Wind Energy – Status, Trends & Opportunities

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Clixoo
Anugraha, 41, NH Road
Chennai 600034, TN, India
Ph: +91-44-32561191
narsi@clixoo.com

Objective

The objective of this report is to provide insights and data on the status and emerging opportunities in the wind energy industry

Target Audience

This report is primarily meant for entrepreneurs, investors or stakeholders in wind energy opportunities.

Key Take-aways

(1) An understanding of the current status and growth of the wind industry, and of its various market and products segments
(2) Current trends in investment and entrepreneurial activities in the industry, and
(3) New and emerging opportunities.

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Apex bodies related to wind energy industry for:
USA
Canada
Japan
China
Germany
UK
France
India

Introduction to the Wind Energy Industry

Wind is air in motion. Winds are caused by the uneven heating of the earth's surface by the sun. The earth's surface is made of different types of land and water. These different types absorb the sun's heat at different rates giving rise to the differences in temperature and subsequently to winds.

During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds. At night, the winds are reversed because the air cools more rapidly over land than over water.

In the same way, the large atmospheric winds that circle the earth are created because the land near the earth's equator is heated more by the sun than the land near the North and South Poles.

One can hence say that wind energy is derived from solar energy.

Wind energy is hardly new; it has been used in some form or another for centuries. However, large-scale, commercial utilization of wind as an energy source is relatively recent.

While the current contribution of wind energy to total energy consumption is small, there are specific regions around the world that are moving much faster on this. Consider the following:

The wind energy industry can be broadly classified as follows:

- Wind Power Plants
    - Wind Turbine Generators
        - Vertical Axis
        - Horizontal Axis
    - Wind Farms
        - Onshore
        - Nearshore
        - Offshore
        - Airborne

Offshore wind farms

Offshore wind development zones are generally considered to be ten kilometers or more from land. Offshore wind turbines are less obtrusive than turbines on land, as their apparent size and noise is mitigated by distance. Because water has less surface roughness than land (especially deeper water), the average wind speed is usually considerably higher over open water. Capacity factors (utilization rates) are considerably higher than for onshore and near shore locations.

Onshore

Onshore turbine installations in hilly or mountainous regions tend to be on ridgelines generally three kilometers or more inland from the nearest shoreline. This is done to exploit the so-called topographic acceleration as the wind accelerates over a ridge. The additional wind speeds gained in this way make a significant difference to the amount of energy that is produced. Great attention must be paid to the exact positions of the turbines (a process known as micro-siting) because a difference of 30 m can sometimes mean a doubling in output.

Nearshore

Nearshore turbine installations are on land within three kilometers of a shoreline or on water within ten kilometers of land. These areas are good sites for turbine installation, because of wind produced by convection due to differential heating of land and sea each day. Wind speeds in these zones share the characteristics of both onshore and offshore wind, depending on the prevailing wind direction.

Airborne

Airborne wind turbine is a design concept for a wind turbine that is supported in the air without a tower. A tether would be used to transmit energy to the ground, either mechanically or through electrical conductors. These systems would have the advantage of tapping an almost constant wind and doing so without a set of slip rings or yaw mechanism, without the expense of tower construction.

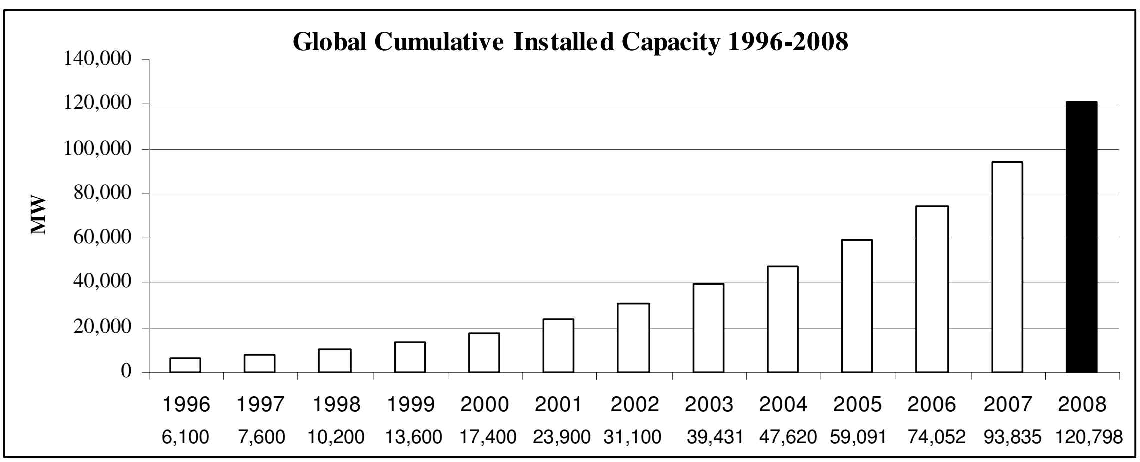
1. The Wind Energy Market

This chapter provides data for the current and future trends in wind energy worldwide, its contribution to total energy consumption and growth rates in various market and product segments. This chapter will provide insights to entrepreneurs on the segments that have the most attractive potential – now and in future.

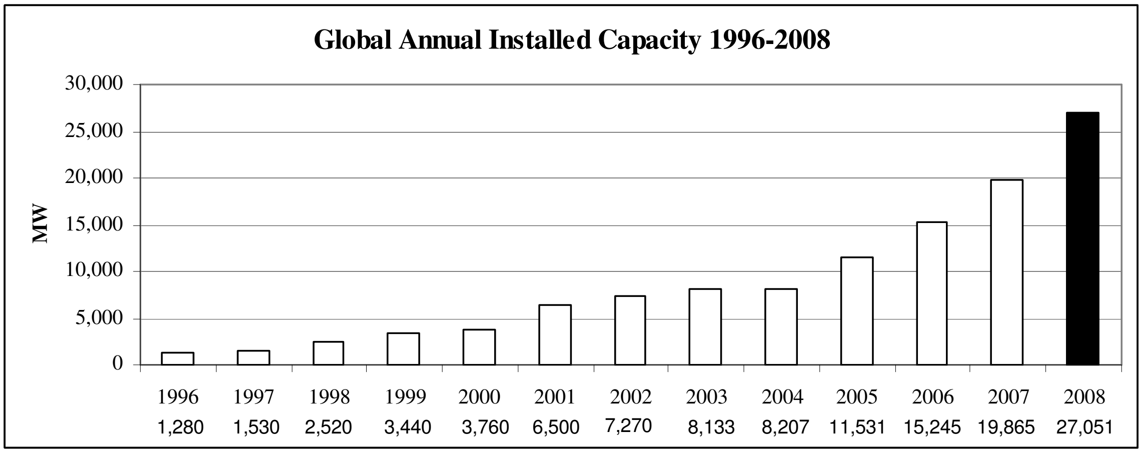
This chapter comprises the following sections

