INDIAN WIND ENERGY OUTLOOK 2009

SEPTEMBER 2009

Contents

Foreword

INDIA HAS LONG PLAYED AN IMPORTANT ROLE in the world's wind energy market. Already established in the 1990s, by 2005 it had developed into the world's fourth largest market, and the only sizeable market in Asia at that time.

In 2008, India was the country that brought online the third largest amount of wind energy, after the US and China, and it now ranks fifth in total installed capacity with 9,645 MW of wind power installed at the end of 2008.

A strong domestic manufacturing base has underpinned the growth of the Indian wind energy market. The Indian wind turbine manufacturer Suzlon is now a recognised player on the global market, and many international companies are established in India.

India has a great untapped potential for wind energy. According to official estimates, the country's total wind energy resource amounts to 48 GW of installed capacity, but some experts think that this figure is on the conservative side, and that technological improvements could significantly increase this potential.

The positive development of wind energy in India has mainly been driven by progressive state level legislation, including policy measures such as renewable portfolio standards and feed-in-tariffs. At the moment, there is no coherent national renewable energy policy to drive the development of wind energy. This is urgently needed to realise the country's full potential and reap the benefits for both the environment and the economy.

The Indian government is currently considering the introduction of a national renewable energy policy, so this report comes as a timely reminder of how important a role wind energy could play in securing India's energy security, curbing its CO_2 emissions, providing new employment and boosting economic development.

As can be seen by the Indian Wind Energy Outlook, the wind industry, both domestic and international, stands ready to do its part in achieving an energy revolution in India. With sufficient political will and the right policy frameworks, it could do even more.

DV GIRI

Chairman
Indian Wind Turbine Manufacturer Association

STEVE SAWYER

Secretary General
Global Wind Energy Council

1. THE STATUS OF WIND ENERGY IN INDIA

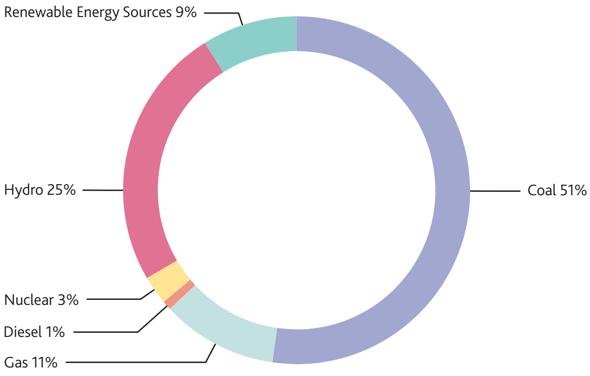
Indian power sector

India's rapidly growing economy and population leads to relentlessly increasing electricity demand. As a result, the country's installed power generation capacity has increased from just 1.4 GW in 1947 to over 150 GW in 2009.

The current generation mix in India is dominated by coal (78.5 GW), large hydropower (36.9 GW) and gas (16.4 GW). Renewable sources rank fourth with an installed capacity of around 13.2 GW.

Despite the massive capacity additions, the Indian government is struggling to keep up with growing demand. The IEA predicts that by 2020, 327 GW of power generation capacity will be needed, which would imply an addition of 16 GW per year. This urgent need is reflected in the target the Indian government has set in its 11th Five Year Plan (2007-2012), which envisages an addition of 78.7 GW in this period, 50.5 GW of which is coal[1].

ELECTRICITY GENERATION CAPACITY IN INDIA



Source: Ministry of Power, June 2009

Renewable Energy in India

In the early 1980s, the Indian government established the Ministry of Non-Conventional Energy Sources (MNES) to encourage diversification of the country's energy supply, and satisfy the increasing energy demand of a rapidly growing economy. In 2006, this ministry was renamed the Ministry of New and Renewable Energy (MNRE).

Renewable energy is growing rapidly in India. With an installed capacity of 13.2 GW, renewable energy sources (excluding large hydro) currently account for 9% of India's overall power generation capacity. By 2012, the Indian government is planning to add an extra 14 GW of renewable sources.

In its 10th Five Year Plan, the Indian government had set itself a target of adding 3.5 GW of renewable energy sources to the generation mix. In reality, however, nearly double that figure was achieved. In this period, more than 5.4 GW of wind energy was added to the generation mix, as well as 1.3 GW from other RE sources. The target set for the period from 2008-2012 was increased to 14 GW, 10.5 GW of which to be new wind generation capacity.

The Indian Ministry of New and Renewable Energy (MNRE) estimates that there is a potential of around 90,000 MW for power generation from different renewable energy sources in the country, including 48,561 MW of wind power, 14,294 MW of small hydro power and 26,367 MW of biomass. In addition, the potential for solar energy is estimated for most parts of the country at around 20 MW per square kilometer of open, shadow free area covered with solar collectors, which would add up to a minimum of 657 GW of installed capacity.

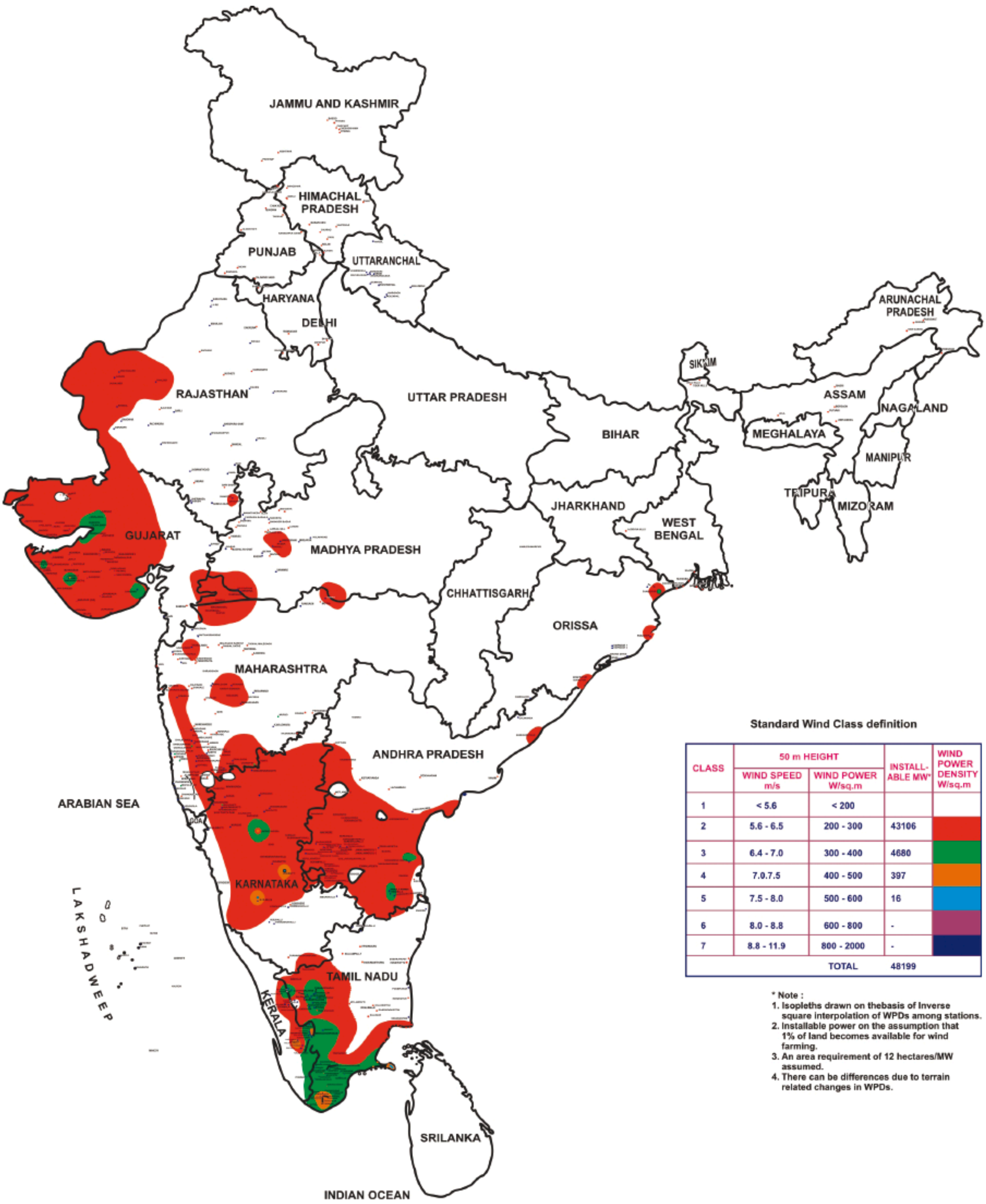
RENEWABLE ENERGY CAPACITY ADDITIONS DURING 10TH/11TH FIVE YEAR PLAN

Technology	Target 2003–2007(MW)	Actual 2003–2007(MW)	Target 2008–2012
Windpower	2,200	5,426	10,500
Small Hydro (< 25 MW)	550	537	1,400
Biomass Power / Cogeneration	725	759	1,700
Biomass Gasifier	37	26	–
Solar PV	2	1	–
Waste to Energy Programme	70	47	400
TOTAL	**3,584**	**6,795**	**14,000**

Source: MNRE

1 http://cea.nic.in/planning/Capacity%20addition%20target%20during%2011th%20plan%20set%20by%20Planning%20Commission%20(Revised)-summary%20region%20wise.pdf

WIND MAP OF INDIA



Standard Wind Class definition

CLASS	50 m HEIGHT		INSTALL-ABLE MW*	WIND POWER DENSITY W/sq.m
	WIND SPEED m/s	WIND POWER W/sq.m		
1	< 5.6	< 200		
2	5.6 - 6.5	200 - 300	43106	
3	6.4 - 7.0	300 - 400	4680	
4	7.0.7.5	400 - 500	397	
5	7.5 - 8.0	500 - 600	16	
6	8.0 - 8.8	600 - 800	-	
7	8.8 - 11.9	800 - 2000	-	
		TOTAL	48199	

* Note :

1. Isopleths drawn on thebasis of Inverse square interpolation of WPDs among stations.
2. Installable power on the assumption that 1% of land becomes available for wind farming.
3. An area requirement of 12 hectares/MW assumed.
4. There can be differences due to terrain related changes in WPDs.

Wind Power Density Map based on Data from 11 States & 2 UTS AT 50M AGL
Source: C-WET

Wind potential

The total potential for wind power in India was first estimated by the Centre for Wind Energy Technology (C-WET) at around 45 GW, and was recently increased to 48.5 GW. This figure was also adopted by the government as the official estimate.

The C-WET study was based on a comprehensive wind mapping exercise initiated by MNRE, which established a country-wide network of 1050 wind monitoring and wind mapping stations in 25 Indian States. This effort made it possible to assess the national wind potential and identify suitable areas for harnessing wind power for commercial use, and 216 suitable sites have been identified.

However, the wind measurements were carried out at lower hub heights and did not take into account technological innovation and improvements and repowering of old turbines to replace them with bigger ones. At heights of 55-65 meters, the Indian Wind Turbine Manufacturers Association (IWTMA) estimates that the potential for wind development in India is around 65-70 GW. The World Institute for Sustainable Energy, India (WISE) considers that with larger turbines, greater land availability and expanded resource exploration, the potential could be as big as 100 GW.

