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CHALLENGES AND OPPORTUNITIES FOR WIND POWER FOR FUTURE ENERGY SUPPLIES IN PAKISTAN

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Due to rapid modernization the energy resources are depleting rapidly throughout the world while the energy demand is rising steadily. The crude oil price has soared upto $140.0 per barrel that has triggered the use of renewable energy recourses. Pakistan particular is the most energy deficient country where a shortfall of as high as 4500 MW is recorded in the recent year. The Renewable Energy Technologies (RET's) are important and had gained the prime importance these days with specific focus on solar and wind power. This paper highlights the challenges and opportunities for wind power in Pakistan. The wind potential in different areas has been explored, including a vital area of about 9700 km^2 in Sindh. Wind power is a new energy resource in Pakistan's history, uptil now main resources are Fossil Fuel contributing 65%, hydel 33% and nuclear only 2% respectively. Wind is an environment friendly resource and its appreciable contribution will be achieved in future. Paper analyses the present energy scenario through wind power in Pakistan and leads to future progress in order to secure energy security in the country.

Keywords: RETs, Energy security, Wind power, Pakistan

1. Introduction

1.1. Challenges: Energy crisis in Pakistan

Pakistan's electricity production was nearly 3,000 megawatts short of demand in March 2008. Pakistan is experiencing these shortages despite its miserly electricity use with per-capita consumption of 546-kilowatt hours per year, a fifth of the global average of 2,586-kilowatt hours, according to statistics from the seven-nation South Asia Association for Regional Cooperation. The power outages have increased generator sales - and their price tags - but have also cooled sales of fans, air conditioners and other appliances with consumers asking why have such devices without the electricity to run them of Pakistan's 19,500 megawatts of production capacity, a little more than 60 per cent is from imported oil and domestic natural gas power plants. Hydro power generated from the country's two major dams accounts for about 30 per cent, and its one nuclear power plant produces less than five per cent. With power needed immediately, wind farms look good because they are relatively fast to install whereas dams and nuclear power plants take five to six years to complete and thermal power plants a couple of years at least [1].

As per Pakistan Economic Survey 2003-04, electricity consumption has increased by 8.6 per cent during first three-quarter of last fiscal year. However, a top level WAPDA official maintained that electricity demand surged upto 13 per cent during last quarter. The survey said household sector has been the largest consumer of electricity accounting for 44.2 per cent of total electricity consumption followed by industries 31.1 per cent, agriculture 14.3 per cent, other government sector 7.4 per cent, commercial 5.5 per cent and street light 0.7 per cent. Keeping in view the past trend and the future development, WAPDA has also revised its load forecast to eight per cent per annum as against previous estimates of five per cent on average. The report maintained that the difference between firm supply and peak demand is estimated at 5,529 MW by the year 2009-10 when firm electricity supply will stand at 15,055 MW against peak demand of 20,584 MW [2].

1.2. Power generation

No power generation project will commission during this fiscal year and the total installed capacity of electricity generation will remain 19,478 MW to meet 15,082 MW firm supply and 14,642 MW peak demands. Giving details of projects, the

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sources said Malakand-lll (81MW), Pehur (18MW) and combined cycle power plant at Faisalabad (450MW) are planned to be commissioned during the year 2007. Mangla Dam raising project would also add 150 MW capacity to the national grid by June 2007. Besides this, Khan Khwar (72MW), Allai Khwar (121MW), Duber Khwar (130MW) and Kayal Khwar (130MW) are expected to be completed in 2008 alongwith Golan Gol (106 MW) and Jinnah (96MW). Moreover, Matiltan (84 MW), New Bong Escape (79MW) and Rajdhani (132 MW) are expected by 2009 while Taunsa (120 MW) is likely to be completed by 2010. Sources say WAPDA has also planned to install a high efficiency combined cycle power plant at Baloki (450MW), which is expected to be completed by 2010. In addition of these, power plant 1 & 2 of 300 MW each at Thar Coal with the assistance of China are also planned for commissioning in 2009, sources said. Moreover, efforts are also under way with China National Nuclear Corporation for the construction of a third nuclear power plant with a gross capacity of 325 MW at Chashma, they added.[20]