1.1 Wind Energy: Current Market

1.1.1 Global Installed Capacity of Wind Power (Current)



Source: Global Wind Energy Council Report, 2008



Source: Global Wind Energy Council Report, 2008

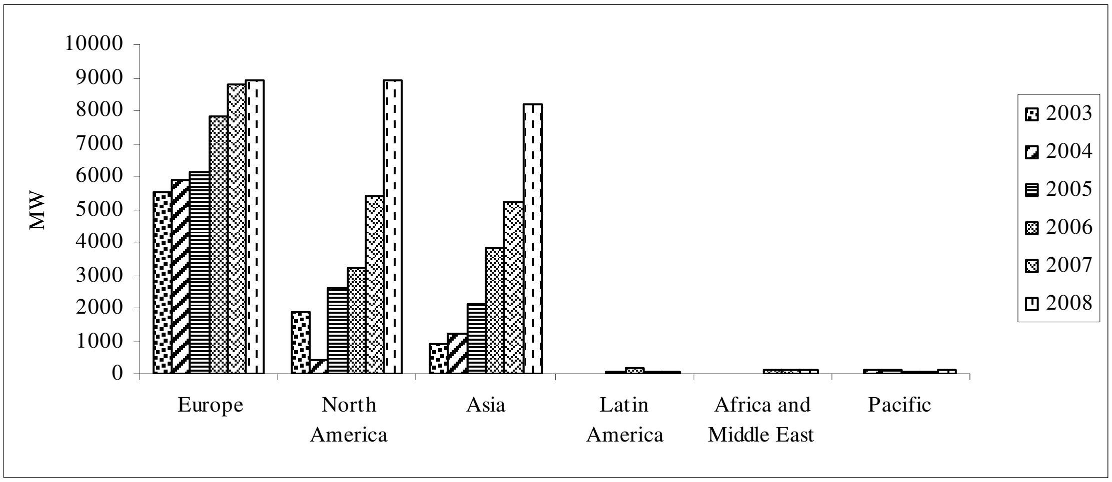
1.1.2 Regional Wind Energy Scenario:

Global Installed Wind power Capacity(MW) - Regional Distribution				
		Revised End 2007	**New 2008**	**Total End 2008**
Africa and Middle East	Egypt	310	55	365
	Morocco	124	10	134
	Iran	67	17	85
	Tunisia	20	34	54
	Other[1]	17	14	31
	Total	539	130	669
Asia	China	5910	6300	12210
	India	7845	1800	9645
	Japan	1538	346	1880
	Taiwan	281	81	358
	South Korea	193	43	236
	Phillipines	25	8	33
	Other[2]	5	1	6
	Total	15795	8579	24368
Europe	Germany	22247	1665	23903
	Spain	15145	1609	16754
	Italy	2726	1010	3736
	France	2454	950	3404
	UK	2406	836	3241

	Denmark	3125	77	3180
	Portugal	2150	712	2862
	Netherlands	1747	500	2225
	Sweden	788	236	1021
	Ireland	795	208	1002
	Austria	982	14	995
	Greece	871	114	985
	Poland	276	196	472
	Norway	326	102	428
	Turkey	147	286	433
	Rest of Europe[3]	955	362	1305
	Total Europe	57139	8877	65946
	Of which EU - 27[4]	56531	8484	64948
Latin America & Caribbean	Brazil	247	94	341
	Mexico	87	0	87
	Costa Rica	70	0	70
	Caribbean	55	0	55
	Argentina	29	2	31
	Others[5]	45	0	45
	Total	533	95	629
North America	USA	16824	8358	25170
	Canada	1846	526	2372
	Total	18670	8884	27542
Pacific Region	Australia	824	482	1306
	New Zealand	322	4	326
	Pacific islands	12	0	12
	Total	1158	486	1644
	World total	93835	27051	120798

Source: Global Wind Energy Council Report, 2007
1 South Africa, Cape Verde,Israel, Lebanon, Nigeria, Jordan;
2 Thailand, Bangladesh, Indonesia, Sri Lanka;
3 Belgium,Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Faroe Islands, Finland, Hungary, Latvia, Lithuania, Luxembourg, Romania, Russia, Slovakia, Switzerland, Ukraine;
4 Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, UK;
5 Colombia, Chile, Cuba;
Please note: project decommissioning of 89 MW androunding affect the final sums

Annual Installed Capacity by Region 2003-2008



1.1.3 Wind Energy Installed Capacity in Top Ten Countries

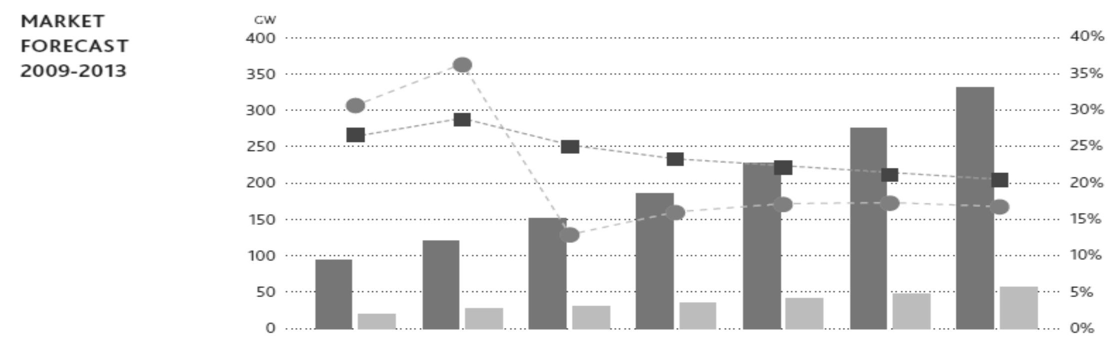
Top 10 Total and New Installed Capacities

Country	MW	Top 10 Total Installed Capacity %	Country	MW	Top 10 New Capacity %
USA	25,170	20.8	US	8,358	30.9
Germany	23,903	19.8	China	6,300	23.3
Spain	16,754	13.9	India	1,800	6.7
China	12,210	10.1	Germany	1,665	6.2
India	9,645	8	Spain	1,609	5.9
Italy	3,736	3.1	Italy	1,010	3.7
France	3,404	2.8	France	950	3.5
UK	3,241	2.7	UK	836	3.1
Denmark	3,180	2.6	Portugal	712	2.6
Portugal	2,862	2.4	Canada	526	1.9
Rest of the World	16,693	13.8	Rest of the World	3,285	12.2
Total top 10	104,104	86.2	**Total top 10**	23,766	87.8
Total	120,798	100	Total	27,051	100

Source: Global Wind Energy Council, Global Wind Report 2008

1.2 Wind Energy: Future Potential

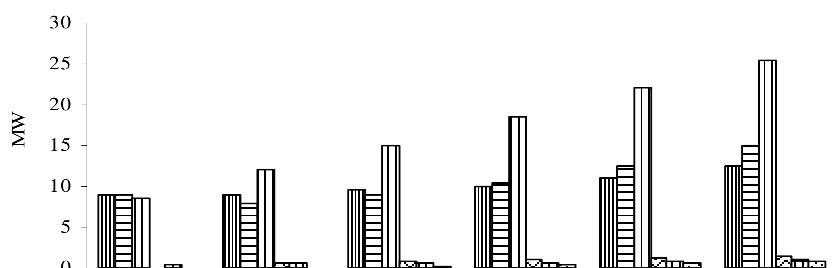
Market Forecast: 2009-2013



	2007	2008	2009	2010	2011	2012	2013
Annual installed capacity (GW)	19.9	27.1	30.4	35.2	41.2	48.2	56.3
Cumulative installed capacity (GW)	93.8	120.8	151.2	186.4	227.6	275.8	332.1
Annual install capacity growth rate	30.7%	36.2%	12.5%	15.7%	17.0%	17.0%	16.8%
Cumulative capacity growth rate	26.7%	28.7%	25.2%	23.3%	22.1%	21.2%	20.4%

