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FUTURE OF PAKISTAN'S ENERGY SECURITY: AN ALTERNATE APPROACH

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Abstract

Internationally, the stress on energy resources is growing. Pakistan is no exception. The country does not have fossil fuel reserves and spends heavily on their import, yet power outages have become frequent in recent years. Energy scarcity would increase with population growth if resources other than the present thermal-based power sector are not tapped. Advances in technology have made new sources of power generation available that are not only affordable and reliable but are also environment friendly. Among them is wind power whose share in energy generation is rapidly growing. Today, wind energy alone provides 198 GW globally — a big achievement for a relatively new technology, particularly in comparison with hydro power's 1010 GW globally. Many countries are now using this source to meet their energy needs. It is estimated that Pakistan can produce 50,000 MW electricity from wind in the Sind province alone. It means the country can exploit this inexhaustible natural resource to ward off the current crisis as well as to meet its future energy needs. Wind energy is viable economically as tech-savvy companies are eager to offer joint ventures in the field.

Key Words: Pakistan, Energy Security, Alternate Energy, Wind, Solar.

Introduction

Economic progress needs secure energy supplies. In developing countries poverty reduction is critically dependent on economic progress. The Commission for Sustainable Development (CSD-9) held in 2001 noted: "To implement the goal accepted by the international community to halve the proportion of people living on less than US$ 1 per day by 2015, access to affordable energy services is a prerequisite."[1]

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[1] Quoted in Sabira Qureshi, "Energy, Poverty Reduction and Equitable Development in Pakistan," in *Powering Pakistan – Meeting Pakistan's Energy Needs in the 21st Century,* ed. Robert M. Hathaway and Michael Kugelman (Karachi: Oxford University Press, 2009), 96.

Gross Domestic Product (GDP) growth is closely linked to energy usage. "The lack of access to modern energy services is inextricably linked to poverty…".[2] In Pakistan, only 60 per cent of the country's population has access to electricity, and less than 50 per cent is linked to the national grid.[3]

This paper discusses the problem of energy shortage in Pakistan and how it can be solved. It has four sections. The first section examines the issue of energy security in Pakistan both in general and technical terms. In the second, the implications of electricity shortages are briefly discussed; while the third and fourth sections explore renewable options for energy security and future energy needs of Pakistan. The findings are summed up in the conclusion.

The Issue

Background

The age of fossil fuels that began with the discovery of oil in mid 19th century and brought about tremendous changes in all aspects of life is approaching its end as fossil fuels that took millions of years to accumulate, are non-renewable. This presents us with a dreadful scenario as virtually all activities of contemporary life had become dependent on the use of fossil fuels.

The population increase has put enormous stress on these reserves. The Production to Reserves ratio is declining.[4] How the world will maintain the pace of progress and development once the fossil based fuels are gone is the big question that confronts leaders, scientists, and engineers. In fact, whether one is aware of it or not, it is a universal challenge.

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[2] Bikash Pandey, "Clean Energy Options for Rural Pakistan: Lessons from South Asia," in *Powering Pakistan – Meeting Pakistan's Energy Needs in the 21st Century,* ed. Robert M. Hathaway and Michael Kugelman (Karachi: Oxford University Press, 2009), 143.

[3] Aram Zamgochian, "US Chamber of Commerce Energy Overview for the Islamic Republic of Pakistan," in *Powering Pakistan – Meeting Pakistan's Energy Needs in the 21st Century,* Robert M. Hathaway and Michael Kugelman (Karachi: Oxford University Press, 2009), 181.

[4] Global R/P ratio for oil in 2010 is 46.2, which means that at the current pace of production the current proven oil reserves of the world would last for 46.2 years,http://www.bp.com/sectiongenericarticle800.do?categoryId=9037157&contentId=7068604. The global R/P ratio for natural gas has declined from 62.7 in 2009 to 58.6 in 2010, http://www.bp.com/sectiongenericarticle800.do?categoryId=9037178&contentId=7068624. The R/P ratio of coal has declined from 210 in year 2000 to 118 in 2010,http://www.bp.com/sectiongenericarticle800.do?categoryId=9037183&contentId=7068609.