1.3. Oil price hike

The overall energy requirement of Pakistan is expected to be about 80 million tons of oil equivalents (MTOE) in 2010, up by about 50% from the 54 MTOE of the current year. A major shortfall is expected in natural gas supplies, as an official energy demand forecast indicates that the demand for natural gas, which makes up about 50% of Pakistan's energy consumption, would increase by 44% to 39 MTOE from 27 MTOE currently [3]. Last week’s crude oil price surge will deal further blows to airlines worldwide. Already wounded by a 50% rise in oil prices since the beginning of this year, airlines face further capacity squeeze that will potentially lead to scrapping of more routes in the coming weeks. Crude oil is expected to test US$152 per barrel soon. This means airlines would have to pay more for their fuel bills. Many airlines have only hedged half of their fuel requirements this year and Malaysia Airlines Bhd (MAS) is one of them. It has 43% of its fuel requirements hedged this year compared with 70% last year. MAS and Air Asia are going for fuel efficient aircraft to counter the effects of high fuel prices. Soaring fuel costs would continue to affect airlines and so far, 26 airlines have collapsed since the beginning of 2008. Many airlines have issued profit warnings and MAS has made it clear that it would be a “tough’’ ride ahead. Singapore-based Standard & Poor's equity research analyst Shukor Yusof said: “The challenge for airlines is to be profitable. However, not all airlines can survive if crude oil continues to stay at high levels. There will be causalities globally.’’ With the capacity squeeze, flight delays and cancellations can be expected. To reduce cost, trimming of workforce is unavoidable and some American airlines have announced plans to lay off their workers. There seems little hope that any hike in airfares would fully cover the rising cost of fuel. Airfares are said to have gone up 20% in the last few months while fuel costs have shot up by 70% since last year [4].

Light, sweet crude for June delivery rose 16 cents to reach a settlement record of $123.69 a barrel on the New York Mercantile Exchange after trading lower for much of the day. Retail gasoline prices rose 2.7 cents to a record $3.645, according to a survey of stations by AAA and the Oil Price Information Service. Diesel prices also rose, adding 0.9 cent to match a record national average of $4.251 a gallon. Iran sees oil at $200 a barrel soon. Iran's oil minister predicted oil prices will soon rise to $200 per barrel. [5]

1.4. Gas price hike

The average price for a gallon of gas in the United States has surpassed the $3.00 mark and is currently at $3.07 per gallon. The sharp rise in gas prices has contributed to record high profits of the major oil companies. According to the Energy Information Administration, the US Department of Energy’s statistical agency, the recent increase in gasoline prices has been due to a “rise in crude oil prices, persistent refinery outages, and seasonal demand growth.” There have been indications of decreased refining capacity. Refinery outages and a decrease in imports have led to a sharp decline in gasoline inventories and are considered to be largely responsible for most of the recent increase in gasoline prices. Since the mid-1990s, due to a deliberate policy on the part of oil companies, US refineries have been operating near capacity. Outages like those that occurred in the wake of Hurricane Katrina in late 2005 have a large impact on gasoline inventories and have consequently driven up prices. Typically, refineries are shut down in the spring, usually justified on the grounds of regular maintenance and repairs. Among the reasons given for the rise in gas prices, one of the more plausible is the most simple: price gouging. Direct manipulation of the energy market, including through the manufacturing of “unplanned” refinery outages, has precedents.

As a result of a large number of mergers since the 1990s, 10 companies control 81 percent of the nation’s oil refineries. The nation’s top five oil companies—ExxonMobil, British Petroleum (BP), Royal Dutch Shell, Chevron and ConocoPhillips—own more than 40 percent of US refineries. Whatever the cause of the present increase in prices, there is no question that refineries are benefiting greatly as a consequence. On May 4, gross profit margins on gasoline refining rose 57 percent from the start of April to $31.22 a barrel. This is the second widest margin recorded in history, according to the New York Mercantile Exchange, and is double the margins from a year ago. The profits per barrel nearly surpassed the record set on September 1, 2005 in the aftermath of Hurricane Katrina, with a per barrel gross profit margin of $31.71 per barrel [6]. Powergen, one of the largest gas and electricity suppliers in the UK with around 9 million customers will be raising their domestic prices again. Electricity and gas prices will rise by 9.7% and 18.4% respectively, these rises being attributed to *"increasing wholesale costs, which have risen by 87% for both electricity and gas since the beginning of last year"* [7].

