. Utilities with a service area in a state without a RPS have also added wind power as a means to diversify generation portfolios. The widespread deployment of low wind speed turbine models has also had an
impact, as the technology has opened up development zones in RES states previously considered uneconomical.

### Table 4.2 States with Renewable Portfolio Standards (RPS)

#### 4.13.2. Production Tax Credit (PTC)

From 1992 through 2008, the production tax credit (PTC) was the primary federal incentive for wind power. In 2009, the ARRA was expanded to include an investment tax credit (ITC) option and a Treasury cash grant option.

Federal Renewable Energy Production Tax Credit (PTC) – The PTC is an inflation-adjusted tax credit for electricity produced from qualifying renewable energy sources or technologies. The PTC gave power producers 1.5 cents (increased annually with inflation) for every kilowatt-hour (kWh) of electricity produced from wind during the first 10 years of operation. The renewable energy production tax credit (PTC), a credit of 2.1 cents per kilowatt-hour, is the primary federal incentive for wind energy
and has been essential to the industry’s growth. Since its establishment in 1992, the PTC has undergone a series of short-term extensions, and Production Tax Credit

<table>
<thead>
<tr>
<th>Incentive Pricing</th>
<th>Program Length</th>
<th>Eligible Technologies</th>
<th>Current Project Activation Deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Policy Act of 1992</td>
<td>Valid for first 10 years of project operation</td>
<td>Wind, closed- and open-loop biomass, geothermal, small irrigation power, municipal solid waste, landfill gas, refined coal, certain hydropower, Indian coal</td>
<td>31 December 2012</td>
</tr>
</tbody>
</table>

Source: US Internal Revenue Service, IHS Emerging Energy Research

Table 4.3 US Federal Production Tax Credit Details

The main incentive scheme in the U.S. to date has been the federal PTC. The relative stability of this market-driver helped to sustain growth in the U.S. from 2005 to 2011. Expiration of this important driver had a devastating impact on new capacity growth in 2000, 2002, and 2004, as evident from figure 8. The expiration of the PTC after 2012 will again effectuate a drop in annual installations starting in 2013 after an expiring policy construction bubble in 2012. Figure 4.11 shows effects of PTC on annual wind power generation in USA>

![Figure 4.11 Wind Power Industry Flourishes with Stable Policy (MW)](image)

The PTC enables owners of wind power plants to offset an amount against their income taxes for the first ten years of a wind power plant’s production. The income tax credit amounts to USD .022 per kWh of electricity from utility-scale wind turbines. Third-party institutional investors with large tax liabilities have thus been regular
investors in wind power projects in the U.S. In exchange for access to the tax credits, investors leverage equity necessary to realize project development. Foreign utilities and relatively small project developers have been disadvantaged since they do not have a significant tax burden in the U.S., although strategic acquisitions can overcome this hurdle.

The PTC has been the primary federal incentive available to encourage wind development throughout much of the industry’s growth in the United States.

Throughout much of the 1990s, the PTC was unable to drive much meaningful wind development. During this time of consistently low natural gas prices and the absence of many current RPS mandates, an immature wind industry could not compete for off take.

The wide fluctuations in wind installations at the turn of the century highlight the industry’s uncertainty, which stemmed from Congress ‘crippling inability to extend the PTC for more than one or two years at a time. In 2000, 2002, and 2004, Congress simply let the program expire before later reinstating it. These gaps in policy resulted in severe market downturns, ranging from 75% to 90% in lost annual growth potential.

A recent effort has ensued to make the production tax credit either refundable or transferable. Because wind energy projects do not provide returns sufficient to capture the full value of the PTC on their own, the PTCs are not currently refundable or tradable, the owner of a wind energy project must either have profits from other activities to provide "tax appetite" or include a tax equity partner in the project financing. In the fourth quarter of 2008 the cost of tax equity capital shot up as a response to the global credit crisis, making the cost of energy from wind energy projects increase by 10% or more.