Energy and Electricity

Electricity is a sub-sector of energy. It is the fastest growing and the most demanded and efficient form of energy. However, energy is not all about electricity. In the areas that are not connected to national grids, energy in other forms is needed for cooking, heating, lighting, irrigation, and other purposes.[5] Electricity today is a critical component of energy yet 18.57 per cent of the world population still has no access to it. With the increasing population and growing demand for electricity due to changing life style, the dwindling fossil fuel resources are making it increasingly difficult and challenging to provide energy security to the coming generations. It is a world wide problem that transcends national boundaries.

Pakistan's Electricity Scenario: Overview

The growing demand and supply gap in terms of energy in general and electricity in particular also afflicts Pakistan. According to *World Energy Outlook-2011*, sixty-four million people in Pakistan do not have access to electricity, whereas 112 million still use biomass for cooking.[6] Energy insecurity haunts the country's economic future as fossil-based fuel reserves are insufficient, electricity production depends on oil imports whose cost daily rises in the international market. The oil import bill of the country has reached 12 billion dollar a year.[7] Despite huge spending and low per capita consumption of electricity (as indicated in Table-I), the country remains unable to meet the demand. Long hours of power outages in the country are resulting in mass public protests. Load-shedding has become a regular topic of newspaper editorials. The economic losses due to closure of small industries and workshops are incalculable. If the situation persists it may trigger political unrest and destabilise the country.

[5] Bikash Pandey, "Clean Energy Options for Rural Pakistan," 145.

[6] *World Energy Outlook 2011 – Energy for all: Financing Access for the Poor* (Oslo: International Energy Agency, October 2011), 11.

[7] Pakistan's petroleum import bill was around US$ 3 billion in 2004, and soared to US$ 8 billion in 2007. See, Sumita Kumar, "Pakistan's Energy Security: Challenges and Options," *Strategic Analysis* vol. 34, no. 6 (November 2010): 916.

Table-I
Selected Indicators for Selected Countries - Year 2009[8]

Country	Population	GDP in Billion 2000 US$	Total Primary Energy Supply	Electricity Consumption/ Population (Kwh/capita)
Pakistan	169.71	111.48	85.52	451
India	1,115.35	874.94	675.83	597
DPRK	23.91	11.53	19.27	743
PRC	1,331.46	2,937.55	2,257.10	2,631
Hong Kong (China)	7.00	231.34	14.94	5,924
Germany	81.88	1,998.65	318.53	6,781
France	64.49	1,472.79	256.22	7,494
Singapore	4.99	143.47	18.48	7,948
South Korea	48.75	752.83	229.18	8,980
The US	307.48	11,357.07	2,162.92	12,884
Canada	33.74	846.83	254.12	15,467
Norway	4.83	195.96	28.24	23,558

The problem gets added importance in the backdrop of the changing demographic realities of the country. Pakistan is witnessing a youth bulge. This generation is likely to consume much more power than did the generation of its parents. It is projected that the demand for electricity would rise to 36,000 megawatt (MW) by 2015, and 114,000 MW by the year 2030.[9] If the state remains unable to end energy poverty, particularly deficiency of electricity, the youth's potential energies will be wasted. Even at present the country's per capita usage of energy is abysmally low at 451 KWh. Table-I provides a comparison of per capita consumption in various countries.

Pakistan's Electricity Situation - Technical Data

At present Pakistan's total installed capacity for electricity generation is 19,786 megawatt[10] - 6,481 megawatt hydro and 12,842 MW thermal (aggregate of WAPDA, KESC, and IPPs); the nuclear contribution is merely 462 megawatt.[11] The hydro capacity has risen from 5,055 megawatt in June 2003 to 6,481 megawatt in June 2009; thermal installed capacity has increased from 12,285 MW to 12,842 megawatt in the same period. The nuclear production

[8] *Key World Energy Statistics - 2011* (Paris: International Energy Agency, 2011), 48-57.
[9] Sumita Kumar, "Pakistan's Energy Security," 922.
[10] "Compendium on Environment Statistics of Pakistan -2010," *Federal Bureau of Statistics*, Government of Pakistan, June 30, 2009, 94.
[11] Ibid. 93-94.

has remained static. According to *Compendium on Environment Statistics for Pakistan – 2010*, the share of thermal capacity in total generation in 2009 was 64.9 per cent which has scaled down from over 69 per cent in 2003.