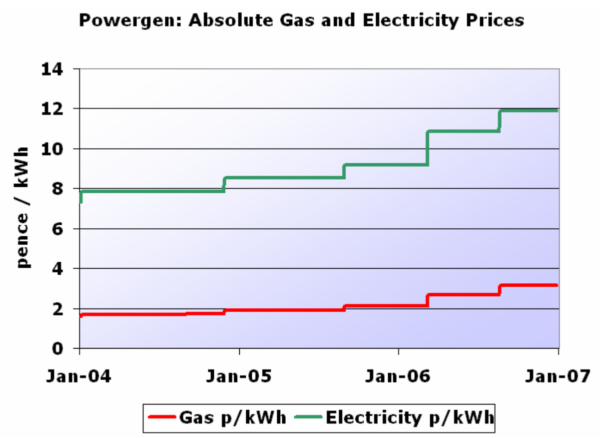

Figure 1. Gas and electricity prices

We can see that gas has increased from 1.61 p/kWh to 3.14 p/kWh and electricity has increased from 7.34 p/kWh to 11.89 p/kWh from the beginning of 2004 to the Aug 06 price rise. The p/kWh spread between gas and electricity has increased over this period with electricity now commanding an 8.75 p/kWh premium over gas where at the beginning of 2004 this was only 5.73 p/kWh.

1.5. Construction costs for new power plants continue to escalate

The costs of building new power plants have more than doubled since 2000, according to the most recent IHS CERA Power Capital Costs Index (PCCI). The latest IHS CERA PCCI shows that the cost of new power plant construction in North America has risen 130 percent in the last eight years. A majority of this cost increase has occurred since 2005, with the index rising 69 percent since then. The IHS CERA PCCI – which tracks the costs of building coal, gas, wind and nuclear power plants indexed to the year 2000 – is a proprietary measure of project cost inflation similar in concept to the Consumer Price Index (CPI). The IHS CERA PCCI now registers 231 index points, indicating a power plant that cost $1 billion in 2000 would, on average, cost $2.31 billion today.

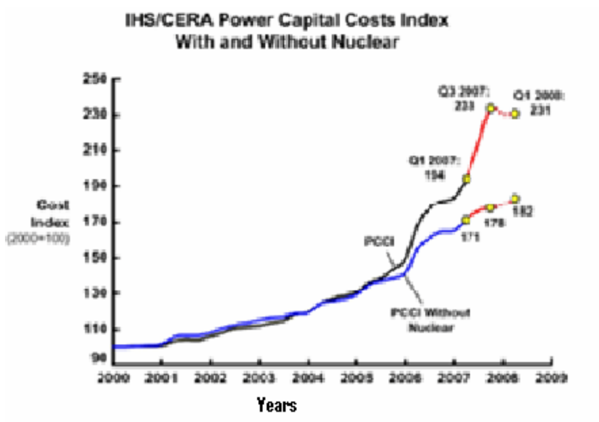

Figure 2. Power capital costs index with and without nuclear.

- Gas has increased by three percent since the third quarter of 2007 and 92 percent since 2000. This has been driven by manufacturers’ response to increased demand for gas turbine costs, as costs increase and lead times continue to extend for equipment delivery. Additional escalation can be attributed to continued increases in labor, engineering and construction costs.
- Coal has increased in cost by 2.3 percent since the third quarter of 2007 and 78 percent since 2000. Strong international demand for

boilers has sustained high cost levels. There has also been high demand for scrubbers in the United States as clean air provisions push utilities to retrofit their coal facilities in order to comply with the 2010 regulations.

1.6. Energy industry capital costs

The IHS CERA PCCI complements the IHS CERA Upstream Capital Costs Index (UCCI) and IHS CERA Downstream Capital Cost Index (DCCI) which measures the cost of construction of new oil and gas production projects such as platforms and pipelines and construction of new refineries and petrochemical plants. Both indices demonstrate the dramatic impact rapidly rising costs are having on the energy industry [8].

1.7. Cost comparisons for new power plants

The life-cycle cost calculations for most of the technologies likely to be used in new power plants. Calculations were made for the following types of plants:

- Sub critical and supercritical pulverized coal,
- Circulating fluidized bed (CFB),
- Integrated gasification combined-cycle (IGCC),
- GE advanced boiling water reactor (ABWR),
- South African pebble bed modular reactor (PBMR) and
- Gas fired combined cycle power plants.

It presents a consistent comparison of the economics and risks of representative designs that are being considered in the power marketplace for projects requiring investments of $1 billion or more. Results of the calculations are presented in graphic form for total capital investment in dollars and dollars per kW, levelized production costs (cost of electricity produced) and a comparison of costs for coal plants with and without sequestration. The cost of electricity for all of the coal fired plants, which were all sized for 500 MW, only varies from just over $0.06 for the two pulverized coal plants to about $0.066 for the CFB plant to about $0.068 for the IGCC plant. The 500 MW size was selected for coal plants and the gas plant because it is the crossover point for costs for the two types of pulverized coal plants. Below 500 MW the subcritical plants are less expensive and above 500 MW the supercritical plants are less expensive.