4.13.3. Investment Tax Credit (ITC)

Despite wind development’s growth under the PTC, the incentive structure’s limitations were acutely exposed by the financial crisis beginning in 2008. Wind developers often did not have sufficient tax burdens to directly take advantage of the incentive, which led them to monetize the PTC via third-party tax equity investors. Companies such as Lehman Brothers, Bear Stearns, and Goldman Sachs were major players in the tax equity market, but with Lehman Brothers' bankruptcy and the near collapse of the entire financial industry, the US wind market had fewer means through which to secure project financing. The American Recovery and
Reinvestment Act (ARRA) by US Govt. addressed this potentially crippling problem and pushed the industry to another year of record additions.

The ARRA gave developers two new avenues to take advantage of the PTC in development, in addition to extending it through 2012. One alternative is an ITC option, which provides an upfront tax credit worth 30% of the project’s capital cost.

The second alternative is a monetization of the 30% ITC through a US Treasury grant. These two provisions were designed as temporary measures and are available under the condition that construction commences by 31 December 2010.

<table>
<thead>
<tr>
<th>Incentive</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Energy Production Tax Credit (PTC)</td>
<td>Historically the backbone of US federal support for the wind industry, the PTC provides a production-based tax credit to the owner of a wind project. Currently equal to US$21/MWh and indexed annually for inflation.</td>
</tr>
<tr>
<td>US Tax Code Section 48 Investment Tax Credit (ITC)</td>
<td>ARRA expanded the Section 48 ITC to be eligible for wind projects. The ARRA allows owners of wind projects with the option to claim the ITC up front for 30% of a wind project’s capital cost in lieu of claiming the PTC. ITC option contains multiple rules and limits unique from the PTC in terms of how and by whom the incentive can be monetized.</td>
</tr>
<tr>
<td>Department of the Treasury Energy Cash Grant Option</td>
<td>Special federal incentive created by ARRA stimulus bill to help alleviate US wind industry reliance on third-party tax equity. Allows wind project owners to claim an up-front direct cash payment from the Treasury Department equal to the value of the 30% ITC option. As with the ITC, Treasury cash grants will be subject to recapture if the eligible wind project is sold within the first five years of operation.</td>
</tr>
</tbody>
</table>

Table 4.4 Narrative of PTC, ITC and Cash grant

4.13.4 Treasury Grant Program

The new provisions in the ARRA allowed the market to sustain the momentum from its years of record-breaking growth. In 2009, the Treasury grant in particular was instrumental in allowing developers to obtain financing and shore up balance sheets despite the collapse of the tax-equity markets.

Through March 2010, the Treasury has distributed US$2.1 billion in grants to 34 utility-scale wind projects totaling over 3.6 GW in capacity.

The ITC and the Treasury grant are cost-based incentives that benefit lower-speed wind sites where lesser capacity factors result in a higher cost-per-kilowatt. Given the larger economic environment, however, projects that may have received a greater benefit under the PTC elected for the Treasury grant to fill the financing gap in the market. Eligibility for the Treasury grant requires a project to be at least 5% under construction by the end of 2010 and be placed in service by the end of 2012. Initial guidance from the Treasury on what constitutes beginning of construction did not
answer all questions, leading the Treasury to release revised guidance in March 2010 that is very favorable to applicants.

There are two primary ways a project may achieve under-construction status: physical work of a significant nature or safe harbor. Treasury guidance explains that work of a significant physical nature includes offsite work to be completed onsite. This consists of, for example, manufacturing of wind turbines and components done offsite for a project but not delivered. For developers that have ongoing manufacturing for multiple facilities, —reasonable methods‖ to associate individual components with specific projects must be used.

The safe harbor guidelines allow a project to be considered under construction if the applicant has paid or incurred more than 5% of the total cost. The revised guidance expands the original safe harbor guidance by allowing costs to a manufacturer or contractor done through a —binding written contract‖ prior to actual construction to be taken into account. However, under this rule only material and labor costs are taken into account, not the manufacturer‘s profit margin.

4.14 Wind Turbine Sizes in US wind Industry

As the wind power industry has matured in the U.S., the nameplate capacity of wind turbines has increased. Improvements to technology and developer interest in capitalizing on economies of scale have driven growth. After increasing by only 1.7% in 2010, average turbine capacity in the U.S. increased by 13% in 2011 to 2MW. Figure 4.12 indicates how average size of WTG has been panning out in USA.