In thermal power generation, only the use of coal declined during the period 2002-3 to 2008-9 from 91,101 tones of oil equivalent (toe) to 50,341 toe, while the use of furnace oil increased from 5,779,335 toe to 7,210,211 toe; of diesel oil from 88,850 toe to 173,945 toe and of gas from 6,440,342 toe to 7,830,065 toe. The total fuel consumption in thermal power increased from 12,399,628 toe to 15,264,564 toe during this period.[12]

Implications of Electricity Shortages in Pakistan

All industries in the country have suffered badly due to power outages. "Electricity shortages have worsened the country's already slumping export sector, while the skyrocketing rise in oil prices threatens Pakistan's financial solvency."[13] This loss of steam in financial and economic sectors translates into developmental and social losses. "High energy costs have generated across-the-board inflation and slowed economic growth, which costs jobs and raises the spectre of political unrest."[14] In the short and long term, the negative fallout of electricity shortages may erode the capacity of social and political order to sustain. As noted by Hathaway, "An energy-deficient Pakistan will be poor, politically unstable, and environmentally unsustainable."[15]

Renewable Options for Energy Security and Global Trends

The better known and used among the renewable sources of energy are hydro and nuclear. But advancements in science and technology have enabled the contemporary world to harness the energy from various other sources as well. Today, we have many viable options available in the form of renewable energy. These include: nuclear, hydro, solar, wind, biomass, tidal, geo-thermal, and wave energy.

Globally, renewable energy's usage in power generation is increasing. In the year 2010, renewable energy used in "power generation grew by 15.5 %, driven by continued robust growth in wind energy (+22.7%)."[16] The share of these renewable forms (excluding hydro and nuclear) in global energy

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[12] Ibid., 96.

[13] Robert M. Hathaway, "Introduction," in *Powering Pakistan – Meeting Pakistan's Energy Needs in the 21st Century,* ed. Robert M. Hathaway and Michael Kugelman (Karachi: Oxford University Press, 2009), ix.

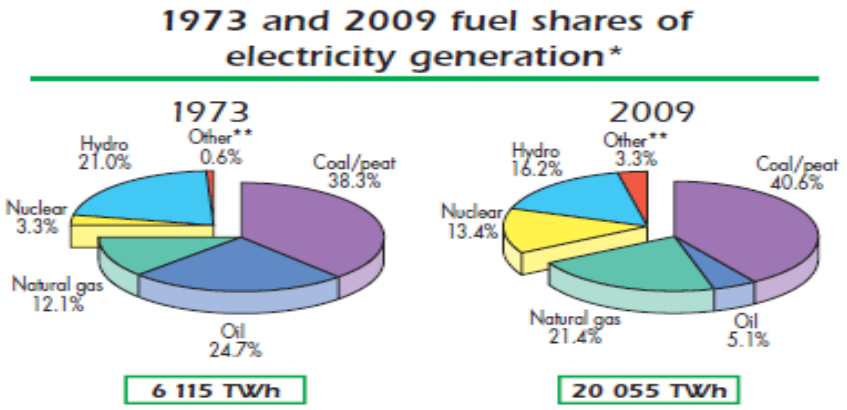
[14] Ibid.

[15] Ibid., xiii.

[16] "BP Statistical Review of World Energy: June 2011," 5, www.bp.com/statisticalreview.

consumption grew from 0.6 per cent in 2000 to 1.8 % in 2010.[17] See figure I for a comparison of fuel shares for electricity generation in 1973 and 2009.

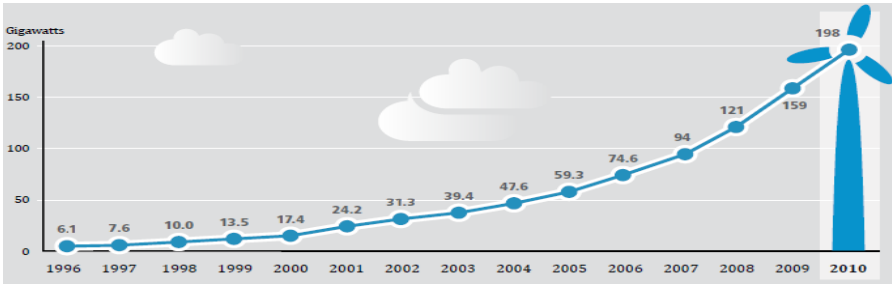
Figure-I
Fuel Share of Electricity Generation – 1973 and 2009[18]



* Excludes pumped storage
** Other includes geothermal, solar, wind, bio-fuels and waste, and heat.