Electricity produced by the two nuclear power plants were $0.058 for the ABWR and $0.06 for the PBMR. The ABWR was sized for 1370 MW, as this is the only size that it will be made and the PBMR was sized to use the 168 MW module that is being used in the South African plant. The combined cycle gas plants could produce electricity at about $0.14 for $11/MMBtu gas and $0.098 for $7/MMBtu gas.

The difference in cost for the coal plants is directly attributable to differences of capital costs. The nuclear plants had capital cost charges per kW about the same as a CFB coal plant but the fuel costs less than half that of the coal plants. The natural gas plants had very low capital cost charges and very high fuel costs [9].

1.8. Capital requirements

A comparison of total capital investment required for each plant in $2006 dollars is shown in Figure 3. Figure 4 presents these values based on $/net kW.

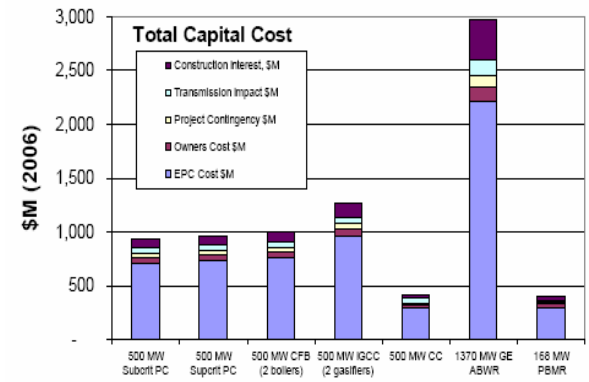

Figure 3. Total capital investment.

The magnitude of these capital requirements is significant. The conventional 500 MW coal projects require on the order of $1B in financing (note that the CFB has two units that could be staged each with about a $0.5B investment). The 1371 MW nuclear unit requires a total investment of over $3B. A 500 MW combined cycle, and a 168 MW PBMR nuclear module each require only $0.4B.

1.9. Annual production costs

Annual first year production costs (2006$) for each plant are shown in Figure 5. Levelized costs in $/MWh are shown in Figure 6.

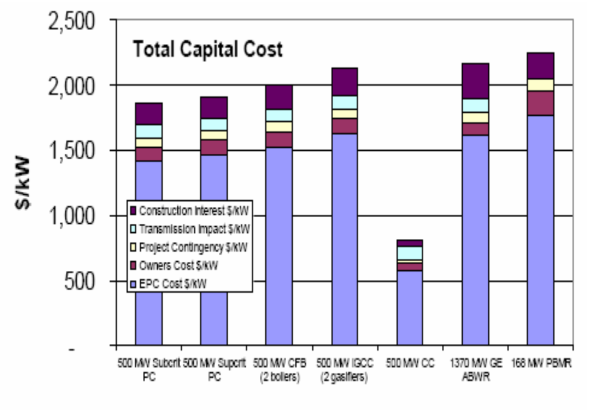

Figure 4. Total Capital Investment per KW.

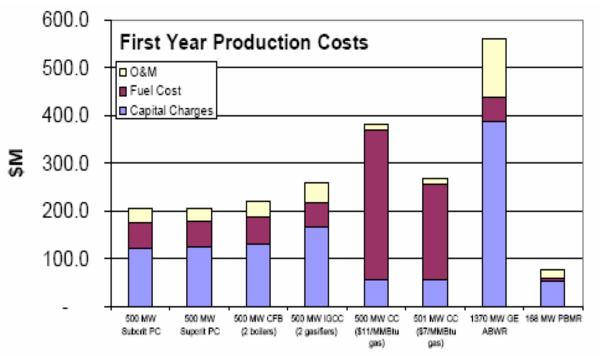

Figure 5.. First Year Production Costs

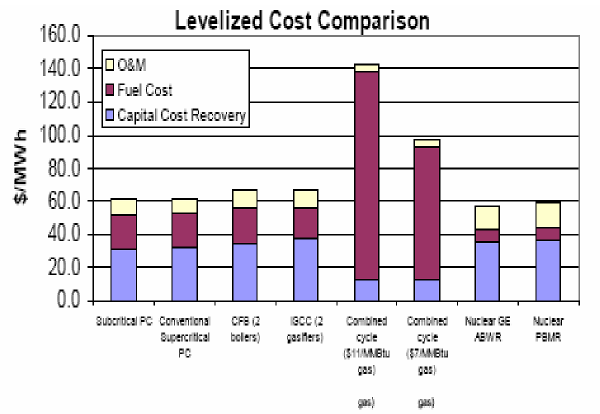

Figure 6. Levelized production costs.