![Figure 4.12 Graph showing Evolution of Turbine Size in the U.S. (MW)](image)
The cumulative average is over 1.7MW if turbines less than 1MW are excluded. Doing so removes thousands of older and smaller legacy turbines, mostly in California, which can then provide a better snapshot of the average size of more modern turbines. A similar trend toward larger turbines is occurring in China and Europe. In Europe, average turbine capacity has exceeded 2MW for several years.

With an abundance of developable land still available and less of a need for higher nameplate rated turbines than in Europe, for example, the U.S. market continues to deploy 1.5MW turbines more than any other rated machine. The 1.5MW platform, which includes GE’s 1.6 units, accounted for 30% of all utility-scale turbines installed in 2011. This represents a 50% drop in market share of the 1.5MW platform, due largely to GE’s – the dominant supplier of 1.5MW turbines in the U.S. market – decrease in annual market share in 2011.

The U.S. has gradually moved toward MMW turbines, as illustrated in figure 71. Part of the shift to larger turbines is that units specifically designed for low and medium wind speeds have become available in the MMW segment. Lower-speed project sites are an area of high growth as high-capacity sites with access to transmission grow rarer.

Turbine OEMs have also pursued specialized low wind speed models in order to address evolving market needs. Nearly all of the major turbines OEMs have introduced turbines that feature extended rotors on existing models. Rotor extensions on the mainstream 1.5–2.5MW turbine segment enable these models to increase energy yield, and thus revenue potential, at low wind speeds. This in turn opens IEC class III wind speed sites for development, which creates market growth opportunities for states with weaker wind resources.

4.15 Wind Resources and Potential in US

Despite the numerous factors impacting demand for wind power, development can only happen where there are adequate resources to make power generation not just feasible, but also economical. Because of wind’s widespread availability both onshore and offshore, wind has the potential to develop in nearly every US state.

Figure 4.13 below shows a US wind resource map which is result of 2010 NREL wind resource study. This analyzes wind resources at 80 meters, which is the current industry standard turbine hub height.
The United States greatest wind resources extend roughly from eastern Montana to western Minnesota, down through the Great Plains into the Texas Panhandle. These exceptional resources have led the US to often be called the ‘Saudi Arabia of Wind’ for its vast potential. The study map reveals the United States ‘enormous wind potential as well as the challenges in connecting the nation’s best wind resources to load centers. The NREL study also assessed each state’s wind potential and found 36 TW hours of potential wind power generation in the lower 48 states. In determining this number, the study took several factors into account to ensure numerical accuracy. The study did not consider sites such as national parks, urban areas, and areas with a slope greater than 20 degrees and only considered areas with the potential for developments to have a capacity factor greater than 30%.
Figure 4.14 above shows state-wise wind resource potential. Texas has by far the greatest wind potential, with over 6,000 TWh of generation potential. Kansas, Nebraska, South Dakota, and Montana round out the top five and all have between 3,000 TWh and 4,000 TWh of potential. The Southeast remains the one major area devoid of vast resource potential. Florida and Mississippi account for only 1 GWh of potential between them. The small, densely populated states in the Northeast have limited space where they are able to harness their onshore wind resource.

4.16 Cost of Energy: Wind Energy vs. other RE sources

It may be seen from figure 4.15 above that Wind Outpaces Other Renewables on Cost Front.
Offshore wind is roughly double the cost of its onshore counterpart, and without a completed US project, project construction and operations costs are not fully understood.

Wind is currently the most mature, lowest-cost source of renewable power, which has helped fuel its widespread proliferation. Geothermal is a low-cost renewable that provides base-load power, but the difficulty and cost to tap adequate underground resources limits its near-term potential. Solar remains one of the most expensive sources of renewable energy, but as the technology scales and matures, costs are rapidly coming down. Solar photovoltaic ability to be placed on rooftops behind the meter will allow solar generation to compete more on the higher-priced retail side of the market. Technologies like solar, tidal, and wave energy must continue to develop and mature to compete with the current costs of onshore wind.

4.17 US Wind Industry Forecast

In general, the forecast is based on an analysis of the practical conditions for wind energy in individual countries and the proven dynamics in specific markets. The most important issues are:

- National energy plans and government support for renewable energy.
- National commitments to binding international targets, so far only achieved in Europe.
- Growth of the market in recent years and the present dynamics of the industry.
- Assessment of wind resources available in the market and how they can be utilized.
- Technological development in terms of commercially available wind turbines.
- Assessment of previous patterns of development in similar markets, and the likelihood of their replication.
- Information about large projects in the planning and preparation phase.
- Increased engagement of utilities and large energy companies.