Source: Global Wind Energy Council Report, 2007

Annual Market Forecast by Region 2008 - 2013



	2008	2009	2010	2011	2012	2013
Europe	8.9	9	9.5	10	11	12.5
North America	8.9	8	9	10.5	12.5	15
Asia	8.6	12	15	18.5	22	25.5
Latin America	0.1	0.7	0.8	1	1.2	1.4
Pacific	0.5	0.6	0.6	0.7	0.8	1
Middle East and Africa	0.1	0.1	0.3	0.5	0.7	0.9

Source: Global Wind Energy Council Report, 2007

1.3 Wind Market Predictions

Global Wind Energy Council (GWEC) is predicting the global wind market to grow by over 155% from its current size to reach 240 GW of total installed capacity by the year 2012. This would represent an addition of 146 GW in 5 years, equaling an investment of over 180bn EUR (277 bn US$, both in 2007 value). The electricity produced by wind energy will reach over 500 TWh in 2012 (up from 200 TWh in 2007), accounting for around 3% of global electricity production (up from just over 1% in 2007). The main areas of growth during this period will be North America and Asia, and more specifically the US and People's Republic of China (GWEC – GLOBAL WIND 2007 REPORT)

1.4 Key Observations & Analysis of the Wind Energy Market

- Global wind energy installed capacity is around 27,000 MW in 2008 and it has brought worldwide installed capacity to 120,798 MW.

- The US and China are leading in new installed capacity in 2008 alone with 8,358 and 6,300 MW respectively.

- The US passed Germany to become the number one market in wind power, and China's total capacity doubled for the fourth year in a row. In 2008 the US is the number one market both in terms of new capacity and in terms of total wind generation capacity.

- With 36% growth rate in the annual market there is huge and growing global demand for emissions-free wind power, which can be installed quickly, virtually everywhere in the world.

- GWEC predicts that in 2013, five years from now, global wind generating capacity will stand at 332 GW, up from120 GW at the end of 2008. During 2013, 56.3 GW of new capacity will be added to the global total, more than double the annual market in 2008.

- The annual growth rates during this period will average 22.4% in terms of total installed capacity, and 15.8% for the annual market. These rates are modest compared to past developments: in the last ten years, it has seen an average increase of 28.2% for total capacity and 28.3% for annual capacity

- Asia's annual market is expected to triple in the next five years, reaching 25.5 GW by 2013

2. Wind Energy Opportunities

The summary section of the first chapter provided insights on some of the key trends in the wind energy industry. These trends will offer ideas to entrepreneurs on the most attractive segments in this industry now, and for the future.

This chapter provides more details on opportunities, in the following sections

2.1 A Framework for Wind Energy Opportunities

A wide range of entrepreneurs and businesses can benefit from the opportunities unfolding in the wind energy industry.

We classify the wind energy opportunities along the following dimensions:

Dimension 1: Investment Required
Dimension 2: Type of Industry

Investment Requirements

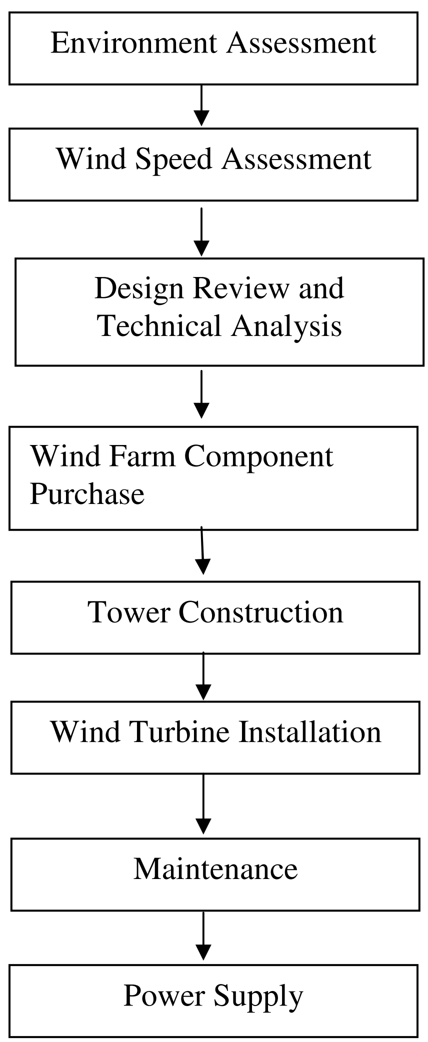
Scale of Investment	Type of Opportunity
Low	• Manufacturing & supply of key components • Training people for the wind energy industry • Consulting & engineering
Medium	• Setting up medium scale wind turbine manufacturing plants • Setting up manufacturing plants for components and accessories for the wind turbine industry • Wind Resource Assessment Providers and Equipment Suppliers
High	• Setting up large-scale wind turbine manufacturing plants • Setting up large wind power plants • Turbine Manufacturers • Wind Farm Construction Companies

Type of Industry

Industry Type	Type of Opportunity
Manufacturing	• Manufacturing turbines • Manufacturing of raw materials, components and accessories for wind energy industry
Trading	• Trading of turbine blades, and a range of wind energy components
Services	• Installation and maintenance of wind turbines • Training people for the wind energy industry

The reader can get more insights into the value addition points of the industry from the Wind Energy industry Value Chain provided below.

Wind Energy Industry Value Chain



2.2 Key Players in the Wind Industry

Key players with a role to play in community wind development include: wind turbine manufacturers, dealers, and distributors; wind project developers; consultants and contractors; electric utilities, advocacy groups; and rural landowners and communities.

Wind Turbine Manufacturers: Large wind turbines are either sold directly by the manufacturer or by the manufacturer's regional dealers and distributors.

Wind Developers: Wind developers buy or lease windy land, finance the installation of wind turbines and operate and maintain the turbines for an extended period. After a project is constructed, the wind developer's role varies. The developer may own and operate the wind farm, or merely operate the project for a different owner.

Private Consultants and Contractors: Private consultants and contractors serve the needs of any party in wind turbine transactions willing to pay their fees. They provide specialized skills or knowledge not generally available. A consulting meteorologist can independently evaluate the wind resources at a site. Engineering consultants can offer technical comparisons among competing wind turbines or provide "due diligence" reports to banks considering loans for proposed wind projects. Contractors are often needed for the construction phase of wind projects for tasks such as pouring concrete and erecting the turbines.

Note: *The American Wind Energy Association (AWEA)'s membership directory can be a good resource for finding consultants.)*

Electric Utilities: The cooperation of electric utilities is required to interconnect any wind turbine with the power grid. Selling electricity to a utility involves negotiations between the non-utility generator (NUG), such as a farmer, and the electric utility. These negotiations generally result in a contract binding both parties to an agreement for a fixed amount of time. Electric utilities also represent the main market for wind-generated electricity, whether they are interested in wind power for their own purposes or are under political, regulatory, or legal pressure or obligation to invest in wind energy.

Advocacy Groups: Clean energy advocates work to educate the public about the benefits of renewable energy and influence public policy to favor clean energy technologies like wind. The fact that wind energy projects often mean large investments in rural communities has captured the attention of groups interested in rural economic development, such as local elected officials, farm groups, and other rural advocacy organizations.