WIND ENERGY POTENTIAL IN INDIA ACCORDING TO C-WET

State	Potential (MW)
Andhra Pradesh	8,968
Gujarat	10,645
Karnataka	11,531
Kerala	1,171
Madhya Pradesh	1,019
Maharashtra	4,584
Orissa	255
Rajasthan	4,858
Tamil Nadu	5,530
TOTAL	**48,561**

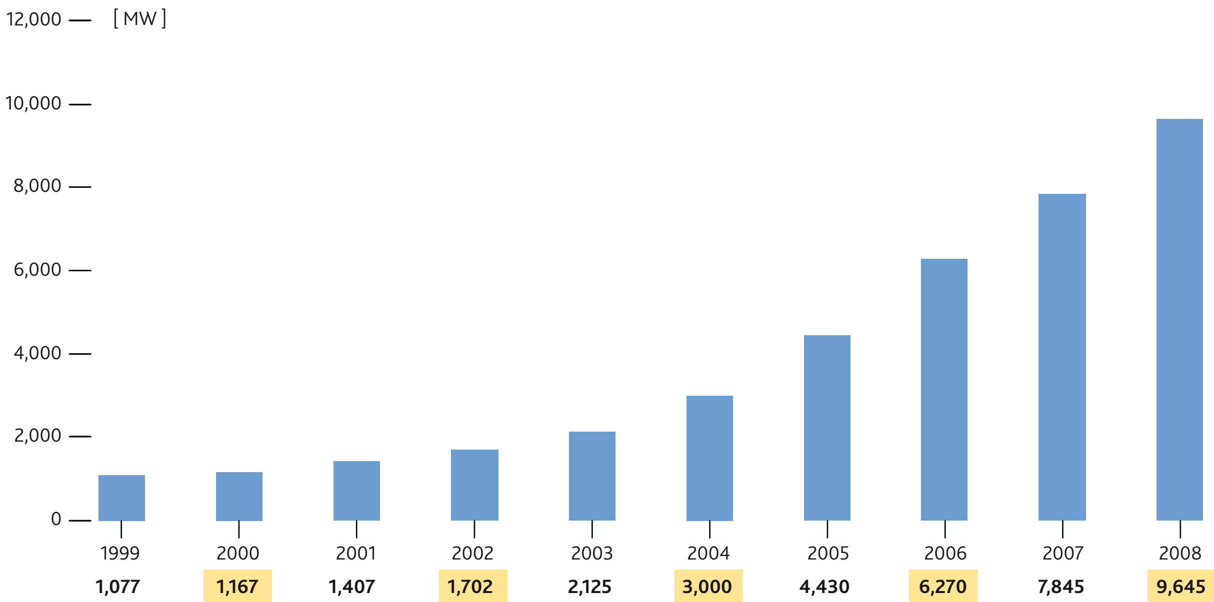
Steady market growth for wind

Wind energy is continuing to grow steadily in India. Wind power capacity of 4,889 MW was added in the last three years, taking the total installed capacity to 10.2 MW on 31 March 2009, up from 7.8 GW at the end of 2007.

Wind power in India has been concentrated in a few regions, especially the southern state of Tamil Nadu, which maintains its position as the state with the most wind power, with 4.1 GW installed at the end of 2008, representing 44% of India's total wind capacity.

This is beginning to change as other states, including Maharashtra, Gujarat, Rajasthan and Karnataka, West Bengal, Madhya Pradesh and Andhra Pradesh start to catch up, partly driven by new policy measures. As a result, wind farms can be seen under construction all across the country, from the coastal plains to the hilly hinterland and sandy deserts. The Indian government envisages the addition of 2 GW/annum in the next five years.

TEN YEAR GROWTH OF INDIAN WIND MARKET (CUMULATIVE CAPACITY IN MW) – 1999-2008



Source: IWTMA

INSTALLED CAPACITY BY REGION

State	Total Capacity as on 31st March 2009	Market Share as on 31st March 2009	Capacity as on 31st March 2008	Market Share as on 31st March 2008
Rajasthan	738,5	7,22%	538,9	6,16%
Gujarat	1565,61	15,31%	1253	14,33%
Madhya Pradeh	212,8	2,08%	187,7	2,15%
Maharashtra	1942,25	19,00%	1755,9	20,08%
Andhra Pradesh	122,5	1,20%	122,5	1,40%
Karnataka	1340,23	13,11%	1011,4	11,57%
Tamil Nadu	4301,63	42,08%	3873,5	44,30%
TOTAL	**10223,52**	**100,00%**	**8742,9**	**100,00%**

Note: The Indian financial year runs from 1 April – 31 March

CDM projects

India signed and ratified the Kyoto Protocol in August 2002, and the possibility to register projects under the Kyoto Protocol's Clean Development Mechanism (CDM) has provided a further incentive to wind energy development in India. The final approving authority for CDM projects is the Ministry of Environment and Forests, following a four stage process at national level.

As of 1 August 2009, 301 Indian wind projects were registered with the CDM Executive Board, accounting for 5,659 MW, second only to China.

TABLE 2: WIND CDM PROJECTS (AS OF 1 AUGUST 2009)

Country	Projects	MW
India	301	5,659
China	371	20,695
Mexico	12	1,272
Brazil	10	674
South Korea	12	339
Cyprus	4	207
Egypt	4	406
Chile	4	111
Morocco	3	92
Dominican Republic	2	165
Costa Rica	2	69
Nicaragua	2	60
Phillipines	1	33
Panama	1	81
Mongolia	1	50
Jamaica	1	21
Colombia	1	20
Israel	1	12
Argentina	1	11
Vietnam	1	30
Uruguay	1	50
Sri lanka	1	10
Cape Verde	1	28
Ecuador	1	2
Total	**739**	**30,095**

Source: http://www.cdmpipeline.org/cdm-projects-type.htm

The development of a domestic industry and foreign investment

India has a solid domestic manufacturing base, including global leader Suzlon, Vestas Wind Tech and RRB. In addition, international companies have set up production facilities in India, including Enercon, Vestas and GE and the new entrants like Gamesa, Siemens, ReGen Power Tech, LM Glasfiber, WinWinD, Kenersys and Global Wind Power. Overall, a dozen international companies now manufacture wind turbines in India, through either joint ventures under licensed production, as subsidiaries of foreign companies or as Indian companies with their own technology.

Over the past few years, both the government and the wind power industry have succeeded in injecting greater stability into the Indian market. This has encouraged larger private and public sector enterprises to invest in wind. It has also stimulated a stronger domestic manufacturing sector; some foreign companies now source more than 80% of the components for their turbines in India. The current annual production capacity of wind turbines manufactured in India is about 3,000-3,500 MW, including turbines for the domestic as well as for the export markets. However, the actual number of turbines produced is driven by market forces, and high interest rates often do not allow for the accumulation of inventory. Thanks to new market entrants, it is expected that the annual production capacity will rise to 5,000 MW per year by 2015.

Indigenously produced wind turbines and turbine blades have been exported to the USA, Europe, Australia, China and Brazil.

Indian company Suzlon, the world's fifth largest turbine manufacturer, provides over 50% of all turbines used in the domestic market. In addition, the company is now well established in the international wind market beyond India, operating in 20 countries around the world and supplying turbines to projects in Asia, North and South America and Europe. Components and turbines have also been exported by Vestas Wind Technologies, Enercon, RRB Energy, Southern Wind Farms and Shriram EPC. Almost all Indian manufacturers are now looking at the export market, where better prices can be achieved than in the domestic market.

2. THE POLICY ENVIRONMENT FOR WIND ENERGY IN INDIA

National policy measures for wind energy

India is heavily dependent on fossil fuels for its energy needs, mainly coal, of which it has significant reserves. However, to fuel a thriving economy and a targeted GDP growth rate of 7-8% per year, the country's electricity demand is projected to more than triple between 2005 and 2030. Already today, electricity shortages are common, and a significant part of the population has no access to electricity at all. To address this problem, the Indian government has envisaged a capacity addition of more than 70,000 MW by 2012. In addition, grid infrastructure problems are getting more pressing as installed capacity grows.

The Indian government's stated target is for renewable energy to contribute 10% of total power generation capacity and have a 4-5% renewables share in the electricity mix by 2012. This means that renewable energy would grow at a faster rate than traditional power generation, accounting for around 20% of the total added capacity planned in the 2008-2012 timeframe.

THE 2003 ELECTRICITY ACT

In spite of its stated target for renewable energy to contribute 4-5% of India's electricity mix by 2012, the country does not have a national renewable energy policy. Currently, the promotion of renewables only figures in one section of the 2003 Electricity Act (86(1)e). This act restructured the Indian electricity industry by unbundling the vertically integrated electricity supply utilities in the Indian states and establishing State Regulatory Commissions (SERCs) in charge of setting electricity tariffs. The act also opened access to the Indian transmission system, allowing consumers to purchase their electricity from any producer.

The Electricity Act also required the SERCs to set Renewable Portfolio Standards for electricity production in their state. Following this, the Ministry for New and Renewable Energy (MNRE) issued guidelines to all state governments to create an attractive environment for the export, purchase, wheeling and banking of electricity generated by wind power projects.

The support for wind power in India includes the following measures:

Fiscal and financial incentives:
- Concession on import duty on specified wind turbine parts
- 80% accelerated depreciation over one or two years
- 10 year income tax holiday for wind power generation projects
- Excise duty relief on certain components
- Some states have also announced special tariffs, ranging from Rs 3-4 per kWh, with a national average of around Rs 3.50 per kWh
- Wheeling, banking and third party sales, buy-back facility by states
- Guarantee market through a specified renewable portfolio standard in some states, as decided by the state electricity regulator by way of power purchase agreements
- Reduced wheeling charges as compared to conventional energy

Land policies:
- The Ministry of Environment and Forests has issued guidelines for diversion of forest lands for non-forest purposes, particularly to enable wind generation
- Clearance of leasing and forest land for up to a period of 30 years for wind developers

Financial assistance:
- Setting up of the Indian Renewable Energy Development Agency (IREDA), the premier finance agency of the Government of India to provide soft loans for renewable energy projects, particularly for demonstration and private sector projects

Wind resource assessment:
- The government set up the Centre for Wind Energy Technology (C-WET) to map wind energy potentials
- The C-WET has set up more than 1,000 wind monitoring and wind mapping centers across 25 states
- Wind mapping at 50 meters (C-WET) and 60-80 meters height (private companies)

NATIONAL FEED-IN-TARIFF

In June 2008, the MNRE announced a national generation-based incentive scheme for grid connected wind power projects under 49 MW, providing an incentive of 0.5 rupees per KWh (0.7 Euro cents) in addition to the existing state incentives. Investors which, because of their small size or lack of tax liability cannot draw any benefit from accelerated depreciation under the Income Tax Act can opt for this alternative incentive instead. However, this tariff is too low to have a significant impact on a project's viability.

A BRIEF COMPARISON OF WIND ENERGY POLICIES IN KEY STATES

States	Tariff rates per kWh	Annual tariff escalation	Wheeling or transmission charges	Capital incentives	Specified Renewable Portfolio Standards for wind
Tamil Nadu	Rs. 3.39	Nil (Fixed for 5 years)	5% of tariff paid	National policies	10% (2008-2009) 13% (2009-2010) 14% (2010-2011)
Gujarat	Rs. 3.37	Nil	4% of tariff paid	Has an exclusive policy in addition to the national policies	2% (2008-09)
Rajasthan	Rs. 4.28-4.50	Rs. 0.02 every year for 10 years	10% of tariff paid	National policies	5% (2008-09)
Karnataka	Rs.3.40	Nil	2% of tariff paid	National policies	2% (2008-09)
Madhya Pradesh	Rs. 4.03	Variable increase up to 20 years and then reduces	2% of tariff paid	National policies	5% (2008-09) and 6% from 2009-2011
West Bengal	Rs.4.00	Nil	Rs. 0.30 per kWh	National policies	8% (2008-09)
Kerala	Rs. 3.14	Fixed for 20 years	Nil	National policies	5% (2008-09)
Maharashtra	Rs. 3.50	Rs. 0.15 per annum for 15 years	7% of tariff paid	National Policies	6% for all RES (2008-09)
Andhra Pradesh	Rs. 3.50	Nil	5% of tariff paid	National Policies	5% (2008-09)
Harayana	Nil	n/a	Nil	National policies	3% (2008-2009)

State policies

RENEWABLE PORTFOLIO STANDARDS AND FINANCIAL INCENTIVES

In the absence of a national renewable energy policy, ten out of the 29 Indian States have now implemented quotas for a renewable energy share of up to 10% and have introduced preferential tariffs for electricity produced from renewable sources. In addition, several states have implemented fiscal and financial incentives for renewable energy generation, including; energy buy back (i.e. a guarantee from an electricity company that they will buy the renewable power produced); preferential grid connection and transportation charges and electricity tax exemptions.

FEED-IN-TARIFFS

Some states with Renewable Portfolio Standards (RPS) or other policies to promote wind generation, have introduced feed-in-tariffs for wind generation which are higher than that for conventional electricity.

The need for an improved national policy framework

India's tremendous wind energy resource has only been partially realised due to the lack of a coherent national renewable energy policy. Currently, the promotion of renewable energy in India is mainly driven by state governments, but inconsistent implementation and the lack of a national policy is hampering genuine progress. While some states have set high renewable portfolio standards, other states only have low or no targets, and enforcement is insufficient. Furthermore, while in theory, RPS and feed-in-tariffs can coexist, this needs to be well managed to avoid inefficiencies.

To boost investment in renewable energy, it is essential to introduce clear, stable and long-term support policies. A number of policy measures at national level, which could be applied concurrently, would significantly improve the framework for renewable energy in India. However, they must be carefully designed to ensure that they operate in harmony with existing state level mechanisms and do not lessen their effectiveness.

A number of policy measures outlined below are already in various stages of being drafted at national level, and some have been initiated by a number of states. It is recommended that these are treated with urgency and implemented at the national level wherever possible.