It is significant to note that the annual cash flows for these projects range from $200M/yr for conventional coal units to $550M/yr for the ABWR. The small 168 MW PBMR module may see a smaller cash flow of less than $100M/yr and a single 250 MW CFB unit would see cash flows slightly higher. The overall levelized costs based on the assumptions in this analysis show that all of the coal and nuclear options are generally competitive on a busbar cost basis. This is due in part to the assumptions used, in that 500MW represents a breakeven point between supercritical and sub critical pulverized coal designs at $1.50/MMBtu coal fuel cost; also this coal price is close to a breakeven value with the nuclear units.

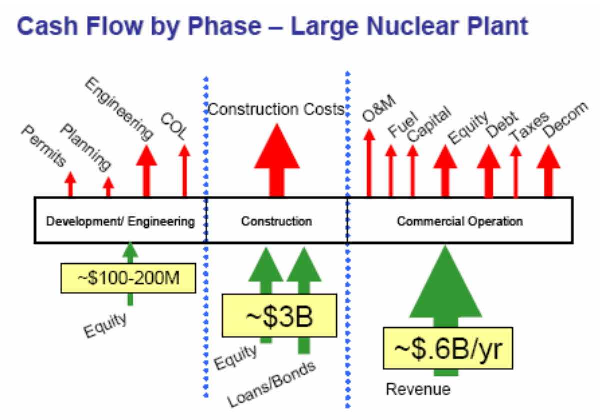

Figure 7. Cash Flow Requirements for a Nuclear Project.

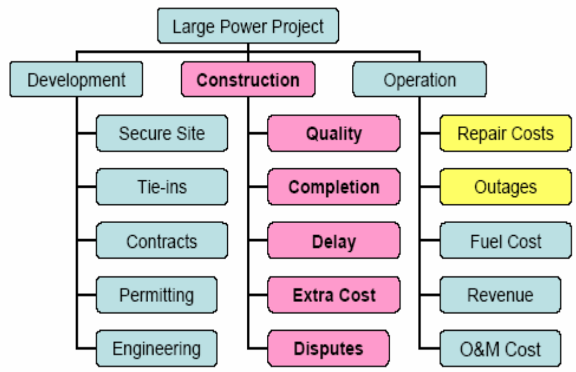

Figure 8. Major Risks by Project Phase.

The rough cash flow requirements of a large nuclear plant and some of the most significant areas of project risk are shown in figures 7 and 8 respectively.

2. Opportunities

2.1. Renewable energy technologies

At present, the world relies heavily on coal, oil, and natural gas for its energy - fossil fuels which are non-renewable. These fuels draw on the earth's finite resources that will eventually run out, becoming increasingly expensive and too environmentally damaging to extract as time goes on.

The use of fossil fuels is now accepted worldwide to be contributing to global warming and climate change. Renewable energy - solar, wind, hydro (water), biomass - is constantly replenished and will never run out. Most renewable energy comes either directly or indirectly from the sun. Solar energy can be used directly for generating electricity, hot water heating and solar cooling, and is suitable for a variety of domestic, commercial and industrial uses.The heat from the sun creates the winds, and this wind energy is captured by turbines which produce electricity. Sunlight also causes plants to grow. The organic matter produced by plants is known as biomass. Biomass can be used to produce electricity, heat and transportation fuels such as bio-diesel.

The energy from water flows in streams and rivers comes from the sun - the hydrological cycles are driven by evaporation - and can be tapped to generate power via water turbines, so producing hydro-electricity. Wave power is generated by winds, which are created by the heat from the sun, whereas tidal power is driven by gravitational energy affected by the sun's mass [10]. Geothermal energy is energy obtained by tapping the heat of the earth itself, usually from kilometers deep into the Earth's crust. It is expensive to build a power station but operating costs are low resulting in low energy costs for suitable sites. Ultimately, this energy derives from heat in the Earth's core [11].