The US wind energy market has witnessed explosive growth since 2005, growing from a total installed base of 8.5 GW to over 35 GW at the end of 2009. A combination of state renewable portfolio standard (RPS) policies, federal incentives, and surging natural gas and power prices fuelled much of the record-breaking growth over this period. However, as the nation slipped into a recession, the trajectory of industry growth has been thrown off course. The financial crisis is largely responsible
for the challenging market environment in which a decline in power demand, lower power prices nationwide, and reduced commodity and natural gas prices have resulted in great uncertainty. Despite near-term market irregularity, future growth prospects remain strong.

There are forecasts the US to add over 165 GW of new capacity through 2025, resulting in a total installed capacity of approximately 200 GW. The global growth of the industry and the proliferation of favorable state and federal policies have put the United States on a trajectory to greatly increase wind installations over the next 15 years. EER’s base-case scenario is anchored by core assumptions about the future dynamics of the US power generation and policy environment.

<table>
<thead>
<tr>
<th>Renewable Policy</th>
<th>2010-2020</th>
<th>2020-2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Federal RPS established by 2013; states with existing higher state mandates are unable to achieve these lofty ambitions, including California, Ohio, and within ISO-NE.</td>
<td></td>
<td>State RPS goals extended through 2025, with more modest increases.</td>
</tr>
<tr>
<td>Some major private transmission initiatives are driven by FTFM State policies (ie. CREZs) and private developer strategies, action largely at regional level.</td>
<td></td>
<td>renewable and federal agencies take on major role in moving transmission planning, permitting, and cost allocation.</td>
</tr>
</tbody>
</table>

| Carbon Policy and Energy Pricing | | |
|----------------------------------|-----------|

| Technology and Supply | | |
|-----------------------|-----------|
| No wind supply chain bottlenecks as manufacturing lines ramp to meet local supply through 2025. | | Chinese players have minimal impact. |
| Asian players role in the sub-component supply chain remain largely unchanged. | | | |
| Lingering installation constraints for offshore wind, becoming less of an issue over time. | | Re-powering takes place in markets with wind installations through 2025. |

Table 4.5 Forecast considerations

**Economic, Political, and Power Market Dynamics Impact Growth:**

The United States has enormous potential for large amounts of onshore wind additions, but it must navigate a challenging near-term environment and continue pursuing public policy that encourages and enables growth throughout the country. In preparing its forecasts, there are several immediate and longer-term economic, political, and power industry factors influencing wind development.

**US Easing Out of Recession in 2010, Market Poised to Improve:**

The prerecession market environment of early 2008, where high power and natural gas prices created a fertile market for wind industry growth, attracted widespread development activity and supply chain investment. At the onset of the crisis, many
developers had projects in advanced stages of development, often already having a power purchase agreement (PPA), a turbine supply agreement, and necessary permits for construction. Difficulties closing financial terms delayed as many as 4 GW of late-stage wind projects originally meant for 2008 activation, and these projects spilled over into 2009.

As the economy moves toward recovery, the wind industry will see the delayed effects of the recession on 2010 build levels. This will be the first time since 2005 that the industry did not surpass the previous year’s growth level. The depressed power prices and decline in turbine prices have made many utilities reluctant to sign power purchase agreements (PPA), opting instead to wait for power and turbine prices to fully bottom out. Utility hesitation to ink PPAs resulted in 35% to 40% of total 2009 build completed without a PPA. As 2010 progresses, an uptick in demand could stimulate utilities’ willingness to sign PPAs for future projects, and development will follow as developers seek to get projects under construction by the end of the year to qualify for the US Treasury grant. The attractiveness of the Treasury grant is likely to spur an uptick in installations in 2011 and into 2012.