Rural Residents and Landowners: As the suppliers of windy land, rural landowners can have substantial influence over how wind energy develops. As the industry has grown, windy landowners and their communities are gaining an understanding of the tremendous value of their wind resource and are finding ways to keep more of the benefits in the local community. These methods range from farmers negotiating better land leases with developers to local and community investments in wind projects

2.3 Wind Farm Components

Data logger
Tower
Anemometers
Wind direction vanes
Blades
Carbon fiber and fiberglass
Drivetrains
Gearboxes
Generators
High-power T&D
Large gearboxes
Large steel casting & alternatives
Magnetic Materials
Pitch Systems
Rotors

2.3.1 Material Usage Trends through 2010

The following observations are based on the results of the material usage analysis:

Turbine material usage is and will continue to be dominated by steel, but opportunities exist for introducing aluminum or other light weight composites, provided strength and fatigue requirements can be met.

Small turbine production volume is increasing rapidly which can be accommodated by manufacturing mechanization and innovation that will lower costs.

Elimination of the gearbox by using variable speed generators will increase through use of permanent magnetic generators on larger turbines increasing the need for magnetic materials.

New high power electronics will help reduce the need for gearboxes and also decrease losses occurred during transmission of wind power to distant load centers.

Simplification of the nacelle machinery may not only reduce costs, but also increase reliability.

Blades are primarily made of GRP, which is expected to continue. While use of CFRP may help to reduce weight and cost some, low cost and reliability are the primary drivers.

Increasing the use of offshore applications may partially offset this trend in favor of the use of composites.

2.4 New Developments in the Wind Energy Industry

A number of technological and product innovations are taking place in the wind energy industry. Some of the recent and emerging trends in wind energy are provided below:

Floating Wind Turbine StatoilHydro has planned to startup is autumn 2009 and build the full scale floating wind turbine, Hywind, and test it over a two-year period offshore Karmoy. The company is investing approximately 400 million NOK. The project combines known technology in an innovative way. A 2.3 MW wind turbine is attached to the top of a so-called Spar-buoy, a solution familiar from production platforms and offshore loading buoys.

The rotor blades on the floating wind turbine will have a diameter of 80 meters, and the nacelle will tower some 65 meters above the sea surface. The floatation element will have a draft of some 100 meters below the sea surface, and will be moored to the seabed using three anchor points. The wind turbine can be located in waters with depths ranging from 120 to 700 meters.

Full-Permanent Magnetic Levitation (Maglev) Wind Power Generator In 2006, Chinese developers unveiled the full-permanent magnetic levitation (Maglev) wind power generator. The Maglev generator is expected to boost wind energy generating capacity by as much as 20 percent over traditional wind turbines. This would effectively cut the operational expenses of wind farms by up to half, keeping the overall cost of wind power under 0.4 yuan ($US 5 cents), according to Guokun Li, the chief scientific developer of the new technology.

The Kite Wind Generator (KiteGen) Massimo Ippolito of Sequoia Automation S.p.a. has developed a simple and elegant concept that promises abundant energy at rock bottom costs: the kite wind generator (KiteGen). This technology is hoped to overcome the height problem to get rid of the tower altogether and use aerodynamic lift to position the wind collecting unit high in the sky. In other words, to use kites

Floating Turbine In December, the Dutch floating-turbine developer Blue H Technologies launched a test platform off Italy's southern coast; the company announced its plans to install an additional test turbine off the coast of Massachusetts, and possibly begin constructing a full wind farm off the Italian coast, next year. Close behind is SWAY, based in Bergen, Norway, which raised $29 million last fall and plans to field a prototype of its floating wind turbine in 2010.

Floating turbines can be assembled onshore and towed into position, making an end run around the offshore construction bottleneck. The platform that Blue H towed out of Brindisi Harbor in Puglia, Italy, this winter is called a tension-leg platform, a conventional offshore oil and gas platform design that floats below the surface, held rigidly in place by chains running to steel or concrete anchors on the seabed. Installed on top is an 80-kilowatt wind turbine fitted out with sensors to record the wave and wind forces experienced 10 kilometers offshore. Much bigger floating versions--2.5-megawatt and 3.5-megawatt turbines of the scale used in today's offshore wind farms--are under construction by Blue H and could be installed as soon as this fall.

Rooftop Turbine a Breakthrough in Wind Power A rooftop wind-turbine the size of a domestic satellite dish is being hailed a breakthrough in the acrimonious debate over the future of wind power. Designed and built in Scotland, the miniature turbines have been fitted to the first roofs in a pilot project which could provide a personal electricity supply for every home on which they are perched.

For the first time, electrical power from renewable sources could be directly installed to individual properties for £1,500 and produce enough energy to run most off-peak appliances in the home and up to a third of all power needs the rest of the time.

Each unit could pay for itself in three to four years. And with a 20-year guarantee from the manufacturers, each turbine could provide householders with up to 16 years of free electricity.

AeroCam The AeroCam, developed by BroadStar Wind Systems, was designed and patented for commercial applications. With its parallel rotor blades, not only does it look radically different from conventional propeller designs, but also can be manufactured, transported, installed and maintained at lower cost.

By harnessing its power in almost any setting, the AeroCam can now generate energy close to where it's actually required. This is a new and exciting product with great potential.

Following four years of research and development and the issuance of U.S. patents, the company is currently in the final stages of negotiations to place the product with two Fortune 100 companies. (2008)

Aerotecture AeroCity LLC on Oct 15, 2008 has introduced Hudson Valley business and government leaders to its urban rooftop "Aerotecture" wind turbine, an engineering installation to be followed by the manufacture of demonstration units in Kingston, NY, early next year. The Aerotecture turbine, with unusual DNA-like helical blades, will deliver energy directly to the buildings on which it is mounted rather than to utilities via transmission lines. This means that the turbine need only compete with the retail price of power (currently over 20 cents per kilowatt hour in New York City) rather than with the wholesale price (closer to five cents); and it can offer the building owner assurance against price increases for the life of the turbine. Multiple turbines will contribute to meeting a building's total power needs.

The Aerogenerator: 9MW Vertical Axis Turbine. The 144-metre high V-shaped structure would be mounted offshore and capable of generating up to 9 megawatts of electricity, roughly three times as much power as a conventional turbine of equivalent size. Unlike conventional turbines this turbine doesn't need to be shut down when wind speeds exceed 64mph, the structure can withstand speeds of up to 110mph. But it will be at least 2013 before we see Aerogenerators as powerful as 9MW.

Hydrokinetic Turbine: The nation's first commercial hydrokinetic turbine, which harnesses the power from moving water without the construction of a dam, has splashed into the waters of the Mississippi River near Hastings, Minnesota.