2.2. Wind energy

A wind turbine is a machine made up of two or three propeller-like blades called the rotor. The rotor is attached to the top of a tall tower. As the wind blows it spins the rotor. As the rotor spins the energy of the movement of the propellers gives power to a generator. There are some magnets and a lot of copper wire inside the generator that makes electricity. Because winds are stronger higher up off the ground, wind turbine towers are about 30 metres tall to allow the rotor to catch more wind energy. The turbines are built with a device that turns the rotor so that it always faces into the wind. Just one wind turbine can generate electricity for a single house or the electrical energy to pump water or to power a mill which grinds grain. The electricity can be used to charge batteries which store the electrical energy.

2.3. Wind farms

Wind farms are places where many wind turbines are clustered together. They are built in places where it is nearly always windy. The electricity that is generated at a wind farm is sold to electricity companies to provide the electricity to people living in cities and towns [12]. At the end of 2007, worldwide capacity of wind-powered generators was 94.1 gigawatts. Although wind currently produces about 1% of world-wide electricity use, it accounts for approximately 19% of electricity production in Denmark, 9% in Spain and Portugal, and 6% in Germany and the Republic of Ireland (2007 data). Globally, wind power generation increased more than fivefold between 2000 and 2007 [13].

Figure 9. Wind farms.

Taking advantage of a particularly gusty period, Spain's wind energy generators this week reached an all-time high in electricity production, exceeding power generated by any other source, the nation's electricity network authority said in a statement. Wind power generation rose to contribute 27 per cent of the country's total power requirement, Wind power contributed 8,375 mega watts to the nation's power consumption of 31,033. Nuclear power, the second largest contributor, added 6,797 mega watts, while coal-fired electric generation came third with 5,081 [14].

Northwest China's Ningxia Hui Autonomous Region will build nine new wind power plants with an investment of $2.2 billion by 2020, according to the local government. The region is expected to become the country's biggest wind power generator in 2020, when it will have the installed capacity of 2.15 million kw.

Table 1. Installed wind power capacity (MW).

Installed wind power capacity (MW)				
Rank	Nations	2005	2006	2007
1	Germany	18,415	20,622	22,247
2	United States	9,149	11,603	16,818
3	Spain	10,028	11,615	15,145
4	India	4,430	6,270	8,000
5	China	1,260	2,604	6,050
6	Denmark (& Faeroe Islands)	3,136	3,140	3,129
7	Italy	1,718	2,123	2,726
8	France	757	1,567	2,454
9	United Kingdom	1,332	1,963	2,389
10	Portugal	1,022	1,716	2,150
11	Canada	683	1,459	1,856
12	Netherlands	1,219	1,560	1,747
13	Japan	1,061	1,394	1,538
14	Austria	819	965	982
15	Greece	573	746	871
16	Australia	708	817	824
17	Ireland	496	745	805
18	Sweden	510	572	788
19	Norway	267	314	333
20	New Zealand	169	171	322
21	Egypt	145	230	310
22	Belgium	167	193	287
23	Taiwan	104	188	282
24	Poland	83	153	276
25	Brazil	29	237	247
26	South Korea	98	173	191
27	Turkey	20	51	146
28	Czech Republic	28	50	116
29	Morocco	64	124	114
30	Finland	82	86	110
31	Ukraine	77	86	89
32	Mexico	3	88	87
33	Costa Rica	71	74	74
34	Bulgaria	6	36	70
35	Iran	23	48	66
36	Hungary	18	61	65
	Rest of Europe	129	163	
	Rest of Americas	109	109	
	Rest of Asia	38	38	
	Rest of Africa & Middle East	31	31	
	Rest of Oceania	12	12	
	World total (MW)	59,091	74,223	93,849

Ningxia's installed capacity of wind power stood at 112,200 kw in 2005, according to the China Electricity Council, an association of Chinese electricity plants. The region ranks fourth in wind power capacity, after Inner Mongolia and Xinjiang Uygur Autonomous Regions, and Liaoning Province. The country has set a target of raising the proportion of renewable energy such as wind and solar power in its total energy supply to 10% by 2010 and to about 16% by 2020 [15].

China -Top wind turbine manufacturer in 2009

Domestic Chinese manufacturers will have an annual production capacity of approx. 10 gigawatts per year by the end of 2009. China will leap to be the top wind turbine producer in 2009, transforming an already fast-growing renewable energy sector [16].

There are now many thousands of wind turbines operating, with a total capacity of 73,904 MW of which wind power in Europe accounts for 65% (2006). World wind generation capacity more than quadrupled between 2000 and 2006. 81% of wind power installations are in the US and Europe, but the share of the top five countries in terms of new installations fell from 71% in 2004 to 62% in 2006. In 2007, the countries with the highest total installed capacity were Germany, the United States, Spain, India and China (see chart).