The hydro source had been an early entrant in the field of renewables because of its technological simplicity. The nuclear source, despite being technologically sophisticated, got importance because of its immense potential, and advanced countries' preference to harness it. However, with the coming stress on hydro resources, and problems associated with nuclear generated energy, the world began moving to new renewables to stave off the coming scarcity in fossil fuel resources. The focus now is fast shifting to other renewables; the wind and solar technologies being in the lead.

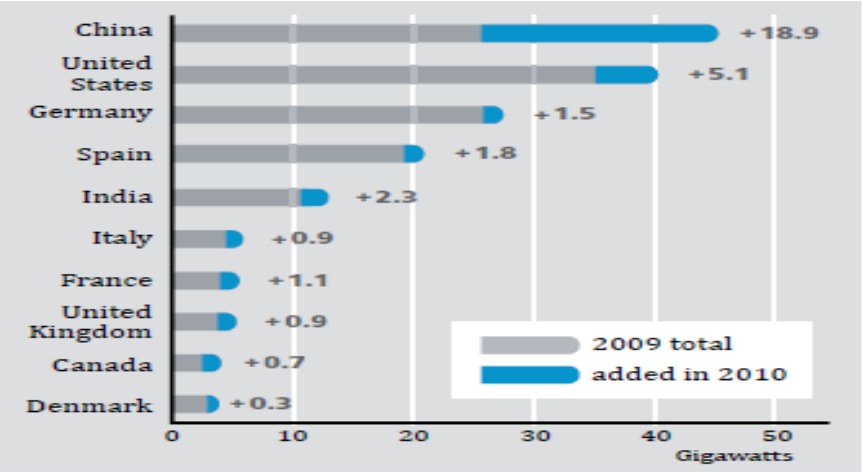
Figure-II
Wind Power Existing World Capacity 1996-2010[19]



[17] Ibid., x
[18] *Key World Energy Statistics - 2011*, 24.
[19] REN21.2011. *Renewables 2011 Global Status Report* (Paris: REN21 Secretariat, 2011), 20.

Wind is the fastest growing renewable source for producing electricity. As depicted in the figure II, total wind electricity generation capacity has grown from 6.1 gigawatt (GW) in 1996 to 74.6 GW in 2006. Since then, it has jumped to 198 GW in another five years; making it around one-fifth of the total hydro-based electricity generation worldwide.[20] The figure III depicts the world's top ten countries in installed wind generation capacity. It is important to note that China's wind generated electricity capacity increased to 18.9 GW in the year 2010 alone. This capacity increase in the wind sector alone nears the total installed capacity of electricity generation in Pakistan.

Figure-III
Wind Power Capacity, Top Ten Countries 2010[21]



Growth of renewables worldwide provides an opportunity to gradually bring down the current reliance on fossil fuels that emit green house gases and pollute the environment. Whereas the world is shifting to renewable energy, particularly wind, Pakistan's policy has been very modest as to targets and slow in implementation. The Alternate Energy Development Board of Pakistan has failed to show the country on the global map of non-traditional renewables.

Future Energy Needs of Pakistan and Options

The per capita energy usage in the country is expected to take a sharp turn upward in the future for the combination of the following factors: extremely

[20] Global total hydro power capacity is 1010 GW, where as wind power capacity has reached to 198 GW as of 2010. REN21.2011. *Renewables 2011 Global Status Report*, 12-13.
[21] REN21.2011, 20.

low per capita usage of energy at present, the youth bulge, and increasing access for a large segment of population to modern amenities of life. Policy makers would be faced with the huge task of finding options to meet the increasing gap that daunts the country.

Pakistan's population is also increasing fast. From 129.7 million in 1998, it has reached to 173.53 million in 2010, and is projected to hit 210.12 million in 2020 and 242.06 million in 2030.[22] It is projected to rise to 335 million by the year 2050, making it the fourth most populous country in the world.[23] The search for resources to feed the country's energy needs is going to be frantic in the years to come.