A NATIONAL RENEWABLE PORTFOLIO STANDARD

The National Action Plan on Climate Change released in 2008 included a proposal for a national renewable energy trading scheme, which would be based on a National Renewable Portfolio Standard. This proposal is currently undergoing approval and it is expected that a notification by the Central Electricity Regulatory Authority, which would be mandatory for all states, may be issued before the end of 2009.

This national RPS, which would be set by the Central Electricity Regulatory Authority, would complement or supplement existing portfolio standards at state level. Such a dynamic national standard will have a minimum stipulated purchase obligation of renewable energy from 2009-2010 and a 1% or 2% increase in the amount every year for the next 10-20 years. This can co-exist with already existing state renewable energy portfolio standards which can be over and above the minimum stipulated in the national standards and so similarly, the annual increment could also increase as per the state norms.

Ideally, a national RPS would be linked to a market based scheme for tradeable renewable energy certificates. In this scheme, states would be encouraged to promote the production of renewable power to exceed the national standard. They would then receive certificates for this surplus power, which would be tradable with other states which fail to meet their renewable standard obligations. Since only grid-connected electricity would be eligible for this scheme, this would particularly benefit the wind industry.

Such a renewable certificate scheme needs to be carefully designed. The targets should be set after considering existing plans for new electricity generation, and in harmony with existing targets at state level. In addition, the scheme must be enforceable through the introduction of a national verification mechanism to ensure that all states comply with the national portfolio standards and face penalties if they do not.

A NATIONAL FEED-IN-TARIFF

The introduction of a national feed in tariff would help to ensure uniform tariff incentives and provide strong investor confidence.

A feed-in-tariff would introduce a Generation Based Incentives (GBI) scheme for electricity from renewable energy. In the short run (up to a maximum period of 5 years), the investor would have an option to either choose the GBI or the existing accelerated depreciation benefits, which are currently in place for the wind sector. However, over a period of time, the accelerated benefits will give way for a progressive performance based generation incentives.

ADDITIONAL MEASURES

An updated wind resource map of India is urgently needed to assess the country's wind energy potential. This should be done on the basis of up to date information on land availability, mast height of modern turbines, technological innovations etc.

Administrative procedures for approving renewable energy projects need to be accelerated to avoid the waste of both time and money spent on getting clearances from a wide range of authorities.

Lastly, the accessibility of financing for renewable energy projects must be improved to ensure fair treatment in terms of interest rates and loan disbursements.

3. THE WIND ENERGY OUTLOOK SCENARIOS

THIS CHAPTER OUTLINES THREE different scenarios for the development of wind energy, both globally, and for India. The scenarios examine the future potential of wind power up to the year 2030, starting from a range of assumptions which will influence the wind energy industry's expected development.

These scenarios are based on a report entitled 'Global Wind Energy Outlook 2008', which was published as a collaboration between the Global Wind Energy Council (GWEC), Greenpeace International and the German Aerospace Centre (DLR). Projections on the future of wind energy development have contributed to a larger study of global sustainable energy pathways up to 2050 conducted by DLR for Greenpeace and the European Renewable Energy Council (EREC).

Scenarios

REFERENCE SCENARIO

Three different scenarios are outlined for the future growth of wind energy around the world. The most conservative **"Reference"** scenario is based on the projections in the 2007 World Energy Outlook from the International Energy Agency (IEA). This takes into account only existing policies and measures, but includes assumptions such as continuing electricity and gas market reform, the liberalisation of cross-border energy trade and recent policies aimed at combating pollution.

MODERATE SCENARIO

The **"Moderate"** scenario takes into account all policy measures to support renewable energy either already enacted or in the planning stages around the world. It also assumes that the targets set by many countries for either renewables or wind energy are successfully implemented. Moreover, it assumes increased investor confidence in the sector as a result of a successful outcome of the current round of climate change negotiations, which are set to culminate at UNFCCC COP-15 in Copenhagen, Denmark, in December 2009.

Up to 2012 the figures for installed capacity are closer to being forecasts than scenarios. This is because the data available from the wind energy industry shows the expected growth of worldwide markets over the next five years based on orders for wind turbines already committed. After 2012 the pattern of development is more difficult to anticipate.

ADVANCED SCENARIO

The most ambitious scenario, the **"Advanced"** version examines the extent to which this industry could grow in a best case 'wind energy vision'. The assumption here is that all policy options in favour of renewable energy, along the lines of the industry's recommendations, have been selected, and the political will is there to carry them out.

While again, the development after 2012 is more difficult to predict, this scenario is designed to show what the wind energy sector could achieve if it were given the political commitment and encouragement it deserves in light of the twin crises of energy security and global climate change. The rapid growth in the sector over the past decade most closely resembles this scenario.

Energy demand projections

These three scenarios for the global wind energy market are then set against two projections for the future growth of electricity demand, one "Reference Demand Projection" and one "Energy Efficiency Demand Projection".

REFERENCE DEMAND PROJECTION

The more conservative of the two global electricity demand projections is again based on data from the IEA's 2007 World Energy Outlook, including its assumptions on population and GDP growth. It takes account of policies and measures that were enacted or adopted by mid-2007, but does not include possible or likely future policy initiatives. It is assumed that there will be no changes in national policies on nuclear power.

The IEA's estimation is that in the absence of new government policies, the India's energy demand will rise from 537 Mtoe in 2005 to 1,299 Mtoe in 2030. Electricity demand rises from 478 TWh in 2005 to 2,700 TWh in 2030.

ENERGY EFFICIENCY DEMAND PROJECTION

The IEA's expectations on rising energy demand are then set against the outcome of a study on the potential effect of energy efficiency savings developed by DLR and the Ecofys consultancy. This study describes an ambitious development path for the exploitation of energy efficiency measures, based on current best practice technologies, emerging technologies that are currently under development and continuous innovation in the field of energy efficiency.

In reality, of course, constraints in terms of costs and other barriers, such as resistance to replacing existing equipment and capital stock before the end of its useful life, will prevent this 'technical' energy efficiency potential to be fully realised. In order to reflect these limitations, we have used the more moderate **Energy Efficiency Scenario** from the study, which is based on implementing 80% of the technical potential.

This scenario results in energy demand increasing by much less than under the Reference projection. Under the Energy Efficiency Demand Projection, energy demand would reach 2,395 TWh in 2030, which is 11% lower than under the Reference Scenario.

Regional breakdown

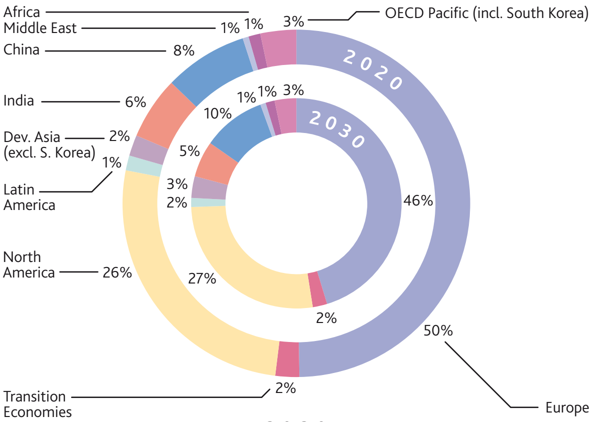
All three global scenarios for wind power are broken down by region of the world based on the regions used by the IEA, with a further differentiation in Europe. For the purposes of this analysis, the regions are defined as Europe (EU-27 and the rest of Europe), the Transition Economies (former Soviet Union states, apart from those now part of the EU), North America, Latin America, China, India, the Pacific (including Australia, South Korea and Japan), Developing Asia (the rest of Asia), the Middle East and Africa.

This breakdown of world regions has been used by the IEA in the ongoing series of World Energy Outlook publications. It was chosen here to facilitate a comparison with those projections and because the IEA provides the most comprehensive global energy statistics. A list of countries covered by each of the regions is shown on p. 26/27.

The level of wind power capacity expected to be installed in each region of the world by 2020 and 2030 is shown in the figures above. This shows that in the **Reference Scenario,** Europe would continue to dominate the world market.
By 2030 Europe would still host 46% of global wind power capacity, followed by North America with 27%. The next largest region would be China with 10%.

The two more ambitious scenarios envisage much stronger growth in regions outside Europe. Under the Moderate scenario, Europe's share will have fallen to 23% by 2030, with North America contributing a dominant 27 % and major installations in China (14%), India (10%) and Developing Asia (10%). Latin America (7%) and the Pacific region (5%) will

REGIONAL BREAK DOWN: REFERENCE SCENARIO [GW]



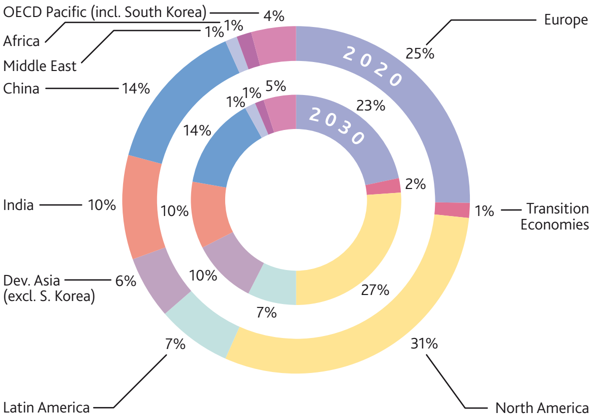
2020

Europe	176 GW
Transition Economies	7 GW
North America	92 GW
Latin America	5 GW
Dev. Asia (excl. S. Korea)	7 GW
India	20 GW
China	27 GW
Middle East	2 GW
Africa	4 GW
OECD Pacific (incl. South Korea)	12 GW

2030

EUROPE	227 GW
Transition Economies	11 GW
North America	132 GW
Latin America	8 GW
Dev. Asia (excl. S. Korea)	16 GW
India	27 GW
China	49 GW
Middle East	4 GW
Africa	7 GW
OECD Pacific (incl. South Korea)	16 GW

REGIONAL BREAK DOWN: MODERATE SCENARIO [GW]



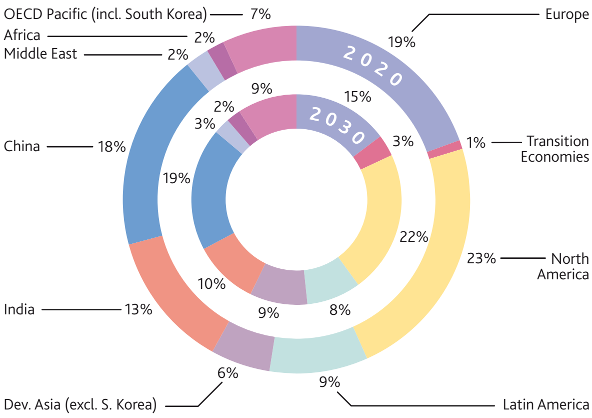
2020

Europe	182 GW
Transition Economies	9 GW
North America	214 GW
Latin America	50 GW
Dev. Asia (excl. S. Korea)	40 GW
India	63 GW
China	101 GW
Middle East	8 GW
Africa	10 GW
OECD Pacific (incl. South Korea)	30 GW

2030

EUROPE	306 GW
Transition Economies	34 GW
North America	366 GW
Latin America	103 GW
Dev. Asia (excl. S. Korea)	140 GW
India	142 GW
China	201 GW
Middle East	20 GW
Africa	21 GW
OECD Pacific (incl. South Korea)	70 GW

REGIONAL BREAK DOWN: ADVANCED SCENARIO [GW]



2020

Europe	213 GW
Transition Economies	10 GW
North America	243 GW
Latin America	100 GW
Dev. Asia (excl. S. Korea)	61 GW
India	134 GW
China	201 GW
Middle East	25 GW
Africa	17 GW
OECD Pacific (incl. South Korea)	75 GW

2030

EUROPE	353 GW
Transition Economies	75 GW
North America	520 GW
Latin America	201 GW
Dev. Asia (excl. S. Korea)	211 GW
India	241 GW
China	451 GW
Middle East	63 GW
Africa	52 GW
OECD Pacific (incl. South Korea)	215 GW

play a smaller role, and the contributions of Africa and the Middle East will be negligible (around 1% each).

The Advanced scenario predicts an even stronger growth for China, which would see its share of the world market increasing to 19% by 2030. The North American market would by then account for 22% of global wind power capacity, while Europe's share would have fallen to 15%, followed by India (10%), Developing Asia (9%), the Pacific region (9%) and Latin America (8%). Africa and the Middle East would again play only a minor role in the timeframe discussed (2% each).

In all three scenarios it is assumed that an increasing share of new capacity is accounted for by the replacement of old plant. This is based on a 20 year average lifetime for a wind turbine. Turbines replaced within the timescale of the scenarios are assumed to be of the same cumulative installed capacity as the original smaller models. The result is that an increasing proportion of the annual level of installed capacity will come from repowered turbines. These new machines will contribute to the overall level of investment, manufacturing output and employment. As replacement turbines their introduction will not however increase the total figure for global cumulative capacity.