![Figure 4.16 US Wind Power Growth Scenario 2010-2025](image)

**Transmission Bottlenecks Cause Drop in Mid-Term Build Levels:**

As wind growth accelerates, it pushes the limits of the US transmission infrastructure. The growth of wind has resulted in numerous transmission proposals designed to link
resource-rich areas with coastal load centers. Following a possible boom year of 2011, transmission constraints will be the primary factor hindering year-over-year growth through 2016. The impact of transmission constraints is most pronounced in 2012–2015, directly limiting wind’s annual additions. The few transmission proposals and developments under construction, including the competitive renewable energy zone (CREZ) lines in Texas and the Tehachapi transmission project in California, will facilitate continued build at levels between 8.5 GW and 9.5 GW between 2012 and 2016.

Transmission development is a notoriously lengthy and difficult process, where national priorities concerning necessary infrastructure development must be balanced against local concerns over economic and environmental impacts. For example, highlighting the long timeframe necessary for transmission projects to reach fruition, the Texas CREZ lines scheduled to be finished in 2013 were initiated in 2005. Comparatively, wind projects can be built in as little as two to three years; major large-scale transmission initiatives, however, can take up to a decade to permit and construct.

Coordinated national policies will be necessary to most efficiently link the US’ vast wind resources to high-demand regions; however, even with enabling policies, there will be a lag of several years for proposals to become operational projects. The completion of some of the major proposed private, state, and regional initiatives currently under development will facilitate growth beginning in 2016–2017. Increasingly coordinated national transmission policies post-2020 will further unlock new areas in the upper Midwest, Great Plains, Rocky Mountain States, and Texas to help the US sustain its year-over-year growth through the end of the forecast period.

**Additional Market Factors Influencing Base-Case Forecasts:**

The pace of the economic recovery and transmission construction are two of the most central issues impacting wind development over the near and long term, but these are not the only factors influencing market growth. EER's forecasts also analyze the impact of the overall US power generation mix, state and federal policy, siting and permitting, developer competition, and supply chain development in determining future build levels.
**Power generation mix:**

Conventional coal and nuclear are the base of the US power generation mix, but emission and fuel waste concerns, cost considerations, and permitting difficulties throughout the forecast period will complicate the build of new conventional sources of generation. Wind is anticipated to primarily compete with natural gas for utility off take rather than with existing base-load power sources.

**State and federal policy:**

EER’s base-case scenario anticipates a federal RPS being established by 2013. However, federal RPS legislation is not likely to be as stringent as some existing states, including California, Colorado, and New England states. As noted above, EER does not anticipate federal greenhouse gas (GHG) legislation and doubts that Environmental Protection Agency (EPA) regulation will have a significant impact on the pricing of conventional power. Regional carbon policies in the Northeast and West through the Regional Greenhouse Gas Initiative (RGGI) and the Western Climate Initiative (WCI) will put some upward pressure on prices, but the absence of a national policy will make existing coal the cheapest power source. The production tax credit or some other form of federal support mechanism for wind will be extended beyond the current 2012 deadline, but will be gradually phased out by 2018.

**Siting and permitting:**

Siting and permitting will still largely be controlled at the local level with the continued adoption of local wind turbine ordinances being the preeminent criteria for siting. Incremental progress is achieved in streamlining permitting in historically difficult states, such as the Northeast and California, for both onshore and offshore development. Along these lines, queue reforms at the regional transmission organization (RTO) level in the Midwest, Southwest Power Pool, and California will likely shorten the interconnection process and help wind projects move forward more quickly.

**Developer competition:**

With PPAs and transmission access scarce in the near term, competition among developers will intensify. In the meantime, developers are also building up project pipelines in areas with greater wind resources that are currently inaccessible in advance of future transmission developments. EER anticipates the larger, well-
capitalized owners and developers will continue to dominate the market, as it becomes increasingly difficult for small new developers to carve out a place in the market without taking on more costly transmission risk.

**Supply chain:**

Increased investment in the domestic US supply chain and the growth of the industry worldwide will alleviate local supply chain bottlenecks through 2025. Companies from the Asia Pacific region will continue to be major players on the subcomponent level, but will have little impact on the original equipment manufacturer (OEM) turbine market until 2019 or 2020. At this time, Chinese players will help reduce the cost of wind turbine products by offering quality, lower-cost solutions; however, OEMs currently in the market will still be able to differentiate themselves through sourcing aboard and will lead in offering innovative products and service options.