The 35-kilowatt turbine is positioned downstream from an existing hydroelectric-plant dam. Hydrokinetic turbines like those produced by Hydro Green Energy and Verdant capture the mechanical energy of the water's flow and turn it into energy, without need for a dam. (Dec 2008)

2.5 Other opportunities

- Wind power provides a very lucrative opportunity in the area of rural electrification. Rural pockets typically have low energy requirements and the demand is highly predictable. Being financially feasible at a lower scale, wind turbines coupled with a low cost storage solution could be a practical and cost effective solution. It requires a relatively smaller outlay and even after accounting for transmission and distribution costs, it could provide good returns on investment.
- The trend in the wind power industry is that of consolidation with companies integrating across the supply chain – from manufacturing of components to consultancy, site preparation, installation and maintenance. As site selection is a crucial factor for financial viability of such projects, there is high demand for such sites.
- Wind power projects use much smaller fractions of land (for the foundation purposes). The remaining land can still be used for its original purposes like agriculture, cattle grazing etc. With weather reports and other related data available from some public and proprietary sources, it is possible for individuals to acquire rights to such sites in advance and then sell them or enjoy site rentals when wind turbines are installed there.
- In some countries, it is also possible to connect wind power projects to utility grids and this power can later be tapped by the end user at a different location (in India this facility is called 'electricity banking'). The utility company deducts a pre-determined amount towards transmission and distribution costs. Such a scheme helps companies subsidize their energy costs.
- Small scale wind power could be tapped by local entrepreneurs to charge deep cycle batteries and supply them to local residents in areas with frequent power outages or during emergencies.

A single wind turbine can provide $2,000-$4,000/year or more in farm income even though only 2-5% of the land within wind farm boundary is used for turbines and access roads. Wind plants can be valuable source of property tax income for local governments (especially rural counties). Wind energy helps diversify income for farmers, ranchers, and other landowners.Each megawatt of wind provides 2.5-3 job-years of employment. Wind provides ~1 skilled O&M (operations/maintenance) job for every 10 turbines installed

Technology is steadily improving (rotor blade airfoils specially designed for wind turbines, variable-speed generators, power electronics, sophisticated computer modeling of design changes)

3. Wind Energy Problems

This chapter comprises the following sections
3.1 Problems for Producers
3.2 Problems for Consumers

3.1 Problems for Producers

- Installing wind turbine requires large open spaces and clean and undisturbed wind with high average wind speed.
- The main difficulty to be faced whenever it is desired to exploit the energy of the wind to produce electrical power arises from the extreme variability of the wind, which is poorly adapted to satisfy a power demand which follows quite different trends. Various accumulation systems have been suggested and tested with fair results, but they are subject to conditions which are often very restrictive and expensive, both from the point of view of their construction and their practical use.
- Economically, the initial cost for wind turbines is greater than that of conventional fossil fuel generators
- Furthermore, wind resources might not be available near cities and, even so, the space might be used for other purposes that can generate larger profits.
- Wind cannot be stored (unless batteries are used)
- Not all winds can be harnessed to meet the timing of electricity demands
- An ‘idling’ back-up energy system needed, usually fossil fuelled

3.2 Problems for Consumers

- From an environmental point of view, there is noise produced by the rotor blades, aesthetic (visual) impacts, there is interference on television signals.
- There are birds flying into the rotors.
- Wind turbines standing in a big field or coastline do damage the view presented by nature.
- In addition, wind does not blow consistently 24 hours a day and that could cause a problem when the demand for electricity peaks.
- It is intermittent and it does not always blow when electricity is needed.

4. Wind Energy Projects & Companies

This chapter comprises the following sections

4.1 Wind Energy Projects

Wind CDM Projects		
Country	**Projects**	**MW**
India	270	5,072
PR China	314	16,977
Mexico	12	1,272
Brazil	11	687
South Korea	11	317
Cyprus	4	207
Dominican Republic	3	173
Egypt	3	285
Phillippines	2	73
Morocco	2	70
Costa Rica	2	69
Nicaragua	2	60
Panama	1	81
Mangolia	1	50
Jamaica	1	21
Colombia	1	20
Israle	1	12
Argentina	1	11
Chile	3	73
Vietnam	1	30
Ecuador	1	2
Total	**647**	**25,560**

Source: UNDP Risoe Center CDM pipeline, 2008

4.1.1 Largest Wind Projects Operating In the U.S. (MW)

Wind farm	Size (MW)	Project owner
Horse Hollow, TX	736	FPL Energy
Sweetwater, TX	585	Babcock & Brown, Catamount
Peetz Table, CO	401	FPL Energy
Capricorn Ridge, TX	364	FPL Energy
Buffalo Gap, TX	353	AES

Note: *Horse Hollow, completed in 2006, remains the largest single wind farm in operation in the U.S. for the second year. All of the top five wind farms are located in the Southwest, where large projects continue to be built.*

4.1.2 Proposed Wind Power Projects in USA

Titan Wind Project (5050 MW): The Titan Wind Project is a proposed 5,050 MW wind power project, formerly known as Rolling Thunder, based in South Dakota. The project is expected to be constructed in several phases and, when completed, will be one of the world's largest wind farms. The project is being developed by Clipper Windpower and BP Alternative Energy and scheduled to be completed in 2014

Tehachapi Renewal Project (4,500 MW): Southern California Edison has started construction of the Tehachapi Renewal Project, a desert wind farm that could provide power for 3 million homes by 2013. Officials estimate that the wind farm will eventually provide 4,500 megawatts of electricity, which would make it the largest wind project in the United States. The project will harness the wind blowing through the Tehachapi Mountains about 100 miles north of Los Angeles.

Pampa Wind Project (4,000 MW): Mesa Power, a company controlled by former Texas oilman, T. Boone Pickens, is planning to build the world's largest wind farm, called the Pampa Wind Project, as part of the Pickens Plan. The proposed 4,000 MW facility will be located near Pampa, Texas, which is on the Texas Panhandle, and will stretch to the east, spanning 400,000 acre in five counties. This will provide enough power for 1.5 million average homes. Mesa Power has placed an order for the first shipment of 667 wind turbines from General Electric— the world's largest wind turbine order for a single location— and this will provide 1,000 MW of wind power capacity for the $2 billion first phase of the project, which should be online by 2011.Lease payments for the land used by the turbines are expected to cost $65 million a year. The total cost of the project is estimated at $8-10 billion.

Hartland Wind Farm (500 MW): The Hartland Wind Farm, is a proposed wind farm which is expected to produce 500 megawatts (MW) of power, using 333 wind turbines, in North Dakota. A second 500 MW phase is also being considered with phase one scheduled for 2009 to 2010 and the second phase to follow, perhaps in 2011 to 2012. Denali Energy Inc. of Baxter, Minn. and Montgomery Energy Partners LP of Houston, Texas, has entered into a joint venture to develop Heartland Wind Farm, LLC. At 1,000 MW, this project has the potential to be one of the largest wind farm developments in the United States.

Stetson Wind Project (57 MW): A leading North American wind power company has made an investment of about $400 million. The $100m 38-turbine wind farm, to be built on Washington County's Stetson Mountain, is expected to generate - at maximum capacity - over 150m kWh of electricity annually, which is roughly equivalent to the amount of yearly electricity used by 27,500 households. The turbine towers will each stand about 262 ft tall and have 253 ft blade diameters; the project is being headed by UPC Wind, a company based in Newton, MA, and will directly supply New England's Power grid.