On the rural side, biogas from animal waste can provide energy for the kitchen and thus help mitigate the increasing use of liquefied petroleum gas.[24] There are several issues related to management that deserve policy makers' attention. For example, billing losses in distribution companies are 17 per cent, which is very high.[25] To reduce these losses management and administration will have to be improved. In addition to administrative issues, "poor quality of infrastructure causes an estimated 30 per cent loss of (sic) transmission per year."[26]

Policy makers will also have to act on the demand side to keep it low by promoting efficient use of energy. Conservation of energy is desperately needed in Pakistan on a war footing, today.[27]

Fossil Fuels

Oil and gas make a bad choice for meeting the future energy needs. As has been noted in Asian Development Bank's January 2010 report, the current

[22] "Compendium on Environment Statistics of Pakistan -2010," 3.

[23] Ibid., 4.

[24] For details see, Shaukat Hameed Khan, "Technology Status and Costs of Emerging Alternative Sources," in *Powering Pakistan – Meeting Pakistan's Energy Needs in the 21st Century,* ed. Robert M. Hathaway and Michael Kugelman (Karachi: Oxford University Press, 2009), 59.

[25] For detailed breakdown of losses in year 2007, see, Vladislav Vucetic and Achilles G. Adamantiades, "Power Sector Reform in Pakistan: Issues and Challenges," in *Powering Pakistan – Meeting Pakistan's Energy Needs in the 21st Century,* ed. Robert M. Hathaway and Michael Kugelman (Karachi: Oxford University Press, 2009), 76.

[26] Aram Zamgochian, "US Chamber of Commerce Energy Overview for the Islamic Republic of Pakistan," in *Powering Pakistan – Meeting Pakistan's Energy Needs in the 21st Century,* ed. Robert M. Hathaway and Michael Kugelman (Karachi: Oxford University Press, 2009), 178.

[27] Conservation in all fields in the country could save a good amount of energy that could then be purposefully used in other activities. In WWII, when Germans developed the first jet fighter, "they were so short of oil that they had to use oxen to pull the jet onto the runway, to conserve aviation fuel," quoted in Jan H. Kalicki and David L. Goldwyn, eds., *Energy and Security – Toward a New Foreign Policy Strategy* (Washington D.C.: Woodrow Wilson Center Press, 2005), 60.

crisis of load shedding in Pakistan "to a large extent is a fuel crisis caused by unexpected and unmitigated increase in Residual Fuel Oil (RFO) prices and by delays in finding a substitute for the depleting domestic gas supplies."[28]

However, since Pakistan has already invested heavily in the gas sector, it should keep this option open and pursue gas pipeline projects such as IPI, and TAPI. The country has an integrated network of transmission 9,257 km long, and distribution and service lines networks covering 74,186 km.[29] This network that has been developed over the last five decades is an asset. However, when planning for the long term, the declining reserve to production (R/P) ratio of gas should inform the decision makers' choices.

International security and political concerns about supplies from Iran, and Turkmenistan via Afghanistan is of course a different variable outside the nitty-gritty of physical planning. At present, the world has 6,609 trillion cubic feet (Tcf) of proven gas, sufficient for 59 years at the current production rate.[30] But the falling R/P ratio is going to make gas costlier.

Though Pakistan has huge reserves of coal in Thar Desert, it is thought to be of a poor quality.[31] Moreover burning coal causes environmental hazards that would be hard for Pakistan to control as the control technology is very expensive and in the development phase.[32] Pakistan may keep this option open for the time till coal can yield clean energy. However as noted by Andreas Kraewer, carbon capture and storage technologies "are unlikely to be broadly available commercially much before 2020."[33]

Traditional Renewables – Nuclear and Hydro

As a renewable resource, nuclear energy has been very efficient. However, Pakistan faces a number of hurdles in developing nuclear power plants. First, building these plants requires huge investments and it takes several years to build them. Second, the unfair policies of western governments would stand in

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[28] "Final Report: Islamic Republic of Pakistan-Rental Power Review," *Asian Development Bank,* January 2010, 22.

[29] Shaukat Hameed, "Technology Status and Costs of Emerging Alternative Sources," 61.