**4.18 US Wind Industry Vision**

Wind power can play a major role in meeting America’s increasing demand for electricity, according to a ground-breaking technical report, 20% Wind Energy by 2030: Increasing Wind Energy’s Contribution to U.S. Electricity Supply, prepared by the U.S. Department of Energy with contributions from the National Renewable Energy Laboratory, the American Wind Energy Association, Black & Veatch and others from the energy sector.

Wind power is capable of becoming a major contributor to America’s electricity supply over the next three decades, according to a report by the U.S. Department of Energy. The ground-breaking report, 20% Wind Energy by 2030: Increasing Wind Energy’s Contribution to U.S. Electricity Supply, looks closely at one scenario for reaching 20% wind energy by 2030 and contrasts it to a scenario of no new U.S. wind power capacity.

The report explores one scenario for reaching 20% wind electricity by 2030 and contrasts it to a scenario in which no new U.S. wind power capacity is installed. It examines costs, major impacts and challenges associated with the 20% Wind Scenario. It investigates requirements and outcomes in the areas of technology, manufacturing, transmission and integration, markets, environment and siting. The report finds that the Nation possesses affordable wind energy resources far in excess of those needed to enable a 20% scenario.
**The 20% Wind Scenario:** To implement the 20% Wind Scenario, new wind power installations would increase to more than 16,000 MW per year by 2018, and continue at that rate through 2030, as shown in Figure A. Wind plant costs and performance are projected to improve modestly over the next two decades, but no technological breakthroughs are needed. In the 20% wind scenario, 46 states would experience significant wind power development.

**Economic Impacts of Wind Power:** The report finds that, during the decade preceding 2030, the U.S. wind industry could:

- support roughly 500,000 jobs in the U.S., with an annual average of more than 150,000 workers directly employed by the wind industry;
- support more than 100,000 jobs in associated industries (e.g., accountants, lawyers, steel workers, and electrical manufacturing);
- support more than 200,000 jobs through economic expansion based on local spending;
- increase annual property tax revenues to more than $1.5 billion by 2030; and
- increase annual payments to rural landowners to more than $600 million in 2030.

**Challenges:** Major challenges along the 20% Wind Scenario path include these:

- Investment in the nation’s transmission system is needed so that the electricity generated is delivered to urban centres that need the increased supply;
- Developing larger electric load balancing areas, in tandem with better regional planning, are needed so that regions can depend on a diversity of generation sources, including wind power;
- Significant growth is needed in the manufacturing supply chain, providing jobs and remedy the current shortage in parts for wind turbines;
- Continued reduction in wind capital cost and improvement in turbine performance through technology advancement and improved manufacturing capabilities is needed;
- Addressing potential concerns about local siting, wildlife, and environmental issues within the context of generating electricity is needed.
The 20% Wind Scenario is not likely to be realized in a business-as-usual future. Achieving this scenario would involve a major national commitment to clean, domestic energy sources with minimal emissions of GHGs and other environmental pollutants.

Political support for wind power and other renewables is growing for a multitude of reasons. The key drivers include climate change, the Kyoto Protocol, the industry’s job creation potential and a desire for greater "security of supply" for energy. Over the past four years energy issues have been at the top of the international agenda. This trend continued in 2011 as the economic crisis lessened and the debate over nuclear power intensified following the Fukushima disaster in Japan. The climate change issue was pushed to the forefront at the beginning of 2007, when the IPCC (Intergovernmental Panel on Climate Change) issued its final “synthesis report” on the latest scientific evidence.

The wind industry was born in the US in the 1980s, and after many years with inconsistent policy initiatives, it returned as a strong force in the energy market in 2001. Following a “stop-go” period it took over world leadership by implementing more than 5,000 MW in 2007 and continued its expansion by adding 9,922 MW in 2009. In February 2009 President Barack Obama signed a $787 billion stimulus package which included a three year extension of the crucial Production Tax Credit, now in effect until the end of 2012. Substantial funds for improvements in the grid infrastructure were also agreed, along with a clear vision of creating millions of new jobs in the renewable energy sector. The documented improvements in wind power’s technical effectiveness and the efforts of a well-organized industry lobby have also both helped to push the technology forwards, as has the desire of politicians to please an increasingly environmentally conscious electorate. Wind power has become accepted as a mainstream technology by utilities all over the world.

