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ENHANCEMENT OF WIND POWER GENERATION IN PAKISTAN

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ABSTRACT: *The widening gap between supply and demand of electricity is a global issue and it needs serious attention. For sustaining economic growth and development, many countries are facing the challenge of high energy demand. The conventional source of energy, fossil fuels, are depleting rapidly. The environmental impact of these fossil fuels are alarming, worsening air pollution. The cost of imported fossil fuels is also increasing. So, there is an urgent need to find energy sources that are reliable, environmental friendly and cost effective. Worldwide, people have shown great interest in developing renewable energy sources. Renewable energy resources are the best replacement of conventional energy resources, but renewable energy resources alone cannot provide for the energy demands of our country. In fact, we need a share of both of them to cope up with the energy requirements of our country. In this study, we will investigate present energy scenario of Pakistan, enhancement of wind power generation in Pakistan, energy policy of Pakistan and solutions for ending energy crisis in Pakistan. Pakistan has plenteous available renewable energy resources of which wind energy has many advantages. Wind energy has attracted many countries and is being used by them to generate electricity. Many countries of the world have adopted this technology as wind is extensively available, has no effect on environment and is low cost. It is a successful, developed, cutting-edge, excellent and leading technology that has a large possibility for the generation of electricity in Pakistan. Several wind projects in Pakistan have been initiated and they have shown very encouraging and assuring signs of future success.*

KEYWORDS: Energy Situation, Wind Energy, National Power Policy, Ending Energy Crisis

1. INTRODUCTION

No nation can make progress without energy. A very big challenge being faced by Pakistan is an energy crisis and Pakistan has to tackle this challenge with wisdom. Pakistan has an abundance of renewable energy resources, but currently only a small percentage of the power being used by the country is from renewable sources. Pakistan spends almost 7 billion US$ on imports of fossil fuels annually to meet its energy needs [1]. This has to be changed because fossil fuels are diminishing rapidly and we cannot rely only on them to fulfil the energy needs of our country. Estimates indicate that the energy demand in Pakistan is likely to increase three-fold by the year 2050[2]. Keeping this thing in mind, Government of Pakistan and the private sector must enhance the power generation in Pakistan using renewable energy options.

2. ENERGY SITUATION IN PAKISTAN

The energy problem in Pakistan started in 2005. Ever since, the gap between supply and demand of electricity has increased and is projected to go up to 23,700 MW by 2030.

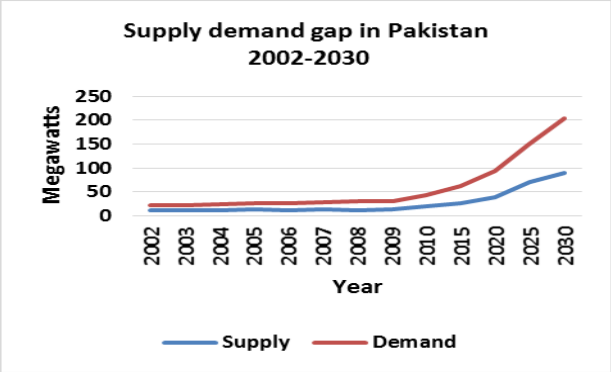

Fig. 1. Supply demand gap in Pakistan 2002-2030 (Pakistan Power Sector Need for Reforms by Kalim A. Siddiqui, 2011)

During 2012-2013, the supply, demand gap remained between 4500-6000 MW. There was a shortfall of 6000 MW in summers of 2014. The supply of electricity at that time was only 11,000 MW. As a result of this large gap between supply and demand of electricity, there is 10-18 hours of load shedding every day.

Dependence on expensive thermal fuel sources like RFO, HSD and mixed have forced Pakistan to generate electricity at higher rates (approximately Rs 12 / unit) which are not affordable by the population in Pakistan. In Pakistan, the electricity generated using RFO costs Rs 17 per unit, using HSD costs Rs 23 per unit and using mixed fuel costs Rs 12 per unit.

In Pakistan, the electricity generated by using mixed fuel costs Rs 12 per unit to the end consumer whereas the price of electricity delivered to the consumer estimated by NEPRA in Rs 14.70 per unit. It shows that a taxpayer has to pay extra Rs 2.70 per unit because of theft of electricity, inefficient system and mismanagement.

Because of the above mentioned problems, subsidies and circular debt are increasing continuously and have reached levels which are unbearable by the government.

96, 122 GWh of electricity was generated in 2012- 2013 which included 64.2% Thermal (28.2% gas, 0.1% coal, 35.9% oil), 31.1% hydle and 4.7% nuclear. There was a slight increase in electricity generation from last year, which was 95,091 GWh. There was an increase in electricity consumption also from the previous year. Electricity consumption in 2012-2013 was 76,789 GWh.