1.4.3 Proposed Wind Power Projects in EU

Markbygden Wind Farm (Up to 4000 MW): Markbygden Wind Farm will be a series of interconnected wind farms in the Markbygden area of northern Sweden, covering some 450 square kilometres. The project will be built between now and 2020, and will have a capacity of up to 4 GW. Enercon has a share in the project and will build a wind tower production plant in the region, as well as a local office for service and maintenance

Atlantic Array (offshore): The Atlantic Array is an offshore wind farm planned for the coast of North Devon, England. With its 1.5 gigawatt capacity, it is one of the world's largest proposed offshore wind farms. The completed wind farm could consist of 350 wind turbines, which the proposers say is enough to power more than 1,000,000 homes. The wind farm has been proposed by Farm Energy2 and, if built, could cost £3bn. The project will start in 2013 and take at least five years to complete.

The London Array (1000 MW) is a planned offshore wind farm in the outer Thames Estuary in the United Kingdom. Of 1 gigawatt capacity, it is expected to become the world's largest offshore wind farm providing around 10% of their target for 2010. The site is seven miles off the North Foreland on the Kent coast in the area of Long Sand and Kentish Knock, and will cover 90 square miles between Margate in Kent and Clacton in Essex.

The completed wind farm will consist of 341 wind turbines of around 3 MW to 7 MW rated capacity, which will provide an average power output of 350 MW at the smallest proposed turbine size. The higher rated turbines to be installed at the latter stages of construction and would provide considerably more power. This is enough to power a quarter of the homes in Greater London or the entire counties of Kent and East Sussex. The wind farm was planned to be built by London Array Limited, a consortium of Shell Wind Energy Ltd, E.ON UK Renewable and DONG Energy, at a cost of £2bn. The original cost was around £1bn.

Triton Knoll (1200 MW): The company npower renewable wants to build giant 1,200MW offshore wind farm in the Greater Wash, off the east coast of England.

Proposed to be constructed in 2010 and complete in 2012. Total cost of the project is [price in million EUROS]: 2084

Gywnty Mor (750 MW) : Another npower offshore scheme, about eight miles off the north coast of Wales, and further out than the existing North Hoyle offshore site. Government and Welsh national assembly officials are weighing up the plans, which would see some 200 turbines put in place to produce 750MW of energy. Construction is expected to start in 2010.

Whitelee (322 MW): Permission for Scottish Power's massive onshore wind farm at Whitelee, near Glasgow, was finally granted after the company agreed to erect a new radar tower for Glasgow airport. The 322MW facility, the largest of its type in Europe, will produce enough electricity to power 200,000 homes when it enters full operation in 2009.

1.4.4 Proposed Wind Power Projects in Australia

The Silverton Wind Farm (1,000MW) is a proposed wind farm to be built in far western New South Wales by renewable energy group Conergy. The wind farm would involve the installation of about 500 wind turbines north-west of Broken Hill. The large wind farm should have the capacity to generate electricity for 400,000 homes, and could be completed by the end of 2009. However, uncertainties with government energy policy may delay the project

Babcock & Brown, one of the world's largest owners and operators of wind energy projects of Australia currently has a total of five wind energy projects under construction in Texas and other states, including Majestic and the following four projects:

-- Gulf Winds Project in Kenedy County, Texas (283 MW)
-- South Trent Project in Nolan and Taylor counties, Texas (101 MW)
-- Wessington Springs Project in South Dakota (50 MW)
-- Butler Ridge Project in Wisconsin (54 MW)

Combined, these five wind projects have a 567.5 MW nameplate capacity and represent an investment of more than $1 billion. Upon completion of these five projects, Babcock & Brown will own, or manage on behalf of Babcock & Brown Wind Partners,25 operational wind farms in the U.S., representing more than 2,000 MW of clean, renewable energy -- or enough to power more than half a million American homes. Included among these is the 585 MW Sweetwater Wind Farms, one of the largest wind farms in the country, located in Sweetwater, Texas. In addition, Babcock & Brown has more than 25 wind energy projects in various stages of development around the country.

AGL Energy Limited (AGL) (95 MW) in March 2009 announced that it had entered into agreements for the construction of the 132MW Hallett 4 wind farm at North Brown Hill in South Australia. The Hallett 4 wind farm will consist of 63 x 2.1MW S88 V3 turbines to be purchased from Suzlon Energy Australia Pty Ltd (Suzlon). Hallett 4 is forecast to have a total development cost of approximately $341 million over 24 months of which approximately $140 million is forecast to be incurred over the remainder of FY2009.

1.4.5 Wind Power Projects in Canada (2007)

Ten wind energy projects were commissioned in 2007 in five different Canadian provinces.

- Alberta led all provinces in 2007, installing three new projects totaling 139 MW. Alberta is now Canada's leading jurisdiction for wind energy with 524 MW.

- The largest wind energy project commissioned in Canada in 2007 was the 100.5 MW Anse-a-Valleau projects in Quebec, the second project to be commissioned from Hydro-Quebec's earlier 1,000 MW request for proposals.

- Two new projects, totaling 77.6 MW were commissioned in Ontario. These two projects brought Ontario's total installed capacity to 491 MW.

- Three smaller projects, totaling 59 MW, were installed in Canada's smallest province, Prince Edward Island (P.E.I.). The installation of these facilities means that P.E.I. has now met its target to produce wind energy equivalent to 15% of its total electricity demand three years ahead of schedule.

- One new 10 MW project was commissioned in Nova Scotia. Turbines for these projects were provided by three manufacturers: Enercon (169 MW), Vestas (116.4 MW) and GE (100.5 MW).

4.2 Wind Industry Suppliers

4.2.1 Turbine Manufacturers

Manufacturers Percentage of 2008 Installations

Company	MW Capacity	No. of Turbines
GE Energy	3657	2438
Vestas	1120	569
Siemens	791.2	344
Suzlon	736.1	363
Gamesa	616	308
Clipper	595	238
Mitsubishi	516.4	515
Acciona WP	409.5	273
Repowe	102	51

Fuhrlander	5	2
DeWind	4	2
AWE	1.8	2
Other	3.9	

Source: http://www.awea.org/publications/reports/AWEA-Annual-Wind-Report-2009.pdf
Note: Includes Turbines Larger than 100 kW

GE Energy continues to dominate the market, with 43% of the newly installed capacity in 2008 and over 48% of the over 5,000 turbines installed in 2008. The turbine market is still fairly concentrated, with the top eight companies accounting for over 98% of the new capacity added. Vestas and Siemens retained the second and third place spots in terms of installed capacity.

New companies are entering the U.S. market each year, however. 2008 saw turbines installed in the U.S. by newcomers to the U.S. market Acciona, REpower, Fuhrlander, DeWind, and AWE.

4.2.2 Project Owners

Project owners represent companies that own the wind farm project for electricity generation.