[30] "BP Energy Outlook 2030," *BP Statistical Review*, London, January 2012, 35, http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/2030_energy_outlook_booklet.pdf

[31] There is a debate on the utility of Thar coal, see, Fouad Khan, "Chasing a Pipe Dream: Three Reasons Why That Coal will not save Pakistan," *Express Tribune*, January 23, 2012, http://tribune.com.pk/story/325560/chasing-a-pipe-dream-three-reasons-why-thar-coal-will-not-save-pakistan/ (accessed January 28, 2012).

[32] Michael T. Klare, *Rising Powers, Shrinking Planet – The New Geopolitics of Energy* (New York: Henry Holt and Company, 2009), 257.

[33] R. Andreas Kraemer, "What Price Energy Transformation?," *Survival* vol. 50, no. 3 (June-July 2008): 14-15.

the way if Pakistan expands its nuclear programme. Third, the Fukushima episode in Japan has alerted the world to the hazards of nuclear plants and quite a few major users are inclined to review their present and future projects. "Japan has cast aside plans to build more nuclear power plants, Germany plans to abandon nuclear power by 2022, and Italy will no longer restart a long moribund nuclear industry. Even nuclear stalwarts such as France - which gets 80 percent of its electricity from nuclear reactors - have begun to analyze what eliminating nuclear might mean as part of a broader energy strategy for 2050…".[34] Given the nature of impediments, while Pakistan should not close the nuclear option for producing electricity, this "must always be a last resort…".[35]

Pakistan has abundant water resources to generate hydroelectricity. But politics has come in the way of building large dams. Without political will and consensus this resource is not likely to be used any time in the near future. Large hydroelectricity generation projects also involve huge cost and several years for completion. Further, a large dam failure can be catastrophic.[36] The problem of intermittence is also severe. According to PEPCO hydroelectricity generation fluctuated from a low of 683 MW in January 2010 to as high as 5,800 MW in summer 2010[37] - a shortfall of 5,117 MW during months when the northern regions have extreme cold weather. Large dams also create ecological problems while electricity from small dams is costlier.

Although Pakistan's untapped hydro potential is large, there is no need to solely focus on this source as the savior. But of course if better alternatives are not there, water would always be there to harness its energy.

Non-traditional Renewables – Wind and Solar

Pakistan needs to think beyond the traditional resources. With the worldwide increasing pressure on fossil fuels, challenges for economically less developed countries are big and complex, though not entirely insurmountable. New developments in renewable energy resources (excluding nuclear and large hydro) have made them attractive and capable to meet Pakistan's growing energy deficit. Now technologically viable, and economically affordable, solar

[34] David Biello, "China's Nuclear Power Plans Unfazed by Fukushima Disaster," Environment 360, August 8, 2011, http://e360.yale.edu/feature/chinas_nuclear_power_plans_unfazed_by_fukushima_disaster/2432/ (accessed January 22, 2012).

[35] Saleem H. Ali, "Resolving Environmental Conflicts in Pakistan's Energy Policy," in *Powering Pakistan – Meeting Pakistan's Energy Needs in the 21st Century,* ed. Robert M. Hathaway and Michael Kugelman (Karachi: Oxford University Press, 2009), 134.

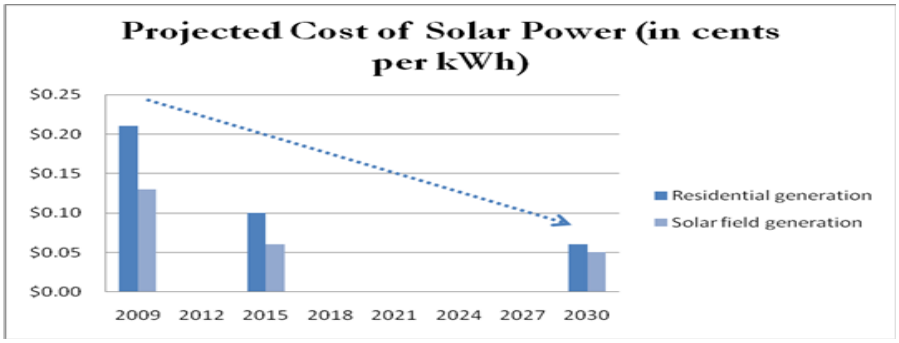
[36] Ibid., 134.

[37] Tahir Basharat Cheema, "Where has all the Power Gone?," Pepco, Government of Pakistan, http://www.pepco.gov.pk/pdfs/wherepower.pdf.

and wind power are among the leading renewables that can generate electricity on a large scale and take up pressure on traditional resources.