By 2010, the World Wind Energy Association expects 160GW of capacity to be installed worldwide, up from 73.9 GW at the end of 2006, implying an anticipated net growth rate of more than 21% per year. In recent years, the United States has added more wind energy to its grid than any other country; U.S. wind power capacity grew by 45% to 16.8 gigawatts in 2007. India ranks 4th in the world with a total wind power capacity of 6,270 MW in 2006, or 3% of all electricity produced in India. In 2005, China announced it would build a 1000-megawatt wind farm in Hebei for completion in 2020. China reportedly has set a generating target of 20,000 MW by 2020 from renewable energy sources — it says indigenous wind power could generate up to 253,000 MW [17].

UNDP/GEF Wind Energy Project (WEP)

United Nation Development Program UNDP have initiated project “Sustainable Development of

Commercial Scale Wind Power Generation Project" referred to as Wind Energy Project (WEP). The project is being funded by Global Environment Facility (GEF) and implemented through Alternative Energy Development Board (AEDB), Government of Pakistan. Duration of project is three years (August 2006-July 2009) and its budget is US $3.1 Million. This project was initiated to establish a wind power industry in the country. Removing policy, regulatory and technical barriers to provide investments in wind farms. Short term policy up till June 2008 is to create conductive environment for investment in wind energy to put Pakistan on the renewable energy map of the world. Phase 2 will consist of initial implementation of the specific enabling environment including contractual and financial conditions to sustain the on grid energy operations on a continued basis.

2.3. Opportunities in wind power sector

Pakistan Meteorological Department (PMD) with the financial collaboration of Ministry of Science & Technology (MoST), has completed its project entitled "Wind Power Potential Survey of Coastal Areas of Pakistan (Phase-I)" in June 2005. Phase-II consisting of Wind Mapping of Northern Areas of Pakistan is own going since July 2005. The primary sources of energy available in Pakistan are oil, natural gas, hydro and nuclear Power. At present oil accounts for approximately 45% of total commercial energy supply. The share of natural gas is 34% while that of hydel power remains roughly at 15%. The increase in cost of fossil fuel and the various environmental problems of large scale power generation have lead to increased appreciation of the potential of electricity generation from non-conventional sources. Wind generated electric power output at Gharo has been estimated by using the 600kW wind turbine Bonus 600/40 MK IV type. The cut-in wind speed of turbine is 3m/s and cutout wind speed is 25m/s. Rotor diameter is 44 meters and hub height has been taken as 50 meter. The monthly and annual wind generated electric power output at Gharo-Sindh alongwith capacity factor are given in Table 2.

Sindh coastal areas have greater wind power potential than Balochistan coastal areas. Potential areas cover 9700 sq.km in Sindh. The gross wind power potential of this area is 43000 MW and keeping in view the area utilization constrains etc. the exploitable electric power generation potential of this area is estimated to be about 11000MW. Feasibility study for the installation of 18 MW Model wind power project is prepared. Total cost of the project is estimated to be about Rs. 850 million and the pay back period would be 7-8 years. The levelised cost of power generation is estimated as Rs. 2.9/kwh [18].

Table 2. Hypothetical wind generated electric energy output & capacity factor for a bonus 600/44MK IV turbine at Gharo.

Months	Capacity Factor	kWh per Month
January	13%	57745
February	16%	65384
March	16%	69869
April	30%	127689
May	60%	268240
June	45%	194703
July	68%	305321
August	35%	157142
September	43%	187858
October	12%	53867
November	10%	44324
December	13%	59327
Annual	28%	1495808

Table 3. Wind turbine specifications.

S. No.	Description	Unit	Type
1	Turbine		Bonus 600/40 MK IV
2	Power	kW	600
3	Cut-in wind	m/s	3
4	Cut-out wind	m/s	25
5	Rotor diameter	m	44
6	Hub height	m	50

Table 4. Wind turbine specifications.