The list of top 20 wind farm project owners in the US is given below for reference (2009 data)

Top 20 Wind Farm Project Owners in The US

Company	MW under "managing ownership"
NextEra Energy Resources	6290.1
lberdrola Renewables	2063.4
MidAmerican Energy	1939.5
Horizon-EDP Renewables	1872.7
Invenergy	1276.5
Babcock & Brown	1118.8
Edison Mission Group	959.9
AES	956.7
E.On Climate and Renewables	726.9

John Deere Wind	527.3
enXco	527
Shell Wind Energy	449
Puget Sound Energy	385.2
Terra-Gen Power	368.5
Duke Energy	321.5
AEP	310.5
Eurus	296.6
Noble Environmental Power	282
Orion Energy Group	280.5
Enel North america	249.3
Others	4167.1

4.2.3 Sub Providers

Sub-providers denote companies that supply components and accessories for the wind energy industry. A list of prominent sub-providers is given below:

- ABB Generators, converters and power solutions
- Bosch Rexroth Gearboxes, brakes, pitch control and yaw systems for wind turbines (Germany, USA)
- DMI Industries Towers for wind turbines (USA)
- DONGKUK S&C, the world's largest manufacturer of wind towers (Korea)
- Hansen Transmissions Int. Gearboxes for wind turbines (Belgium)
- LM Glasfiber Blades for wind turbines (Denmark)
- Marmen inc. Towers for wind turbines (Canada)
- Moventas Gearboxes for wind turbines (Finland)
- Polymarin Composites Blades for wind turbines (Netherlands)
- PSM, the world's largest manufacturer of tower flange (Korea)
- TAEWOONG Main shaft, Tower flange, Inner ring, Quter ring, Yaw bearing (Korea)
- Wind-Fix Fasteners for wind turbines and rotor blades (Netherlands)
- Winergy Gearboxes and generators for wind turbines (Germany)
- Gexpro Services Supply chain management company and supplier of fasteners, fabricated parts and electrical components for blades, nacelles and towers (USA, Europe, Asia)
- Sadad Machine co. Manufacturer of towers, foundations and chasis of yaw system, research & development on multi megawatt wind turbines. (Iran)

5. Wind Energy Financing and Investments

This chapter comprises the following sections

5.1 Investment Trends in Wind Energy
5.2 Venture Capital Companies in Renewable Energy including Wind Energy

5.1 Investment Trends in Wind Energy

Once again, global investment in sustainable energy broke all previous records, with $148.4 billion of new money raised in 2007, an increase of 60% over 2006. A total financial transaction in sustainable energy, including acquisition activity, was $204.9 billion. Asset finance – investment in new renewable energy capacity - was the main driver for this surge in investment, rising 68% to reach $84.5 billion in 2007, fuelled mainly by the wind sector. Wind continues to dominate sustainable energy investment

Wind continued to attract the most investment ($50.2 billion), mainly for new capacity build. Wind investment focused on the US, China and Spain, which together accounted for nearly 60% of new wind farms built worldwide in 2007. Wind dominated public market investment ($11.3 billion), although wind companies raised no money in the US in 2007.

In asset finance, the wind sector attracted $39 billion in 2007 adding another 21GW of capacity. Global installed wind capacity exceeded 100GW in March 2008. Wind investment focused on the US, China and Spain, which together accounted for nearly 60% of new wind farms built worldwide in 2007. Much of the investment was shaped by regulation – renewable portfolio standards in various US states, an imminent cut in feed-in tariffs in Spain and incentives to build wind farms even if turbines lie idle in China.

In M&A activity in 2007, wind attracted $11.5 billion of deals accounting for almost 65% of the total paid for power generation and equipment manufacturing companies across all sectors.

Recent Investments in Wind Energy

USA

- Venture capital and private equity investment in the wind energy sector hit a record $5.8 billion in the three months from April to June, up from $2.6 billion in the first quarter.

- GE, the largest supplier of wind turbines in the United States aid that it would invest a total of $100 million in three wind farms under construction in northern and western New York. The investment by GE Energy Financial Services brings the total commitment in renewable energy to more than $4 billion. GE Energy

Financial Services has or will invest in 76 wind farms worldwide with a total capacity of more than 4,000 megawatts. The company plans to spend $6 billion on renewable energy by 2010. (July 9, 2008)

- Several Texan transmission companies announced that they were forming a consortium to invest in the $5 billion cost of building new power lines to take advantage of the state's vast wind power. The consortium, comprised of existing transmission operators, includes Dallas-based Oncor, the state's largest power delivery company, Electric Transmission Texas (ETT) and units of American Electric Power Co. among others. Those new lines, dubbed by Oncor as a "renewable energy superhighway," will accommodate about 18,500 megawatts of wind generation by 2012-- enough energy to power 4 million homes. Texas currently leads the nation in wind capacity at about 5,500 MW. (July 2008)

- Airtricity, the leading renewable energy company, has made an initial investment in the U.S. of $270 million planned for the development of wind farms in Texas, New York and the Pacific Northwest and total investments in excess of $1.5 billion by 2010 in the North American market. Airtricity will use the initial investment to install turbines on a wind farm developed in conjunction with RGI, Inc. The wind farm, located in the Abilene area, will have an installed capacity of 125MW and will generate sufficient power to supply over 75,000 homes. (2005)

- Otter Tail Power Company, a division of Otter Tail Corporation (Nasdaq:OTTR), announced that it has entered into agreements to build and own 48 megawatts of wind energy generation at a wind energy facility planned in Barnes County, North Dakota. Otter Tail Power Company expects to invest more than $121 million on this project, which includes the cost of wind energy turbines, site construction, and required transmission construction. Once built, this project would increase the amount of wind-generated electricity owned or purchased by the company to 130 megawatts, enough to power more than 38,000 homes

Rest of the World

- One of the world's largest energy companies, Iberdrola, of Spain, proposed to build hundreds of wind turbines in New York, significantly raising the stakes in a nine-month battle with state regulators over its intended purchase of a power company. (2008)

- Tanti group of companies, the promoters of Suzlon Energy Ltd, jointly with Bahrain-based Arcapita Bank, has acquired Honiton Energy Holdings, a Chinese wind energy firm. The joint venture partners will invest $2 billion by 2012 to develop a 1,650-MW portfolio of wind farms in the Inner Mongolia region of China. (Jul 2008)

- Blackstone puts money in European wind farm: Buyout shop Blackstone Group LP on Tuesday unveiled an alliance with a German investment company to build a wind farm in the North Sea costing more than €1 billion. Germany, the world's top producer of wind power, followed by the U.S., saw regulation amended in June providing incentives for renewable energy. Furthermore, the project is part of Germany's objective to reduce greenhouse gas emissions by 40% by 2020. Last year, Germany and Europe's biggest utility E.ON AG paid out $1.4 billion to acquire the U.S. assets of Ireland's Airtricity Holdings Ltd. (July 2008)

- GE Energy Financial Services, based in Stamford, Connecticut USA, with European operations based in London, invests about $3 billion annually in the world's most capital-intensive industry, energy. With more than $10 billion in assets, GE Energy Financial Services offers structured equity, leveraged leasing, partnerships, project finance and broad-based commercial finance to the global energy industry from wellhead to wall socket. Energy Financial Services has developed a strong record investing in solar, biomass, hydro, wind and geothermal power, and is growing its portfolio of more than a half-billion dollars in renewable energy assets. (July 2008)

- China Wind Power Takes off: Wind-power plants are attracting growing investment in China, according to the United Nations Environment Programme (UNEP). Investment in the country's sustainable energy sector grew by 91 % last year to a record high of $10.8 billion, most of which has flowed to wind-power generating units, says UNEP's report Global Trends in Substantial Energy Investment 2008.