Main Assumptions and Parameters for India

GROWTH RATES

Market growth rates in these scenarios are based on a mixture of historical figures and information obtained from analyses of the wind turbine market. Annual growth rates of 25% per annum, as envisaged in the Advanced version of the scenario, are high for an industry which manufactures heavy equipment. The wind industry has experienced much higher growth rates in recent years, however. In the last five years, the average annual increase in cumulative installed wind power capacity in India was more than 35%; for the nine year period from 2000-2008, it was over 28%.

It should also be borne in mind that while growth rates eventually decline to single figures across the range of scenarios, the level of wind power capacity envisaged in 20 years' time means that even small percentage growth rates will by then translate into large figures in terms of annually installed megawatts.

These scenarios assume that significant repowering (replacing of smaller old turbines by modern and more powerful machines) will take place in the period up to 2030. In addition, with a coastline of 7,000 km, it is expected that offshore installations will play an important role in that timeframe, thereby substantially increasing the overall wind energy potential.

TURBINE CAPACITY

Individual wind turbines have been steadily growing in terms of their nameplate capacity – the maximum electricity output they achieve when operating at full power. The average capacity of wind turbines installed in India in 2008 was 1MW, up from just 400 kW in 2000. Globally, the largest turbines now available for commercial use are up to 6 MW in capacity.

We make the conservative assumption that in India, the average size will gradually increase from today's figure to 1.5 MW in 2013, increasing to 2 MW by 2030. It is possible that this figure will turn out to be greater in practice, requiring fewer turbines to achieve the same installed capacity.

It is also assumed that each turbine will have an operational lifetime of 20 years, after which it will need to be replaced. This "repowering" or replacement of older turbines has been taken into account in the scenarios.

CAPACITY FACTOR

'Capacity factor' refers to the percentage of its nameplate capacity that a turbine installed in a particular location will deliver over the course of a year. This is primarily an assessment of the wind resource at a given site, but capacity factors are also affected by the efficiency of the turbine and its suitability for the particular location. For example, a 1 MW turbine operating at a 25% capacity factor will deliver 2,190 MWh of electricity in one year.

From an estimated average capacity factor in India today of 20.5%, the scenario assumes that improvements in both wind turbine technology and the siting of wind farms will result in a steady increase.

The scenario projects that the average capacity factor in India will increase to 23% by 2011, 25% by 2021 and then 27.5% from 2026.

CAPITAL COSTS

The capital cost of producing wind turbines has fallen steadily over the past 20 years as turbine design has been largely concentrated on the three-bladed upwind model with variable speed and pitch blade regulation, manufacturing techniques have been optimised, and mass production and automation have resulted in economies of scale.

While the years 2006 to 2008 have seen a marked increase in the price of new wind turbines globally, caused by rising raw material prices and shortages in the supply chain for turbine components, the ramifications of the financial crisis has reversed this upwards trend. As financing for new projects became harder to come by, previous supply chain difficulties were overcome. In addition, decreasing raw material prices also helped bring prices down. As a result, since late 2008, global turbine prices have dropped by 18% for turbines to be delivered in the first half of 2010[1)].

1 *New Energy Finance, Press release: Newly launched Wind Turbine Price Index shows an 18% decrease in contract prices for delivery in H1 2010 (29 July 2009)*

SUMMARY OF GLOBAL WIND ENERGY OUTLOOK SCENARIO FOR 2020

Global Scenario	Cumulative wind power capacity [MW]	Electricity output [TWh]	Percentage of world electricity [Energy Efficiency]	Annual installed capacity [MW]	Annual investment [€ bn]	Jobs [million]	Annual CO_2 savings [m tCO_2]
Reference	352,000	864	4.1%	24,000	32.14	0.54	518
Moderate	709,000	1,740	8.2%	82,000	89.39	1.30	1,044
Advanced	1,081,000	2,651	12.6%	143,000	149.35	2.21	1,591

SUMMARY OF WIND ENERGY OUTLOOK SCENARIO FOR 2020 – INDIA

Global Scenario	Cumulative wind power capacity [MW]	Electricity output [GWh]	Share of electricity demand	Annual installed capacity [MW]	Investment [mil Rs]	Jobs	Annual CO_2 savings [k tCO_2]
Reference	20,332	40,665	2.6-2.8%	610	30,498	15,317	40,025
Moderate	63,230	126,459	8.1-8.7%	8,247	412,367	136,539	124,470
Advanced	134,828	269,656	17.3-18.6%	9,438	471,899	177,074	265,415

SUMMARY OF GLOBAL WIND ENERGY OUTLOOK SCENARIO FOR 2030

Global Scenario	Cumulative wind power capacity [MW]	Electricity output [TWh]	Percentage of world electricity [Energy Efficiency]	Annual installed capacity [MW]	Annual investment [€ bn]	Jobs [million]	Annual CO_2 savings [m tCO_2]
Reference	679 ,000	1,783	5.8%	36.6,000	47.10	0.74	1,070
Moderate	1,834 ,000	4,818	15.6%	100,000	104.36	1.71	2,891
Advanced	3,498,000	9,088	29.5%	165,000	168.14	2.98	5,453

SUMMARY OF WIND ENERGY OUTLOOK SCENARIO FOR 2030 – INDIA

Global Scenario	Cumulative wind power capacity [MW]	Electricity output [GWh]	Share of electricity demand	Annual installed capacity [MW]	Investment [mil Rs]	Jobs	Annual CO_2 savings [k tCO_2]
Reference	27,325	65,580	2.4-2.7%	820	40,987	19,765	62,050
Moderate	142,219	341,325	12.6-14.2%	6,772	338,616	142,219	322,953
Advanced	241,349	579,238	21.4-24.2%	9,500	475,000	213,450	548,061

Overall, it can be said that the cost of wind turbine generators has fallen significantly during the last decades, and the industry is recognised as having entered the "commercialisation phase", as understood in learning curve theory.

In India, turbine prices have always been lower than the global average, thanks to lower labour and production costs. For the purpose of these scenarios, the current costs of 53.5 mil Rs/MW (771,000 €/MW) were taken as a starting point, and these are projected to decrease to 50.0 mil Rs/MW by 2010 and then stabilize at that level. All figures are given at 2008 prices. The reason for this graduated assumption, is that the manufacturing industry has not so far gained the full benefits from series production, especially due to the rapid upscaling of products. Neither has the full potential of the latest design optimisations been realized. In addition, increasing levels of local manufacture of all turbine components in India will also help bring costs down, as imports of more expensive parts from international markets can be minimised.

Scenario Results for India

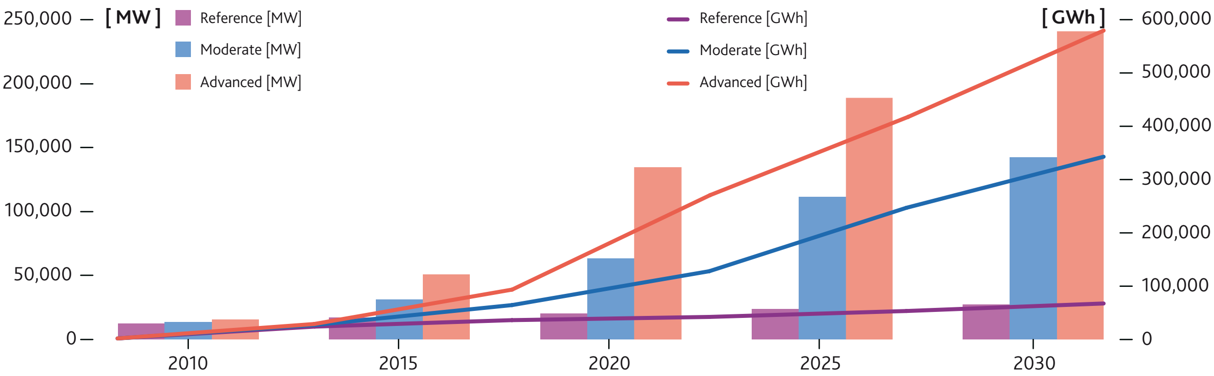
An analysis of the Global Wind Energy Outlook scenarios shows that a range of outcomes is possible for the global wind energy market, based on the assumptions outlined above.

REFERENCE SCENARIO

The **Reference scenario**, which is derived from the International Energy Agency's World Energy Outlook 2007, starts off with an assumed growth rate of 15.5% for 2009, decreases to 6.5% by 2010, and then stabilises at 3% by 2016.

As a result, the scenario foresees that by the end of this decade, cumulative capacity in India would have reached 12.5 Gigawatts (GW), producing 22.5 TWh per year. By 2020, installed wind energy capacity in India would stand at 20.3 GW, growing to 27.3 GW by 2030, with an annual

CUMULATIVE CAPACITY [MW] AND ELECTRICITY GENERATION [GWH] – INDIA



CUMULATIVE CAPACITY [MW] AND ELECTRICITY GENERATION [GWH] INDIA

Year		2010	2015	2020	2025	2030
Reference	[MW]	12,495	17,119	20,332	23,571	27,325
	[GWh]	22,491	34,238	40,665	51,856	65,580
Moderate	[MW]	13,741	31,436	63,230	111,432	142,219
	[GWh]	24,734	62,873	126,459	245,151	341,325
Advanced	[MW]	15,070	45,991	134,828	189,104	241,349
	[GWh]	27,127	91,982	269,656	416,028	579,238

capacity increase of around 800 MW. Depending on the demand side developments, the penetration of wind energy in India would, in this scenario, decrease from 3.3% in 2010 to 2.4-2.7% in 2030.

MODERATE SCENARIO

Under the **Moderate** wind energy scenario growth rates are expected to be substantially higher than under the Reference version. The assumed cumulative annual growth rate starts at 20.7% for 2009, decreases to 18% by 2010, continues to fall gradually to 12% by 2020 until it reaches 5% in 2025.

The result is that by the end of this decade, Indian wind power capacity is expected to have reached 13.7 GW, with annual additions of around 2 GW. By 2020, the annual market would have grown to 8 GW, and the cumulative wind power capacity in India would have reached 63 GW. By 2030 a total of over 142 GW would be installed, with annual additions in the region of 6.8 GW.

In terms of generated electricity, this would translate into 126.5 TWh produced by wind energy in 2020 and 341.3 TWh in 2030. For the share of wind power in the overall electricity mix, this would translate into 3.6% in 2010, 8.1-8.7% in 2020 and increase to 12.6-14.2% by 2030.

ADVANCED SCENARIO

Under the **Advanced** wind energy scenario, an even more rapid expansion of the global wind power market is envisaged. The assumed growth rate starts at 25% in 2009, falls to 25% by 2010, then to 24% by 2016, going down to 5% by 2026. The result is that by the end of this decade, Indian capacity would have reached 15.1 GW, with annual additions of around 3.8 GW. By 2020, capacity stand at 134.8 GW, and by 2030, total wind generation capacity would reach 241.3 GW. The annual market would by then stabilise at around 10 GW.

In terms of generated electricity, this would translate into 270 TWh produced by wind energy in 2020 and 579 TWh in 2030. This would meet between 17.3% and 18.6% of India's electricity demand in 2020 and 21.4-24.2% in 2030.

SHARE OF ELECTRICITY DEMAND – INDIA

	Year		2010	2020	2030
REFERENCE					
	Ref. demand	%	3.3%	2.6%	2.4%
	Energy efficiency	%	3.3%	2.8%	2.7%
MODERATE					
	Ref. demand	%	3.6%	8.1%	12.6%
	Energy efficiency	%	3.6%	8.7%	14.2%
ADVANCED					
	Ref. demand	%	3.9%	17.3%	21.4%
	Energy efficiency	%	3.9%	18.6%	24.2%

Costs and Benefits

Generating increased volumes of wind powered electricity will require a considerable level of investment over the next 20 years. At the same time raising the contribution from the wind will have substantial benefits for the global climate, reduction of air pollution, economic development and increased job creation in India, and thus provide a significant boost to the Indian economy.