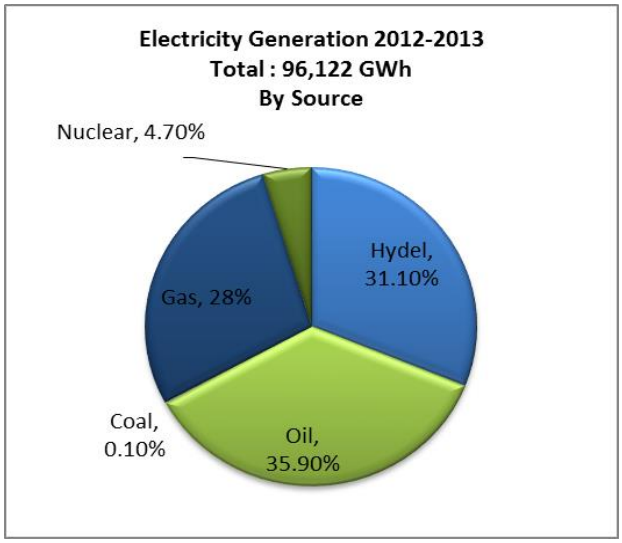

Fig. 2. Electricity generation in Pakistan by source 2012-2013 (Pakistan Energy Year Book, 2013)

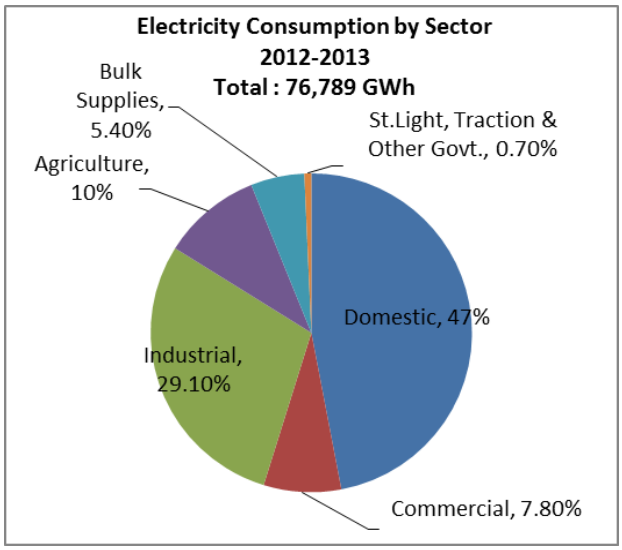

Fig. 3. Electricity consumption by sector in Pakistan 2012-2013 (Pakistan Energy Year Book, 2013)

The total primary energy supplies by source for the year 2012-2013 were 64.6 Million TOE comprising of 48.2% gas, 32.5% oil, 11% hydroelectricity, 0.1% imported electricity, 1.7% nuclear electricity, 6% coal, 0.5% LPG. The primary energy supplies remained almost the same as for the previous year i.e.64.7 Million TOE (2011-2012). On the other hand, the total final energy consumption by source for the year 2012-2013 was 40.18 Million TOE comprising of 15.6% electricity, 9.1% coal, 43.6% gas, 30.4% oil and 1.3% LPG. The final energy consumption by source increased slightly as compared to previous year (2011-2012) in which the final energy consumption by source was 40 Million TOE.

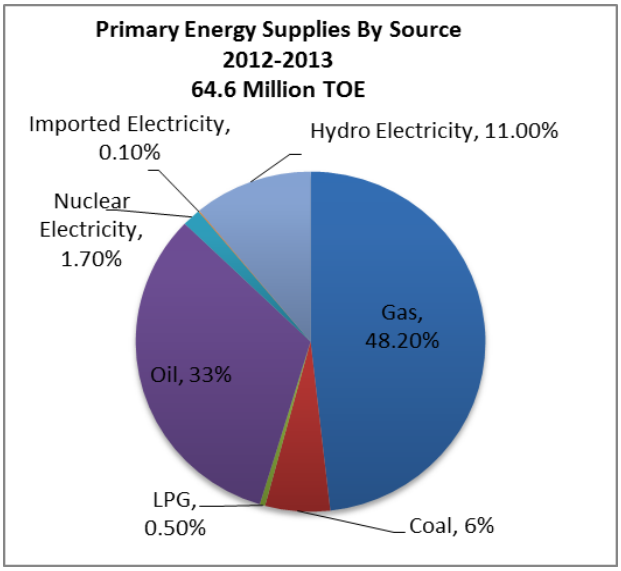

Fig. 4. Primary energy supplies by source in Pakistan 2012-2013 (Pakistan Energy Year Book, 2013)

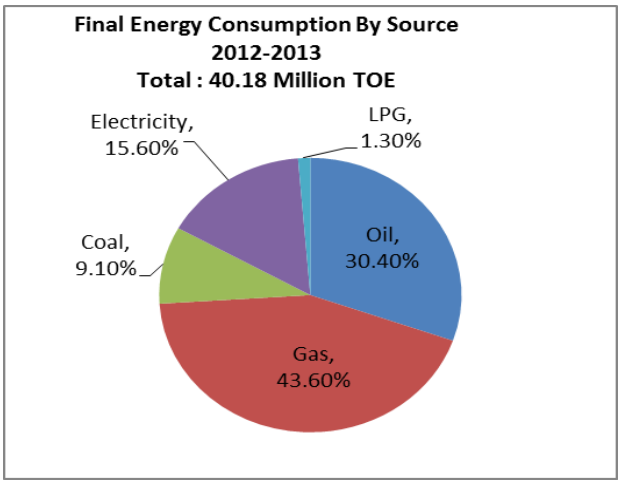

Fig. 5. Final Energy consumption by source in Pakistan 2012-2013 (Pakistan Energy Year Book, 2013)

93% of the world's energy needs is being provided by fossil fuels whereas 7% of it is being provided by renewable energy. We are going to run short of fossil fuels soon and we have to look for alternate energy resources to meet up with the increasing human energy demand.