- Suzlon to buy Chinese wind energy firm for $500 mn: The acquisition will be concluded through Colossus Holdings, a Singapore-based holding company of the Tanti group, and Bahrain-based private equity company Arcapita Bank for over $500 million (Rs 2,162 crore),. The Tanti Group will own 26 per cent of the Chinese company and the rest will be funded by Arcapita. The partners will spend another $2 billion by 2012 to develop a 1,650 mega watt portfolio of wind farms in the Inner Mongolia region of China. (July 2008)

- Bahrain-headquartered investment firm Arcapita Bank has formed a joint venture partnership with Colossus Holdings, a Singapore-based holding company of Indian Tanti group, to acquire Honiton Energy Holdings, a developer and operator of wind power generation facilities in China. Arcapita and Colossus plan to have invested at least $2bn into Honiton by 2012 to develop a 1,650 MW portfolio of wind farms in the Inner Mongolia region. This is Arcapita's first investment in China. (September 2007)

- China focused investment fund, announces that it is investing £3.0 million for a 12% stake in Asia Wind Group Ltd ("Asia Wind" or "the Company"). Asia Wind is a Guernsey incorporated investment company which intends to build a significant portfolio of wind energy related businesses, capitalising on the rapidly expanding wind energy sector in Asia and availability of leading edge Western technologies.(2008)

- Following this investment London Asia Capital plc ("LAC") has agreed to transfer all of its wind projects and opportunities, built up over several years, to Asia Wind. Christoph Löslein, who to date has acted as a consultant to LAC's energy and environment interests and who is adirector of LAC subsidiary company Clean Technology plc, has become Chief Executive of Asia Wind. Simon Littlewood and Victor Ng, both Executive Directors of the Fund and of LAC, have joined the Board of Asia Wind as non-executive directors. Companies associated with them were involved in the initial founding and funding of Asia Wind and remain shareholders.

- Marubeni Corporation of Japan to invest $16.6 million in California Wind Developer Oak Creek Energy Systems Marubeni to provide funds to support leading California developer's wind energy projects. The transaction will occur through a$16.6 million equity investment in Oak Creek Holdings, Inc., a newly formed parent holding company. Oak Creek, a leading California renewable energy company in development, construction and operation of wind energy projects, will also enter into a Development Agreement which will give it the opportunity to be Marubeni's exclusive wind energy development partner for North America. (Dec 2007)

5.2 Venture Capital Companies in Renewable Energy including Wind Energy

- Advanced Equities Inc.
- BDC Venture Capital
- Chrysalix Energy Venture Capital
- CMEA Ventures
- Draper Fisher Jurvetson
- Israel Cleantech Ventures
- Khosla Ventures
- Kleiner Perkins Caufield & Byers
- Masdar Clean Tech Fund
- New Enterprise Associates
- Oceanshore Ventures
- Redpoint Ventures
- RockPort Capital Partners
- Scatec Adventure AS
- Virgin Green Fund
- Vulcan Capital
- Wexford Capital LLC

6. Wind Energy Apex Bodies

Apex bodies related to Wind energy industry are provided for the following countries:

USA
Canada
Japan
China
Germany
UK
France
India

Apex Bodies For Wind Energy in USA			
Name of the Apex Body	**Address**	**Telephone Number**	**Email ID, Website**
AWEA (American Wind Energy Association)	1101 14TH Street NW, 12th Floor, Washington, DC 20005,	Phone: (202) 383-500 Fax: (202) 383-2505	windmail@awea.org
Windustry	2105 1st Avenue South, Minneapolis MN 55404	Toll free: 800-946-3640 Phone: 612-870-3461 Fax: 612-813-5612	info@windustry.org
Wind Powering America			wpa@nrel.nrel.gov
Utility Wind Integration Group	Utility Wind Integration Group PO Box 2787 Reston, Virginia 20195 USA	Charlie Smith, Executive Director Phone: 703-860-5160 Fax703-860-1544	charlie@uwig.org
National Wind Coordinating Collaborative	c/o Resolve 1255 23rd Street NW, Suite 875 Washington, DC 20037	(888) 764-WIND (202) 965-6398 Fax: (202) 338-1264	aarnold@resolv.org

Apex Bodies For Wind Energy in Canada			
Name of the Apex Body	**Address**	**Telephone Number**	**Email ID, Website**
Canadian Wind Energy	Suite 810, 170 Laurier Avenue West Ottawa, Ontario Canada K1P 5V5	Phone: 613-234-8716 or 1-800-922-6932 Fax: 613-234-5642	info@canwea.ca

Apex Bodies For Wind Energy in Japan			
Name of the Apex Body	**Address**	**Telephone Number**	**Email ID, Website**
Japan Wind Energy Association	Kitanomaru Koen, Chiyoda-ku, Tokyo 102-0091, Japan 2-1		jwea@jsf.or.jp
Japanese Wind Power Association		Phone: + 81 3 5297 5578	Email: info(at)jwpa.jp Web: www.jwpa.jp

Apex Bodies For Wind Energy in China			
Name of the Apex Body	**Address**	**Telephone Number**	**Email ID, Website**
Chinese Wind Energy Association (CWEA)	Room301,Building 13, No.18,Bei San Huan Dong Lu Beijing (100013) China	Telephone: 86-10-64228218/19 Fax: 86-10-64228215	Email: cwea@cwea.org.cn Website: http://www.cwea.org.cn/
The Chinese Renewable Energy Industries Association (CREIA)	No.A2106 Wuhua Plaza, CheGongZhuang Street A4, XiCheng District, Beijing, 100044 China	Phone: +86 10 68002617-18 Fax: +86 10 68002674	E-mail: creia@creia.net

Apex Bodies For Wind Energy in Germany			
Name of the Apex Body	**Address**	**Telephone Number**	**Email ID, Website**
Federation of German Wind Power	Stresemannplatz 4 24103 Kiel	Phone. 0431 - 66 8 77 64	reeder@wind-fgw.de
World Wind Energy Association	Head Office Charles-de-Gaulle-Str. 5 53113 Bonn Germany	Phone: +49 228 369 40 80 Fax: +49 228 369 40 84	
German Wind Energy Association(BWE)	Hauptstadtbüro Marienstr. 19/20 10117 Berlin	Phone.: +49 (0)30 28 48 21 06 Fax: +49 (0)30 28 48 21 07	Mail: bwe-berlin[et]wind-energie.de

Apex Bodies For Wind Energy in UK			
Name of the Apex Body	**Address**	**Telephone Number**	**Email ID, Website**
British Wind Energy Association	Renewable Energy House 1 Aztec Row, Berners Road London, N1 0PW, UK	Phone: 020 7689 1960 Fax: 020 7689 1969	General email: info@bwea.com

Apex Bodies For Wind Energy in India			
Name of the Apex Body	**Address**	**Telephone Number**	**Email ID, Website**
Indian Wind Turbine Manufacturers Association	Suite# A2 OPG Towers, 74(Old No.133), Santhome High Road, Chennai 600 004.	Tel.(091)(44)24620227., Mobile: 9909916077	dvgiri@pioneerwincon.com secretaryy@indianwindpower.com
Indian Wind Energy Association	PHD House, 3rd Floor Opp. Asian Games Village August Kranti Marg, New Delhi 110016	Telefax: +91 11 26523042	manish@inwea.org

Apex Bodies For Wind Energy in Italy			
Name of the Apex Body	**Address**	**Telephone Number**	**Email ID, Website**
APER	APER ha sede in Piazza L. di Savoia 24, 20124 - Milano (MI) - Italia	Tel: +39 02 76319199 Fax: +39 02 76397608	http://www.aper.it
Italian Wind Energy Association ANEV	Via Piemonte, 39 - 00187 Roma	Tel +390642014701- Fax: +390642004838	segreteria@anev.org