The future looks bright for the wind power industry because it is exploiting an inexhaustible resource and could be facing an insatiable demand. Demand will be just that in the not too distant future if the industry continues to reduce costs. Economics are crucial if wind energy is to be the preferred means of cutting carbon emissions, with larger wind turbines and improved knowledge of siting, servicing and maintenance being the main driving forces. It is clear, however, that an analysis of costs should not just take into account the cost of the wind turbines themselves and their efficiency. Costs must be looked at in a system context, where the owners (utilities) look at their total economy in relation to the choice of generation mix. In
2008, the high level of oil prices continued, even increasing to a new peak of US$ 147 per barrel in July, followed by a sharp decline to US$ 50 by the end of the year. At the start of 2012, the oil price was US$100. The usually conservative IEA’s World Energy Outlook now estimates that the price of oil will increase to US$ 200 per barrel by 2020.

Following model is employed by US governments to support wind power, and the use of these very much influences our forecast for wind energy development in the different markets. These models are:

2. Renewable Portfolio Standards (RPS), which lay down a rising percentage of renewables supply, as used in the USA, the EU and China.
3. Bidding processes, as used in the USA (Request for Proposals), Ireland and UK
4. Price premium/energy taxes and other tax related benefits.
5. Green certificate markets, where production of renewable electricity is rewarded by the issuing of certificates. These are then sold in a market where power companies and consumers buy them to fulfill their obligation to cover a defined part of their consumption from renewable electricity.

The PTC (Production Tax Credit), however, has also shown itself to be an effective instrument for establishing a wind energy market in the United States. A popular more recent model is the green certificate system, coupled with an “RPS-type” obligation on the consumer side of the market. The wind industry in the United States has continued to benefit from the Production Tax Credit (PTC), which is set to expire at the end of 2012.

The Investment Tax Credit and its alternative 30% cash grant for new construction will also expire at the end of 2012. These expiries resulted in a surge of construction in 2011, as companies sought to capitalize on the ITC, and a further boom is expected in 2012 as companies take advantage of the PTC before it is set to expire.

The United States performed slightly below expectations in 2011 and installed 6.8 GW of capacity, bringing its cumulative total to over 40 GW. Installations are expected to surge again in 2012, for the reasons noted above, but will drop again in 2013 as increasing uncertainty limits market growth. Despite this the United States is anticipated to remain a global leader in wind, with over 46 GW expected over the five year forecast period, resulting in 87 GW of cumulative capacity.
There are many significant factors which may impact the wind energy market in the US, including increasing transmission concerns, improved production of natural gas and a corresponding decline in prices and a changing political climate.

The greatest uncertainty comes from the political situation, as the conservative Republican Party currently holds control of the US Congress, while the Democratic Party controls the Presidency and a narrow majority in the Senate.

Thirty three US states have independently passed renewable portfolio standards and these targets are increasingly driving wind energy implementation in the absence of a federal renewables target. The policies range from the ambitious, such as California’s goal of 33% renewable energy by 2020, to more modest targets, such as Virginia’s goal of 12% voluntary compliance by 2022. Further potential policy drivers include a federal renewable energy standard or a cap and trade law for carbon emissions, but despite lobbying by the American Wind Energy Association these ideas have little immediate political support. Industries and some individual states are also legally challenging the interpretation by the Environmental Protection Agency of the Clean Air Act, which is currently being used to regulate greenhouse gases. An overturning of the EPA’s current policy on emissions could cause regulatory confusion and undercut the move towards renewables. The cost of upgrading transmission capacity and the grid remains a significant financial hurdle to adopting wind energy more widely. Despite these setbacks, more than 8 GW of capacity was under construction at the end of 2011, setting the stage for a bumper year. The last time construction reached this level was at the end of 2008, leading to the record year of 2009. In this year’s forecast, demand for wind capacity is anticipated to increase from 6,810 MW in 2011 to 8,250 MW in 2012. The ongoing forecast shows growth moving up to 12 GW per annum by 2016. While significant growth in the US market is expected, most states are behind their mid- and long-term goals. The forecast also shows a downturn in installed capacity for 2013, following the boom-bust cycle that occurred in 2000, 2002, and 2004, when the PTC was not immediately renewed.

Despite this the United States is expected to remain the second largest wind market in the world and a major player in manufacturing.