The addition of solar energy to Pakistan's power supply can provide some relief to its present generation capacity. Active solar heating policy can free 30 per cent of the natural gas consumed in homes.[38] Pakistan should therefore focus on solar energy in a hedging role against growing needs and the rising cost of energy from traditional resources.

Figure-IV
Solar Power Cost - Future Projections[39]



The cost of solar generated electricity is also expected to slide down (see figure IV). "For example, a study published in *Scientific American* for January 2008 suggests that a massive array of photovoltaic panels in the American Southwest, when connected to new electrical infrastructure, could supply as much as 69 percent of the nation's electricity by 2050 at rates equivalent to today's costs for conventional power sources."[40]

The Wind Option

Technological advancements have made wind an attractive option for renewable energy. Pakistan has tremendous potential in this form of energy. The wind corridor near Gharo in Sindh province is estimated to have the potential of 50,000 MW.[41] In *Powering Pakistan: Meeting Pakistan's Energy Needs in the 21st Century*, Shaukat Hameed Khan, member of Pakistan's Planning Commission, notes: "Wind is cheaper than natural gas even without subsidies,

[38] Shaukat Hameed, "Technology Status and Costs of Emerging Alternative Sources," 58.

[39] *Blueprint for a Secure Energy Future* (Washington: The White House, March 2011), 7.

[40] Michael T. Klare, *Rising Powers, Shrinking Planet*, 253.

[41] Asad Umar, "The Role of the Private Sector in Pakistan's Energy Sector," in *Powering Pakistan – Meeting Pakistan's Energy Needs in the 21st Century*, ed. Robert M. Hathaway and Michael Kugelman (Karachi: Oxford University Press, 2009), 167.

and on good sites, wind is even closing in on coal. The technology is mature and has reached full industrial levels, spread over several years' extensive development in many countries."[42] In addition to their green nature, and a hedging role against increasing oil prices, wind turbines can be rapidly installed; in just one year versus four years for coal and seven years for nuclear plants.[43]

There is a competition between the great powers of today to develop energy potential from wind and solar resources. Investments in new renewables (wind, solar, bio-mass) energy have gone up from US$ 22 billion in 2004 to US$ 211 billion in 2010 with wind receiving the major share.

Figure-V
Global New Investments in Renewable Energy – 2004-2010[44]

As noted in Obama's *Blueprint for a Secure Energy Future*, "Less than thirty years ago, the United States boasted more than 80 percent of the world's wind capacity and 90 percent of its solar capacity. We invented the photovoltaic solar panel, built the first megawatt-sized solar power station, and installed the first megawatt-sized wind turbine. Yet today, China has moved past us in wind capacity, while Germany leads the world in solar."[45] It is expected that this competition will help foster wind and solar research to reach new levels of efficiency soon.

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[42] Shaukat Hameed, "Technology Status and Costs of Emerging Alternative Sources," 55.
[43] Ibid., 56.
[44] REN21.2011, 35.
[45] *Blueprint for a Secure Energy Future,* 32.

Pakistan should therefore pursue non-traditional renewable sources of energy, particularly wind. This transformation of energy resource would not only relieve the country from the huge economic burden that comes with imported fossil fuels, but also the political stress that is attached to building large water reservoirs to generate electricity. Moreover the clean energy obtained from wind and solar sources would also help in keeping the country safe from environmental and security hazards attached to coal and nuclear power generation.

Conclusion

In the years to come, the gap between demand and supply of electricity in Pakistan will increase exponentially. Pakistan can secure its energy supplies by aggressive pursuit of wind and solar energy. These non-traditional renewable sources can also harness business potential in the country if Pakistan collaborates with business corporations that produce wind turbines and solar cells. Such joint ventures would be attractive for foreign companies as Pakistan ranks ahead of India and Bangladesh in South Asia in the World Bank's 'Ease of Doing Business Index'. Pakistan offers a readily available market, and potential access to future markets in the other South Asian and Central Asian countries. Pakistan's policy makers should thus invite Chinese, Japanese, Norwegian and Korean companies for joint ventures in wind electricity production. Pakistan has a success story in the form of M-2 motorway built by a Korean company. Now is the time to build an energy highway for Pakistan's journey to progress and prosperity.■