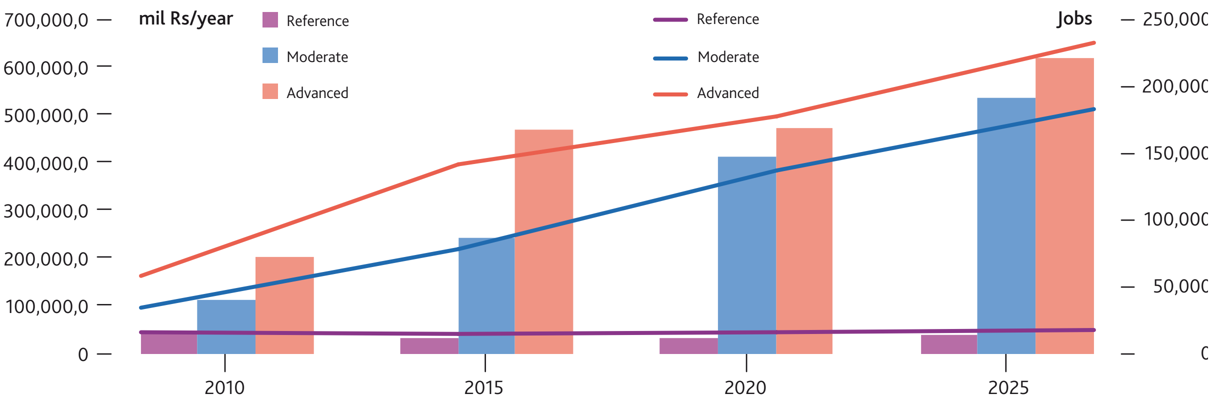
INVESTMENT

The relative attraction to investors of the wind energy market is dependent on a number of factors. These include the capital cost of installation, the availability of finance, the pricing regime for the power output generated and the expected rate of return.

The investment value of the generation equipment in the future wind energy market envisaged in this scenario has been assessed on an annual basis. This is based on the assumption of a gradually decreasing capital cost per kilowatt of installed capacity, as explained above.

In the **Reference scenario** the annual value of investment in wind power equipment in India falls from 96.3bn Rs in 2008 to just 43 bn Rs in 2010 and to 30.5bn Rs bn by 2020, where it will level off [all figures at €2008 values]. In the **Moderate scenario** the annual value of investment in the Indian wind power sector reaches 111 bn Rs in 2010 and around 412 bn Rs by 2020. In the **Advanced scenario** the annual value of investment reaches 199 bn Rs in 2010 and reaches around 472 bn Rs by 2020. All these figures take into account the value of repowering older turbines.

INVESTMENT AND EMPLOYMENT – INDIA



INVESTMENT AND EMPLOYMENT – INDIA

	2010	2015	2020	2025	2030
REFERENCE					
Annual installation [MW]	812	599	610	707	820
Cost mil Rs/MW	53.5	50.4	50.0	50.0	50.0
Investment mil Rs/year	43,017	30,180	30,498	35,356	40,987
Employment	15,535	14,095	15,317	17,049	19,765
MODERATE					
Annual installation [MW]	2,096	4,795	8,247	10,660	6,772
Cost mil Rs/MW	53.5	50.4	50.0	50.0	50.0
Investment mil Rs/year	111,020	241,539	412,367	532,999	338,616
Employment	33,926	77,614	136,539	182,404	142,219
ADVANCED					
Annual installation [MW]	3,768	7,359	9,438	12,371	9,500
Cost mil Rs/MW	53.5	50.4	50.0	50.0	50.0
Investment mil Rs/year	199,550	467,985	471,899	618,563	475,000
Employment	57,770	141,039	177,074	232,108	213,450

Although these figures may appear large, they should be seen in the context of the total level of investment in the global wind power industry, which has seen an investment of more than €35.6 bn in 2008 alone. This is projected to reach €150 bn annually by 2020 in the global advanced scenario.

EMPLOYMENT

The employment effect of this scenario is a crucial factor to weigh alongside its other costs and benefits. High unemployment rates create social problems and continue to be a drain on the economies of many countries in the world. Any technology which demands a substantial level of both skilled and unskilled labour is therefore of considerable economic importance, and likely to feature strongly in any political decision-making over different energy options.

A number of assessments of the employment effects of wind power have been carried out in Germany, Denmark and the Netherlands. The assumption made in this scenario is that for every megawatt of new capacity, the annual market for wind energy will create employment at the rate of 15 jobs through manufacture, component supply, wind farm development, installation and indirect employment. As production processes are optimised, this level will decrease, falling to 11 jobs by 2030. In addition, employment in regular operations and maintenance work at wind farms will contribute a further 0.33 jobs for every megawatt of cumulative capacity.

Under these assumptions, more than 400,000 workers are employed in the global wind energy sector in 2008, with 28,400 in India alone.

Under the **Reference scenario** based on the IEA's predictions, this figure would decrease to just 15,500 jobs in India by the end of this decade and remain stable through 2020. In the **Moderate scenario**, close to 34,000 people would be employed by the Indian wind power sector by 2010, and more than 136,500 by 2020 and 142,000 by 2030. The **Advanced scenario** would see the employment level rise to 57,700 by 2010, about 177,000 by 2020 and 213,500 by 2030.

CARBON DIOXIDE SAVINGS

A reduction in the levels of carbon dioxide being emitted into the global atmosphere is the most important environmental benefit from wind power generation. Carbon dioxide is the gas largely responsible for the human-induced greenhouse effect, leading to the disastrous consequences of global climate change.

At the same time, modern wind technology has an extremely good energy balance. The CO_2 emissions related to the manufacture, installation and servicing over the average 20 year lifecycle of a wind turbine are "paid back" after the first three to six months of operation.

The benefit to be obtained from carbon dioxide reductions is dependent on which other fuel, or combination of fuels, any increased generation from wind power will displace. Calculations by the World Energy Council show a range of carbon dioxide emission levels for different fossil fuels. Given the dominance of coal in India's current electricity mix, it has a relatively high carbon intensity.

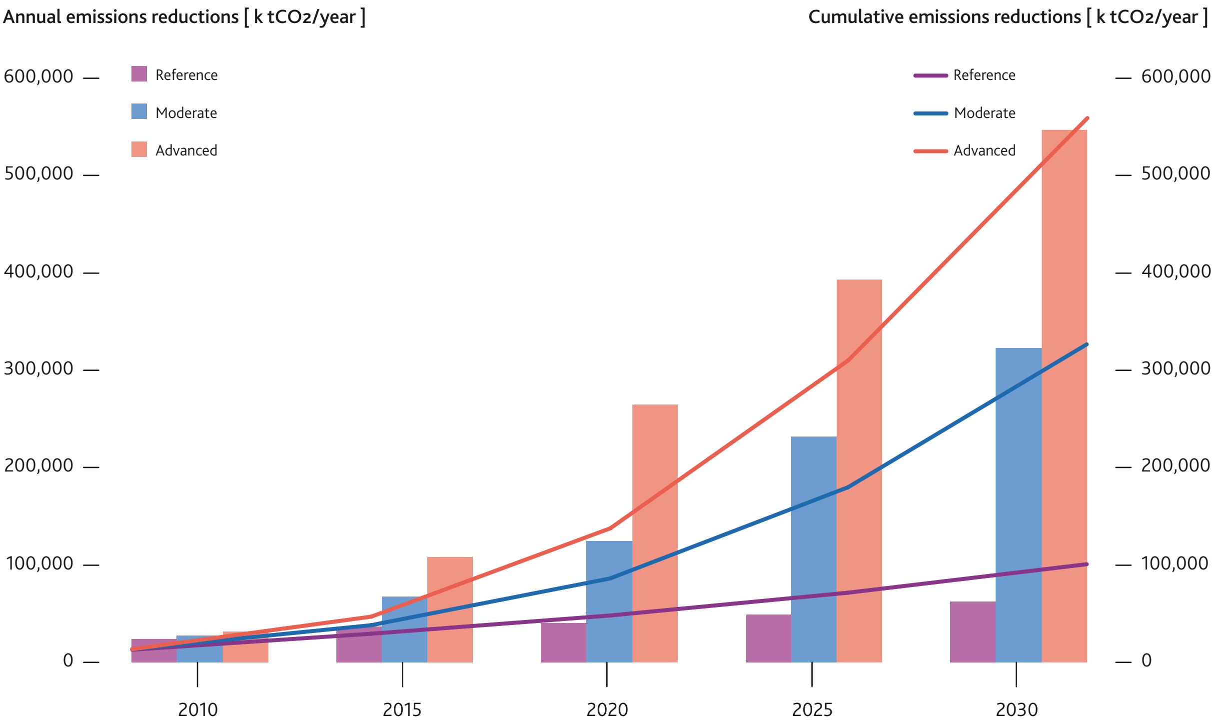
For the purpose of this report, we assume 1,076 gCO_2/kWh as an average value for the carbon dioxide reduction to be obtained from wind generation. Over time, as more renewable energy is introduced into the Indian power system and old coal fired power stations are replaced with much cleaner gas plants, this figure is assumed to decrease to 946 gCO_2/kWh by 2020[2)].

Taking account of these assumptions, the expected annual saving in CO_2 by wind energy in India under the **Reference scenario** would be 24.2 million tons annually in 2010, rising to 40 million tones by 2020 and 62 million tons in 2030. The cumulative CO_2 savings since 1999 would amount to 469 million tonnes of CO_2 by 2020 and 992 million tonnes by 2030.

The overall CO_2 savings from wind energy would be negligible in this scenario, compared with the 1,729 million tons of CO_2 that the IEA expects the Indian power sector will emit every year by 2030.

2 *Government of India, Planning Commission: Integrated Energy Policy, August 2006; Greenpeace International: Energy [R]evolution – India, 2009*

ANNUAL AND CUMULATIVE CO_2 EMISSIONS REDUCTIONS INDIA



ANNUAL AND CUMULATIVE CO_2 EMISSIONS REDUCTIONS INDIA

Year		2010	2015	2020	2025	2030
Reference	Annual CO_2 emissions reductions [k tCO_2]	24,200	36,841	40,025	49,064	62,050
	Cumulative CO_2 emissions reductions [k tCO_2]	118,498	281,547	468,587	700,028	992,723
Moderate	Annual CO_2 emissions reductions [k tCO_2]	26,614	67,651	124,470	231,956	322,953
	Cumulative CO_2 emissions reductions [k tCO_2]	121,880	371,516	851,346	1,787,831	3,255,961
Advanced	Annual CO_2 emissions reductions [k tCO_2]	29,188	98,973	265,415	393,635	548,061
	Cumulative CO_2 emissions reductions [k tCO_2]	125,251	457,957	1,361,502	3,088,461	5,579,917

Under the **Moderate scenario,** Indian wind energy would save 26.6 million tons of CO_2 annually in 2010, 124.5 million tonnes of CO_2 in 2020, rising to 323 million tonnes per year in 2030. The cumulative savings by 2020 would be 851.3 million tonnes of CO_2, and over the whole scenario period up to 2030, this would come to 3,256 million tonnes, more than three times the amount saved under the Reference scenario.

Under the Advanced scenario, the annual CO_2 savings from wind power would increase to close to 29.2 million tonnes by 2010, 265.4 million tonnes by 2020, and 548 million tonnes by 2030. Between 1999 and 2020, over 1,361.5 million tones of CO_2 would be saved by wind energy alone. This would increase to 5,580 million tones over the whole scenario period up to 2030.

GENERATION COSTS

Various parameters need to be taken into account when calculating the generation costs of wind power. The most important of these are the capital cost of wind turbines (see above), the cost of capital (interest rates), the wind conditions at the site, and the price received for the electricity generated. Other important factors include operation and maintenance (O&M) costs, the lifetime of the turbine and the discount rates which are applied.

The total cost per generated kWh of electricity is traditionally calculated by discounting and levelising investment and O&M costs over the lifetime of a wind turbine, then dividing this by the annual electricity production. The unit cost of generation is thus calculated as an average cost over the

lifetime of a turbine, which is normally estimated at 20 years. In reality capital costs will be higher in the early years of a turbine's operations while the loan is being paid off, where as O&M costs will probably be lower at the beginning of a turbine's operation and increase over the lifespan of the machine.

Taking all these factors into account, the cost of generating electricity from wind energy currently ranges from approximately 4-6 €cents/kWh at high wind speed sites up to approximately 6-9 €cents/kWh at sites with low average wind speeds[3].

However, over the past 15 years the efficiency of wind turbines has been improving thanks to better equipment design, better siting and taller turbines. Furthermore, it can be assumed that optimised production processes will reduce investment costs for wind turbines, as described above.

These calculations do not take into account the so-called 'external costs' of electricity production. It is generally agreed that renewable energy sources such as wind have environmental and social benefits compared to conventional energy sources such as coal, gas, oil and nuclear. These benefits can be translated into costs for society, which should be reflected in the cost calculations for electricity output. Only then can a fair comparison of different means of power production be established. The European Commission's ExternE project[4] estimated the external cost of gas fired power generation at around 1.1-3.0 €cents/kWh and that for coal at as much as 3.5-7.7 €cents/kWh, compared to just 0.05-0.25 €cents/kWh for wind.