S. No.	Description	Unit	Type
1	Plant Capacity	MW	
2	No of wind Turbines	Number	
3	Plant factor	(Estimate %)	30
4	Life time	Year	20
5	Weight of Heaviest part*	Ton	20
6	Weight of tower*	Ton	20-30

Figure 10. Wind Mapping of Coastal Areas along Sind

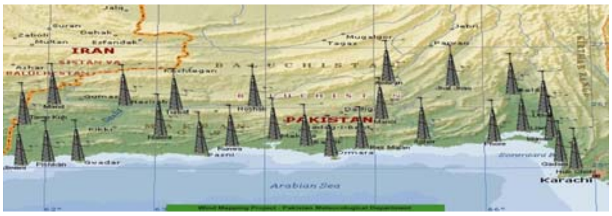

Figure 11. Wind Mapping of Coastal Areas along Baluchistan

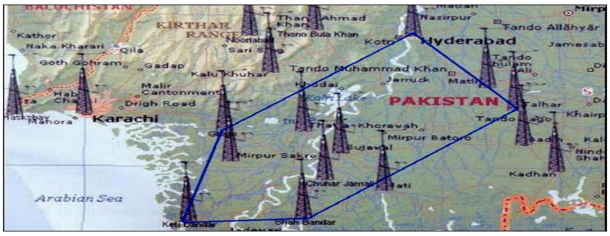

Figure 12. Wind Potential Areas along the Sind Coast.

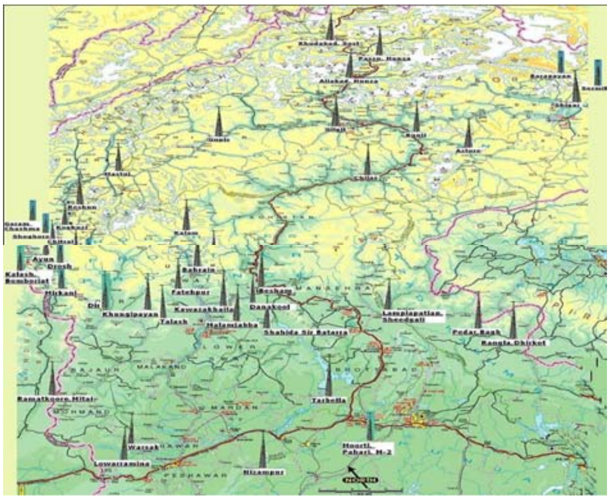

Figure 13. Wind mapping of northern areas of Pakistan.

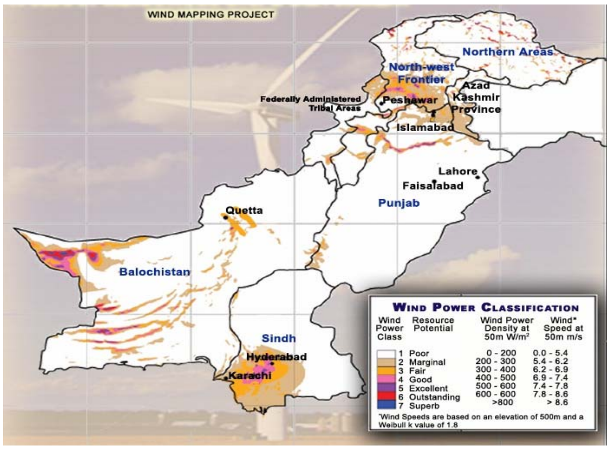

Figure 14. Wind power potential throughout Pakistan.

The above graphs show that there is a lot of wind potential throughout Pakistan like wise in India [19] and world wide [21] which should be exploited as early as possible in order to fulfill the energy demand of the country.

3. Concluding Remarks

Wind Power has a bright future in Pakistan and can improve the power production scenario in the country. Wind is a clean source and as it is being analyzed the coastal areas in Sind have a vital potential which needs to be harvested. The potential areas along the Sind Coast include Jamshoro, Nooriabad, Hyderabad, Gharo, Thatta, Kotri, Matli, Talhar, Shah Bandar, Keti Bandar and Mirpur Sakro. The coastal areas in Baluchistan include Liari, Hub Chowki, Jiwani, Pasni, Gawadar, Ormara and Gadani. The exploitable wind power potential in Sind is about 11000 MW which is an appreciable value and needs to be harvested. The potential Northern Areas are near and around Peshawar mainly Shaheed Gali,Chitral etc.

In the present scenario with rising oil and gas prices and construction cost of fossil fuel plants, these challenges can be faced by making use of the opportunities which are hidden in Wind Power. Therefore, there is a vital Wind potential in Sind, Baluchistan and the Northern Areas in North Western Frontier Province in Pakistan which if harvested can be a clean and cheap source of energy and it would lead to the progress and prosperity of country and the country would be energy self sufficient. Hence Wind energy would be an important energy source for Pakistan in near future.

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