On top of this, of course, needs to be added the 'price' of carbon within the global climate regime and its regional/ national incarnations such as the European Emissions Trading Scheme (ETS).

Furthermore, these calculations do not take into account the fuel cost risk related to conventional technologies. Since wind energy does not require any fuel, it eliminates the risk of fuel price volatility which characterises other generating technologies such as gas, coal and oil. A generating portfolio containing substantial amounts of wind energy will reduce the risks of future higher energy costs by reducing society's exposure to price increases for fossil fuels. In an age of limited fuel resources and high fuel price volatility, the benefits of this are immediately obvious.

In addition, the avoided costs for the installation of conventional power production plant and avoided fossil fuel costs should also be taken into consideration. This further improves the cost analysis for wind energy. In 2007, for example, €3.9bn worth of fuel costs were avoided in Europe through the use of wind energy, and this figure is predicted to increase to €24bn by 2030[5].

3 For Europe, see European Wind Energy Association (2009): Wind Energy – The Facts and EWEA: Economics of Wind Energy (2009); for China, see GWEC/CREIA/CWEA (2006): A study on the Pricing Policy of Wind Power in China
4 http://www.externe.info/externpr.pdf
5 EWEA (2008): Pure Power – Wind Energy Scenarios up to 2030

Research Background

THE GERMAN AEROSPACE CENTRE

The German Aerospace Centre (DLR) is the largest engineering research organisation in Germany. Among its specialities is development of solar thermal power station technologies, the utilisation of low and high temperature fuel cells, particularly for electricity generation, and research into the development of high efficiency gas and steam turbine power plants.

The Institute of Technical Thermodynamics at DLR (DLR-ITT) is active in the field of renewable energy research and technology development for efficient and low emission energy conversion and utilisation. Working in co-operation with other DLR institutes, industry and universities, research is focused on solving key problems in electrochemical energy technology and solar energy conversion. This encompasses application oriented research, development of laboratory and prototype models as well as design and operation of demonstration plants. System analysis and technology assessment supports the preparation of strategic decisions in the field of research and energy policy.

Within DLR-ITT, the System Analysis and Technology Assessment Division has long term experience in the assessment of renewable energy technologies. Its main research activities are in the field of techno-economic utilisation and system analysis, leading to the development of strategies for the market introduction and dissemination of new technologies, mainly in the energy and transport sectors.

SCENARIO BACKGROUND

DLR was commissioned by the European Renewable Energy Council and Greenpeace International to conduct a study on **global sustainable energy pathways** up to 2050[6)]. This study, published in 2007, laid out energy scenarios with emissions that are significantly lower than current levels. Part of the study examined the future potential for renewable energy sources; together with input from the wind energy industry and analysis of regional projections for wind power around the world, this forms the basis of the Global Wind Energy Outlook scenario.

The **energy supply scenarios** adopted in this report, which both extend beyond and enhance projections by the International Energy Agency, have been calculated using the MESAP/PlaNet simulation model used for a similar study by DLR covering the EU-25 countries ("Energy revolution: A sustainable pathway to a clean energy future for Europe", September 2005 for Greenpeace International). This model has then been developed in cooperation with Ecofys consultancy to take into account the future potential for energy efficiency measures.

ENERGY EFFICIENCY STUDY[7)]

The aim of the Ecofys study was to develop low energy demand scenarios for the period 2003 to 2050 on a sectoral level for the IEA regions as defined in the World Energy Outlook report series. Energy demand was split up into electricity and fuels. The sectors which were taken into account were industry, transport and other consumers, including households and services.

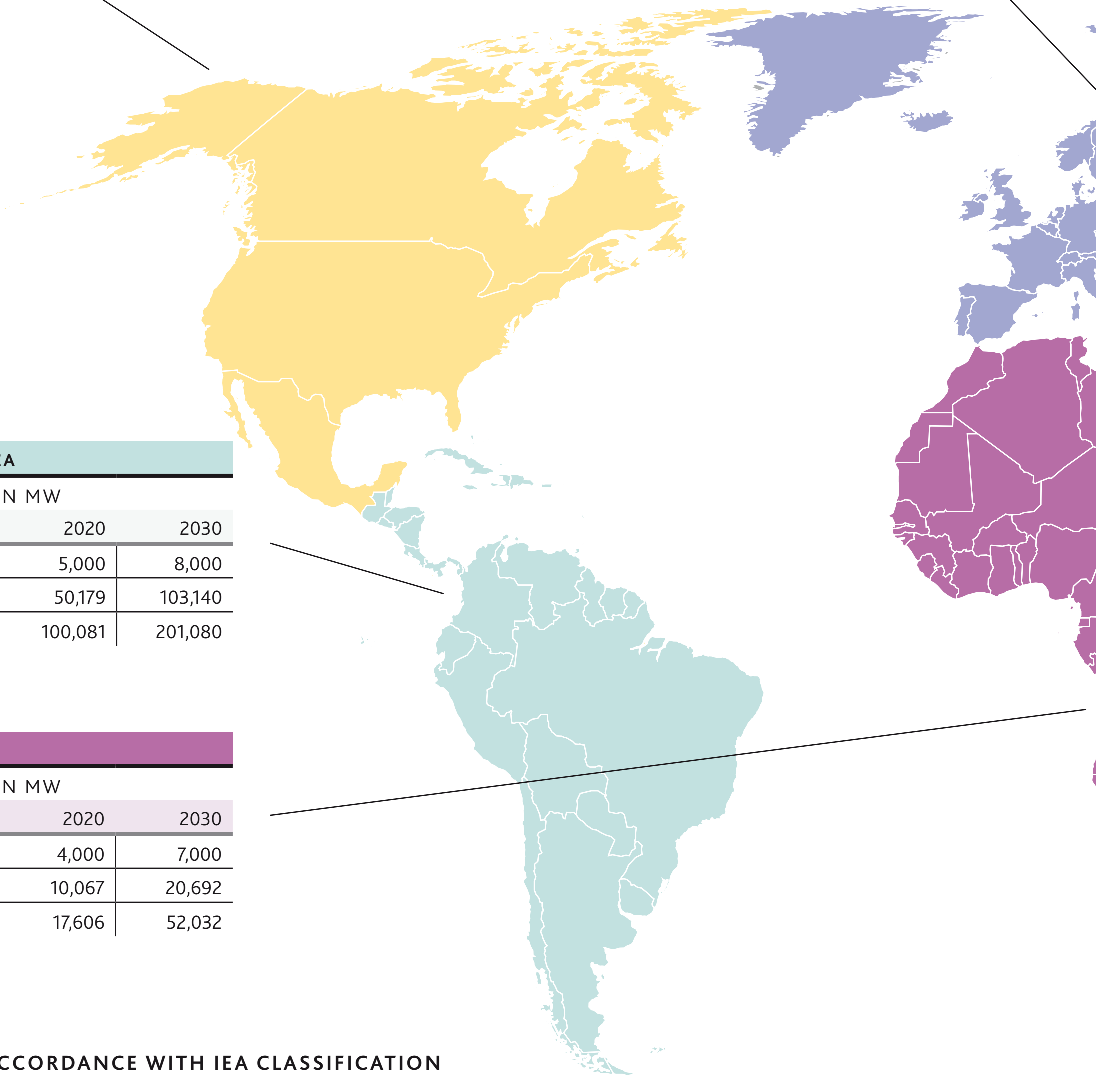
The Ecofys study envisages an ambitious overall development path for the exploitation of energy efficiency potential, focused on current best practice as well as technologies available in the future, and assuming continuous innovation in the field. The result is that worldwide final energy demand is reduced by 35% in 2050 in comparison to the reference scenario. Energy savings are fairly equally distributed over the three sectors. The most important energy saving options are the implementation of more efficient passenger and freight transport and improved heat insulation and building design.

While the Ecofys study develops two energy efficiency scenarios, only the more moderate of these has been used in this report.

6 *Krewitt W, Simon S, Graus W, Teske S, Zervos A, Schaefer O, "The 2 degrees C scenario – A sustainable world energy perspective"; Energy Policy, Vol.35, No.10, 4969-4980, 2007*
7 *www.energyblueprint.info*

NORTH AMERICA			
TOTAL CAPACITY IN MW			
	2010	2020	2030
Reference scenario	28,000	92,000	132,000
Moderate scenario	41,195	214,371	366,136
Advanced scenario	41,195	252,861	519,747

EUROPE			
TOTAL CAPACITY IN MW			
	2010	2020	2030
Reference scenario	77,000	176,300	226,730
Moderate scenario	89,227	182,464	306,491
Advanced scenario	89,132	212,632	353,015



LATIN AMERICA			
TOTAL CAPACITY IN MW			
	2010	2020	2030
Reference scenario	2,000	5,000	8,000
Moderate scenario	2,496	50,179	103,140
Advanced scenario	2,496	100,081	201,080

AFRICA			
TOTAL CAPACITY IN MW			
	2010	2020	2030
Reference scenario	1,000	4,000	7,000
Moderate scenario	785	10,067	20,692
Advanced scenario	887	17,606	52,032

DEFINITIONS OF REGIONS IN ACCORDANCE WITH IEA CLASSIFICATION

OECD Europe: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom

OECD North America: Canada, Mexico, United States

OECD Pacific: Australia, Japan, Korea (South), New Zealand

Transition Economies: Albania, Armenia, Azerbaijan, Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Estonia, Serbia and Montenegro, the former Republic of Macedonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Romania, Russia, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, Cyprus [1], Malta [1]

India

Other developing Asia: Afghanistan, Bangladesh, Bhutan, Brunei, Cambodia, Chinese Taipei, Fiji, French Polynesia, Indonesia, Kiribati, Democratic People's Republic of Korea, Laos, Macao, Malaysia, Maldives, Mongolia, Myanmar, Nepal, New Caledonia, Pakistan, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Sri Lanka, Thailand, Vietnam, Vanuatu

Latin America: Antigua and Barbuda, Argentina, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, St. Kitts-Nevis-Anguila, Saint Lucia, St. Vincent and Grenadines, Suriname, Trinidad and Tobago, Uruguay, Venezuela

Africa: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Democratic Republic of Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, United Republic of Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe

Middle East: Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen

China: People's Republic of China including Hong Kong

1 Cyprus and Malta are allocated to the Transition Economies for statistical reasons

TRANSITION ECONOMIES

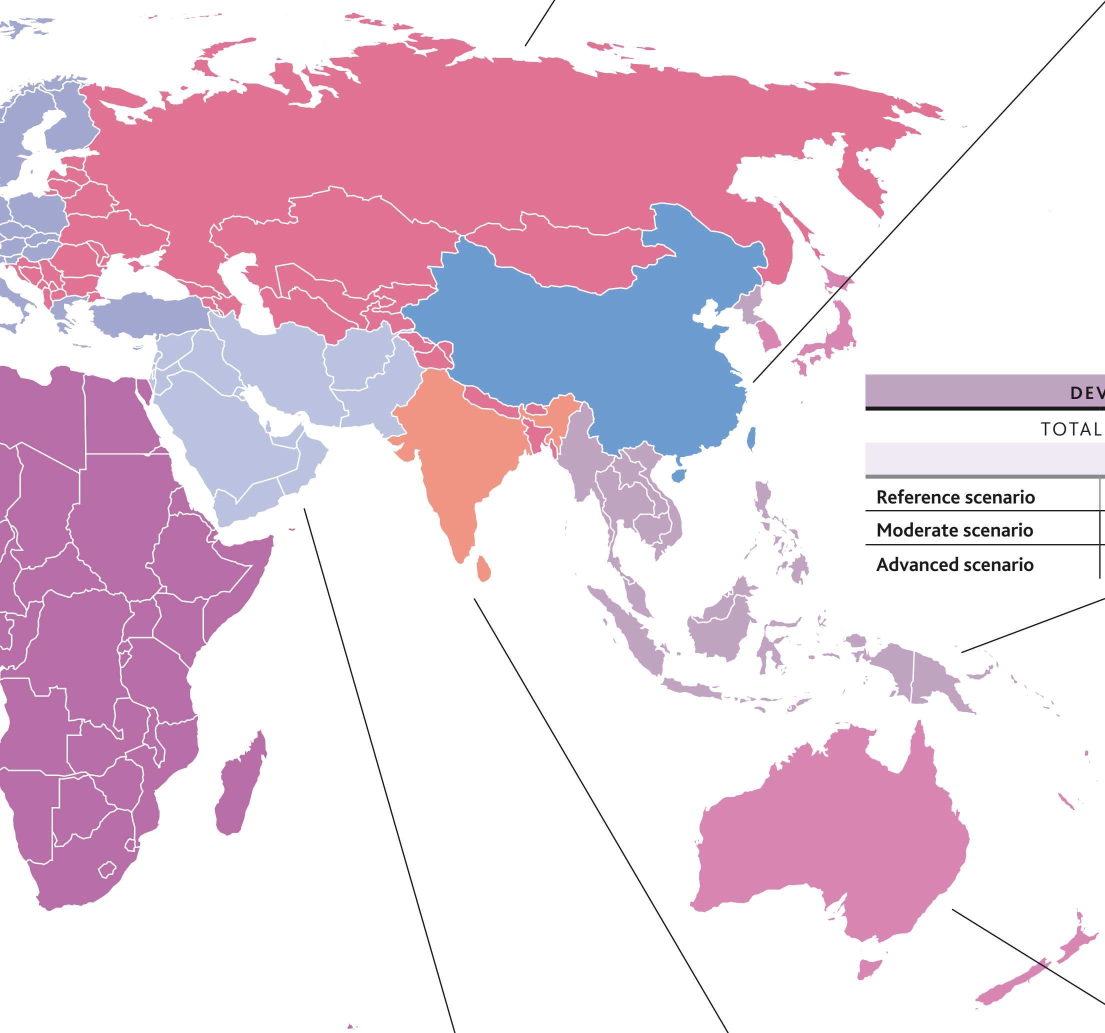
TOTAL CAPACITY IN MW

	2010	2020	2030
Reference scenario	2,000	7,000	11,000
Moderate scenario	449	9,183	33,548
Advanced scenario	449	10,411	75,231

CHINA

TOTAL CAPACITY IN MW

	2010	2020	2030
Reference scenario	9,000	27,000	49,000
Moderate scenario	17,507	100,724	200,531
Advanced scenario	19,613	200,880	450,582



DEVELOPING ASIA

TOTAL CAPACITY IN MW

	2010	2020	2030
Reference scenario	2,000	7,000	16,000
Moderate scenario	1,670	40,274	140,897
Advanced scenario	1,817	60,735	210,808

OECD PACIFIC

TOTAL CAPACITY IN MW

	2010	2020	2030
Reference scenario	5,000	12,000	16,000
Moderate scenario	3,688	30,018	70,698
Advanced scenario	3,739	75,380	215,362

MIDDLE EAST

TOTAL CAPACITY IN MW

	2010	2020	2030
Reference scenario	1,000	2,000	4,000
Moderate scenario	577	8,150	20,136
Advanced scenario	413	25,398	62,777

INDIA

TOTAL CAPACITY IN MW

	2010	2020	2030
Reference scenario	12,495	20,332	27,325
Moderate scenario	13,741	63,230	142,219
Advanced scenario	15,070	134,828	241,349

4. INTERNATIONAL ACTION ON CLIMATE CHANGE AND THE IMPLICATIONS FOR WIND ENERGY

The Kyoto Protocol

The Kyoto Protocol is an international treaty, agreed in December of 1997 as a subsidiary Protocol to the United Nations Framework Convention on Climate Change of 1992 (UNFCCC). The Kyoto Protocol sets a binding target for industrialised countries (Annex 1 countries) to reduce their emissions of greenhouse gases by an initial aggregate of 5.2% against 1990 levels over the period 2008–2012. This spread of years is known as the "first commitment period". The Protocol finally entered into force in 2005.

It is recognised that industrialized countries are largely responsible for the historic build up of greenhouse gases in the atmosphere, and that developing countries need to expand their economies in order to meet social and development objectives. Therefore, China, India and other developing countries do not have quantified, binding emission reduction commitments for the period from 2008-2012. However, it was agreed that they still share a 'common but differentiated responsibility' to reduce emissions.

The overall objective of the international climate regime is to achieve "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (human) interference with the climate system". National emissions reduction obligations under the Kyoto Protocol range from 8% for the European Union to 7% for the United States, 6% for Japan, 0% for Russia and permitted increases of 8% for Australia and 10% for Iceland. These figures exclude international aviation and shipping.

As of July 2009, 186 countries had ratified the protocol. Of these, 38 industrialized countries (plus the EU as a party in its own right) are required to reduce their emissions to the levels specified for each of them in the treaty. 145 developing countries have ratified the protocol, including Brazil, China and India, but have no reduction obligation. The United States is the only industrialized country not to have ratified the Protocol, and Kazakhstan is the only other signatory not to have ratified the agreement so far, although the Kazak government has recently signaled its intention to ratify.

FLEXIBLE MECHANISMS

To combat climate change it does not matter where emissions are reduced, it is the overall global reduction that counts. As a result the Kyoto Protocol has taken a strong market approach, recognising that it may be more cost-effective for Annex I parties to pay for emissions reductions in other countries, for example in the developing world or other countries where there is a large potential for cost-effective reductions. Industrialised countries therefore have the ability to apply three different mechanisms with which they can collaborate with other parties. These are Joint Implementation (JI), the Clean Development Mechanism (CDM) and Emissions Trading.

Emissions Trading

Under the International Emissions Trading provisions, Annex I countries can trade so called "Assigned Amount Units" (AAUs) among themselves. These are allocated to them on the basis of their overall emissions reduction targets. The emissions trading scheme also sees this activity as "supplemental to domestic actions".

Those parties that reduce their emissions below the allowed level can then trade some part of their surplus allowances to other Annex I parties. It is unlikely that there will be very many Annex I parties who will be sellers of AAUs, and an equally small number of buyers, at least in the first commitment period.

Joint Implementation

Under Joint Implementation, an Annex I country can invest in emissions reduction projects in any other Annex I country as an alternative to reducing emissions domestically. This allows countries to reduce emissions in the most cost-effective way, and apply the credits for those reductions towards their own emissions reduction target. Most JI projects are expected to take place in the so-called "economies in transition to a market economy", mainly Russia and Ukraine. Most of the rest of the "transition economies" have since joined the EU or are in the process of doing so, and therefore are or will be soon covered under the EU emissions reduction legislation.

The credits for JI emission reductions are accounted for in the form of Emission Reduction Units (ERUs), with one ERU representing a reduction of one ton of equivalent. These ERUs come out of the host country's pool of assigned

emissions credits, which ensures that the total amount of emissions credits among Annex I parties remains stable.

ERUs will only be awarded for Joint Implementation projects that produce emissions reductions that are "...additional to any that would otherwise occur" (the so-called "additionality" requirement), which means that a project must prove that it would only be financially viable with the extra revenue of ERU credits. Moreover, Annex I parties may only rely on joint implementation credits to meet their targets to the extent that they are "supplemental to domestic actions". However, since it is very hard to define which actions are "supplemental", this clause is largely meaningless in practice.

Clean Development Mechanism

The Clean Development Mechanism allows Annex I parties to generate or purchase emissions reduction credits from projects undertaken in developing (non-Annex I) countries. In exchange, developing countries will have access to resources and technology to assist in development of their economies in a sustainable manner. The credits earned from CDM projects are known as "certified emissions reductions" (CERs). These projects must also meet the requirement of "additionality".

A wide variety of projects have been launched under the CDM, including those involving renewable energy, energy efficiency, fuel switching, landfill gases, better management of methane from animal waste, the control of coal mine methane and controlling emissions of certain industrial gases, including HFCs and N2O.

China has traditionally dominated the CDM market. In 2007 it expanded its market share of transactions to 62%. However, CDM projects have been registered in 45 countries and the UNFCCC points out that investment is now starting to flow into other parts of the world, not only to India and Brazil, but also to Africa, Eastern Europe and Central Asia.

In 2008, the CDM accounted for transactions worth €24bn[1)], mainly from private sector businesses in the EU, European governments and Japan .

The average time for CDM projects to be agreed is currently about 1-2 years from the moment that they enter the "CDM pipeline" which contains nearly 4,000 projects as of October 2008. More than 500 projects have received CERs to date, and over two thirds of those CERs have come from industrial gas projects. Renewable energy projects have been slower to reach fruition, and the rigorous CDM application procedure has been criticized for being too slow and cumbersome. The "additionality" requirement in particular has been a stumbling block since it is difficult to prove that a project would not be viable without the existence of CERs.

CARBON AS A COMMODITY

The Kyoto Protocol's efforts to mitigate climate change have resulted in an international carbon market that has grown tremendously since the entry into force of the Protocol in 2005. While previously, the relatively small market consisted mostly of pilot programmes either operated by the private sector or by international financial institutions such as the World Bank, the market experienced strong growth since 2006. The total traded volume of emissions increased from 1.6 billion tons of CO_2 in 2006 to 4.9 billion tons in 2008, reaching a value of €92 billion in 2008, with the average world carbon price at around €19 per ton of CO_2[2)].

While the international carbon market has expanded to include a wide variety of project types and market participants, it has to date been dominated by the EU Emissions Trading System (ETS) and the CDM.

The EU emissions trading scheme continues to account for around two thirds of the global carbon market volume (3.1 bn tCO_2) and around three quarters of the value (€67bn).

1 Point Carbon: Carbon Market Monitor, 2008: Year in review (12 January 2009)

One ton of CO_2 traded at between €13.5 and €29.4[3)]. In December 2008, European institutions reached an agreement on the EU's new energy and climate package, which includes a revision of the EU ETS. Key elements include the cap, the credit limit, the level of auctioning and new sectors and gases included. With the agreement on the package, the EU ETS took a significant step towards better long-term stability.

The CDM market increased dramatically to 1.6 bn tCO_2 worth €24bn in 2008, making up a third of the physical and 26% of the financial market. The UN international transaction log was, on 16 October 2008, linked with the EU emissions trading registry, which allowed for CER credits to be transferred to the EU market. This represented an important step for the CDM market as it reduced the delivery risk into the EU ETS. In addition, the new EU climate package has provided certainty about the overall use of CERs in the EU ETS until 2020[4)].

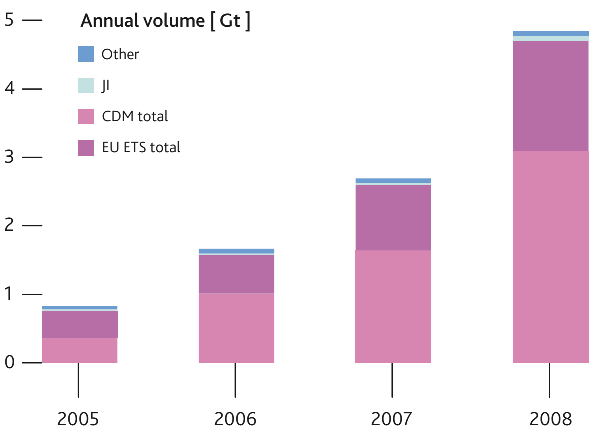
The JI market, while still small, also finally started to take off in 2007, nearly doubling in volume to 38 $MtCO_2$ and more than tripling in value to €326 million. In 2008, according to World Bank statistics, the JI global market reached about 30 Mt CO_2 in volume, with a face value of €200 million.

Three key elements are shaping global carbon markets in 2009: the economic downturn, the UN climate negotiations and developments in the US. Experts predict that the economic crisis will result in a leveling off of the carbon trading activity in 2009[5)]. While the EU ETS will remain the dominant market, both CDM and JI markets are likely to be affected by a lack of investments, as well as uncertainty over the structure of the post-2012 carbon markets and declining emissions in many countries[6)]. However, many experts believe that this downturn will be temporary and that investment in CDM will pick up again later in the year.

Providing that the price for carbon is high enough, the carbon market is a powerful tool for attracting investment, fostering cooperation between countries, companies and individuals and stimulating innovation and carbon abatement worldwide. In theory, at least, the price of carbon should more or less directly reflect the rigorousness of the economy-wide caps of the Annex B countries. The reality is, however, more complicated, since there is only one real 'compliance market' at present, which is the EU ETS, while the CDM and JI markets are just getting started. It is also not clear what role Canada, Japan and Australia will play in the carbon market during the first commitment period; and of course, the original conception and design of the carbon market was predicated on the fact that the United States would be a large buyer, which has not turned out to be the case, at least not for the first commitment period.

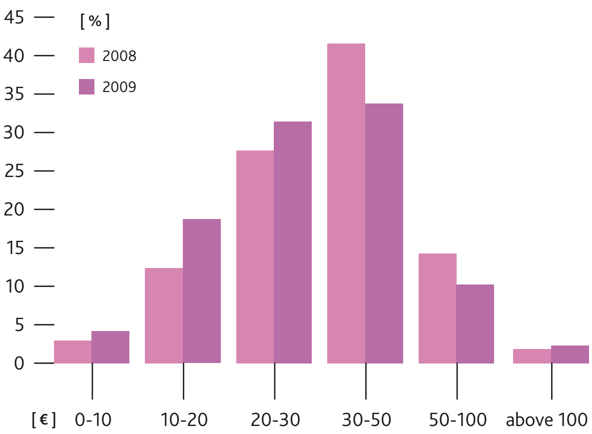
Governments negotiating the post-2012 climate agreement seem committed to 'building carbon markets' and 'keeping the CDM', but it appears certain that the CDM will undergo changes in the post-2012 framework. *Figure 2* shows a survey of carbon market practitioners conducted by Point Carbon at the end of 2008 about the price of carbon in 2020.

FIG. 1: ANNUAL CONTRACT VOLUMES 2005-2008



Source: Point Carbon

FIG. 2: OPINION POLL: WHAT WILL BE THE COST OF CARBON IN 2020?



Source: Point Carbon

2,3,4,5,6 Carbon 2009 – Emission trading coming home

Wind energy CDM projects

The Clean Development Mechanism has contributed to the deployment of wind energy globally. As of October 2008, a total of 739 wind energy projects were in the "CDM pipeline", totaling an installed capacity of over 30,000 MW. This represents 16% of the total number of projects introduced into the pipeline. More than 13 million CERs have already been issued to these wind projects, a number that will go up to a total of 273 million by the end of the first commitment period in 2012 for the projects currently in the pipeline.

The majority of these projects are located in China and India. In China, 90% of wind energy projects have applied for CDM registration, and there are now 371 projects in the CDM pipeline, making up more than 20 GW of capacity. India has 301 projects in the pipeline, totalling more than 5.6 GW.

The limited number of countries with CDM-supported wind projects reflects the fact that carbon finance is a useful, and in some cases necessary condition for the development of wind power, but it is by no means sufficient. In the case of both India and China carbon finance functions alongside a wide range of other measures necessary for countries to diversify and decarbonise their power supply sectors.

There are signs that some other countries may join the list of major host countries for wind power projects assisted by CDM carbon finance. However, it is clear that the ultimate responsibility for this lies with active government implementation of policies and measures to create the enabling environment within which carbon finance can play its role – as an important source to defray the marginal costs of wind power versus conventional fossil fuel plants. This is particularly the case in the absence of an economy-wide cap on carbon emissions.

TABLE 1: CDM PROJECTS IN THE PIPELINE (AS OF 1 AUGUST 2009)

Type	Projects	1000 CERs	2012 kCERs	2020 kCERs
Afforestation	5	134	160	13,364
Agriculture	1	26	260	468
Biogas	657	40,995	194,875	477,750
Biomass energy	30	5,824	32,122	59,286
Cement	3	29	167	396
CO2 capture	68	30,261	130,358	352,852
Coal bed / mine methane	8	2,449	9,700	25,033
Energy distribution	21	1,010	3,873	10,457
EE households	152	4,938	24,031	50,813
EE industry	447	60,977	260,996	646,333
EE own generation	16	194	816	1,939
EE service	46	17,235	31,045	177,577
EE supply side	121	40,653	178,008	455,948
Fossil fuel switch	26	11,497	54,569	125,545
Fugitive	15	3,433	16,801	43,226
Geothermal	23	82,498	479,243	1,108,036
HFCs	1,242	132,382	478,083	1,510,258
Hydro	273	42,192	211,423	5,02,126
Landfill gas	522	24,500	118,585	274,073
N2O	67	47,818	249,501	626,189
PFCs	13	3,959	12,723	40,245
Reforestation	44	2,364	12,202	38,053
Solar	35	689	2,247	6,981
Tidal	1	315	1,104	3,631
Transport	12	1,059	4,994	13,148
Wind	740	66,880	273,449	773,673
Total	**4,588**	**624,311**	**2,781,335**	**7,337,398**

Source: http://www.cdmpipeline.org/publications/CDMpipeline.xls

TABLE 2: WIND CDM PROJECTS (AS OF 1 AUGUST 2009)

Country	Projects	MW
India	301	5,659
China	371	20,695
Mexico	12	1,272
Brazil	10	674
South Korea	12	339
Cyprus	4	207
Egypt	4	406
Chile	4	111
Morocco	3	92
Dominican Republic	2	165
Costa Rica	2	69
Nicaragua	2	60
Phillipines	1	33
Panama	1	81
Mongolia	1	50
Jamaica	1	21
Colombia	1	20
Israel	1	12
Argentina	1	11
Vietnam	1	30
Uruguay	1	50
Sri lanka	1	10
Cape Verde	1	28
Ecuador	1	2
Total	**739**	**30,095**

Source: http://www.cdmpipeline.org/cdm-projects-type.htm

Wind energy JI projects

There are currently 21 wind energy projects in the JI pipeline, totaling an installed capacity of 1,121.6 MW. The biggest of these (300 MW) is located in the Ukraine. Other projects are based in Bulgaria, Poland, Lithuania, Estonia and New Zealand. While the JI market is still relatively small today, the mechanism could serve to incentivise large countries such as Russia and the Ukraine to tap into their very large wind energy potential.

The path to a post-2012 regime

The first commitment period of the Kyoto Protocol is coming to an end in 2012, and negotiations are now taking place with the aim of agreeing a second commitment period for the post-2012 period. These negotiations are set to culminate at the COP15 meeting in Copenhagen in December 2009.

TABLE 3: JI PROJECTS IN THE PIPELINE (AS OF 1 AUGUST 2009)

Type	Projects	1000 ERUs	2012 kERUs
Afforestation	0	0	0
Agriculture	0	0	0
Biogas	4	410	2,099
Biomass energy	26	2,228	10,930
Cement	2	421	1,558
CO2 capture	1	268	1,071
Coal bed/mine methane	18	9,790	48,949
Energy distribution	9	809	4,022
EE households	0	0	0
EE industry	13	5,168	24,297
EE own generation	2	1,757	8,666
EE service	0	0	0
EE supply side	16	3,666	14,773
Fossil fuel switch	11	2,148	10,567
Fugitive	36	21,396	99,532
Geothermal	0	0	0
HFCs	4	2,131	8,274
Hydro	10	969	4,106
Landfill gas	19	2,570	12,281
N2O	23	22,121	94,288
PFCs	1	233	1,165
Reforestation	0	0	0
Solar	0	0	0
Tidal	0	0	0
Transport	0	0	0
Wind	21	2,259	9,718
Total	216	78,344	356,297

Source: http://cdmpipeline.org/publications/JIpipeline.xls

There is a universal agreement that efforts to curb carbon emissions need to continue beyond 2012 and that an international agreement to supplement and/or replace the Kyoto Protocol is needed. This has been encouraged by the conclusions of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, which showed that climate change is developing faster than previously thought.

In addition, a number of independent studies, such as the report for the British government by former World Bank Chief Economist Sir Nicholas Stern, have highlighted concerns that the economic and social costs associated with the increasing impacts of climate change far outweigh the costs of effective mitigation of greenhouse gas emissions.

In Bali in 2007, governments agreed to negotiate a follow-up climate deal by the time the UNFCCC conference takes place in Copenhagen in December 2009. However, the last 14 months have seen little progress, and there is now pressure to meet the December deadline.

Danish authorities expect up to 18,000 people in Copenhagen for two weeks. In addition to the negotiators, this includes Heads of State and Government; Environment, Energy and Finance Ministers; thousands of reporters from around the world and advocates representing business and industry, environmental groups, research NGOs, trade unions and indigenous people's groups. In the midst of this, officials are supposed to come up with a comprehensive agreement to set the global economy on a path to a sustainable future.

Even in this time of financial crisis and economic downturn, the climate issue remains high on the agenda.

- **The need for strong commitments**
  Rigorous, legally-binding emission reduction targets for industrialised countries will send the most important political and market signal that governments are serious about creating a framework for moving towards a sustainable energy future. The indicative range of targets for industrialised countries agreed by the Kyoto Protocol countries - reductions of 25-40% below 1990 levels by 2020 - is a good starting point. They would need to be closer to the upper end of that range, however, to stay in line with the European Union's stated policy objective of keeping global mean temperature rise to less than 2°C above pre-industrial levels.

- **Carbon prices**
  In addition to achieving climate protection goals, strong emission reduction targets are necessary to bolster the price of carbon in emerging carbon markets. The regime also needs to be broadened so that we move towards a single global carbon market, with the maximum amount of liquidity to achieve the maximum emission reductions at the least cost.

  While the EU ETS and the Clean Development Mechanism are the two major segments of the market, and are growing enormously, they need to be broadened and deepened until they are truly global and the market is able to 'find' the right price for carbon.

  Achieving that objective may take significant experimentation and time, but it must be clear that that is the final objective, and that governments are agreed in sending the market a signal that the global economy needs to be largely decarbonised by 2050, and more or less completely decarbonised by the end of the century.

- **Technology transfer**
  One of the fundamental building blocks of the UNFCCC when it was first agreed in 1992 was the commitment by industrialised countries to provide for the development and transfer of climate-friendly technologies to developing countries. For various political and economic reasons this has been difficult to achieve in practice. Much technology has been 'transferred' or diffused throughout the globe but it is difficult to attribute this directly to the policies of the UNFCCC.

  Although the dissemination of climate-friendly technology has direct relevance to the wind industry, a fair balance of commitment between governments and the private sector in pursuing this objective still has to be agreed. If these parameters were clear, it is possible that a useful role for the UN system on this subject might be devised.

- **Expanded carbon markets**
  In pursuit of the final objective of a global, seamless carbon market, a number of steps should be taken. First and foremost, it is essential that the United States join the global carbon market, which was in fact designed largely at the instigation of the US and with the expectation that it would be the major 'buyer' on the global market.

  Secondly, the membership of Annex B needs to be expanded to include those countries which have recently joined the OECD and those whose economies have grown to reach or even exceed OECD or EU average income per capita. Thirdly, there are many proposals under discussion for improving the scope and effectiveness of the CDM in the period after 2012.

- **A sectoral approach for the power sector**
  To ensure the maximum uptake of emissions-reducing technology for the power generation sector, GWEC and others are exploring options for a voluntary *Electricity Sector Emissions Reduction Mechanism*[7]. The main characteristics of this proposal involve establishing a hypothetical baseline of future emissions in the electricity sector of an industrialising country, quantifying the effect of national policies and measures and on that basis establishing a 'no lose' target for the entire electricity sector. Reductions in emissions below that baseline would then be eligible to be traded as credits on international carbon markets, although there would be no penalty associated with not meeting the target.

The advantages of this system over the current project-based CDM would be in terms its relative simplicity and much greater scope. As well as providing potentially very large sources of investment in the decarbonisation of the energy sector of a rapidly industrialising country, it would incentivize energy efficiency as well as any other emission reducing technology without having to go through the application process on a project by project basis.. It would also be a good stepping stone between the current situation of non-Annex I countries and their eventual assumption of an economy wide cap as the regime develops

7 GWEC/Greenpeace China: A Discussion Paper on a Mechanism for Sectoral Emission Reduction Action (2009)

ABOUT GWEC
GLOBAL REPRESENTATION FOR THE WIND ENERGY SECTOR

GWEC is the voice of the global wind energy sector. GWEC brings together the major national, regional and continental associations representing the wind power sector, and the leading international wind energy companies and institutions. With a combined membership of over 1,500 organisations involved in hardware manufacture, project development, power generation, finance and consultancy, as well as researchers, academics and associations, GWEC's member associations represent the entire wind energy community.

THE MEMBERS OF GWEC REPRESENT:

- Over 1,500 companies, organisations and institutions in more than 70 countries
- All the world's major wind turbine manufacturers
- 99% of the world's more than 121 GW of installed wind power capacity

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ABOUT IWTMA
INDIAN WIND TURBINE MANUFACTURERS ASSOCIATION

The Indian Wind Turbine Manufacturers Association (IWTMA) is the only industrial body representing the country's wind turbine manufacturers, providing a single contact point for policy makers at national and state level, regulators and utilities. IWTMA's main objective is to promote wind energy in India, facilitate the extension of knowledge in the field and interact with national and global energy bodies.

IWTMA is a founding member of the Global Wind Energy Council (GWEC), alongside other national and regional associations including the European Wind Energy Association and the American Wind Energy Association.

IWTMA is also associated with industrial bodies in India, including FICCI, ASSOCHAM and CII. It also has close cooperations with ECN, RISO and EWEA through the European India Wind Energy Network (EIWEN).

IWTMA is represented on all Committees, Councils and Advisory groups constituted by the Ministry of New and Renewable Energy (MNRE), CWET and others, including financial institutions like IREDA.

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ABOUT WIND POWER WORKS

Wind Power Works is a global campaign to promote wind power as a key solution to combat climate change. The campaign is led by GWEC and backed by industry and associations around the world.

See *www.windpowerworks.net* for more detail.

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