In Pakistan, the crude oil and natural gas reserves as reported on June 30, 2008 were 43.83 and 551.2 Million TOE respectively. With present rate of consumption, the reserves are sufficient for meeting oil and gas energy demands of next 2.28 and 18.45 years respectively [3]. The crude oil Production for 2012-2013 was 76,277 barrels per day. And the natural gas production was 4,126 Million cubic feet per day. During 2012-2013, oil consumption was up by 4% and natural gas consumption was down by 1.6% as compared to

previous year (2011-2012). In 2013, 76 Oil reserves and 184 gas reserves were discovered. The installed electricity generation capacity in Pakistan was around 22,797 MW in 2014. Most of it was unavailable to the consumer because of non-payment by the government to the Independent Power Producers (IPP's), inefficient administration and line losses. For generating electricity to overcome energy crisis, Pakistan extensively depends on fossil fuels. This is transferred to the consumer of electricity in the form of very high electricity bills. Regardless of very high production cost, Government of Pakistan had been offering subsidies to the industries which resulted in the buildup of circular debt.

3. WIND ENERGY IN THE WORLD

The worldwide wind capacity has reached 336,327 MW (336GW) by the end of June 2014. Asia is now the leading wind continent with 36.9% of the global installed wind capacity. Asian market has overtaken the European market, which has 36.7% of the global installed wind capacity. The Chinese market has shown a very strong performance and it is close to 100 GW of installed wind capacity. India, the second largest wind market in Asia and worldwide number five had 21,262 MW total installed wind capacity in June 2014.

China, USA, Germany, Spain and India are the top five wind markets of 2014. Following table shows the total installed wind capacity of various countries by June 2014.

Table 1. Total Installed wind capacity of various countries by June 2014 (World Wind Energy Association)

Position	Country	Total capacity by June 2014 (MW)
1	China	98,588
2	USA	61,946
3	Germany	36,488
4	Spain	22,970
5	India	21,262

According to U.S Energy Information Administration (EIA), the total world energy consumption will grow by 53% from 2008-2035 [4].

4. WIND ENERGY IN PAKISTAN

Wind energy is a developed and advanced technology which has a huge potential for electricity generation. Government of Pakistan has started some wind energy projects which are showing very positive signs of future success. There exists a potential of 346,000 MW of wind energy in Pakistan. Along the Sindh coast, there exists great potential to harvest wind energy.

There is worldwide interest in wind energy these days and it is assumed to be the fastest growing energy resource. The Gharo-Keti Bandar wind corridor in Sindh can generate more than 60,000 MW of electricity. According to a report compiled by USAID (Unites States Agency for International Development), Pakistan has a potential of producing approximately 150,000 MW of power from wind energy [5]. Wind speed 5-7 m/s persists in the coastal regions of Sindh and many valleys in the North West region of the country at a height of 50m [6]. Many potential sites for wind energy generation in Pakistan have capacity factor of more than 25% which is internationally considered suitable for the installation of commercial wind farms [7].

Dams and nuclear plants take 5-6 years to complete, thermal plants take at least 2 years to complete but wind power plants take the shortest time to complete i.e. 12-18 months. There is no running cost of wind power plants.

Several companies in Pakistan have formed an association to start manufacturing different components of wind turbines. They will manufacture micro wind turbines and parts of big wind turbines.

4.1 Achievements of PCRET:

According to PCRET, PCRET installed 155 units of total generating capacity of 143 KW with wind turbines of 0.5-10 KW capacity/unit while electrifying 1600 houses. More than 400 wind electrification applications are in progress [8].

4.2 Achievements of AEDB:

AEDB is identifying new wind corridors in Pakistan. AEDB has developed grid integration plan 2010-2015 for wind power projects [9]. Pakistan has started manufacturing micro wind turbines and parts of large wind turbines. M/s Descon is manufacturing wind turbine towers and has provided them for the first wind power project in Pakistan. AEDB is raising the public awareness of ARE technologies with the support of media and stakeholders by organizing exhibitions, arranging road shows, talk shows, seminars and conferences.

5. ONGOING WIND POWER PROJECTS IN PAKISTAN

For setting up a wind power IPP, some activities are required in a sequence. The procedure for setting up a wind power IPP is shown in the figure below:

Table 2. Procedure for setting up a wind power IPP in Pakistan

Step	Title	Responsible Authority
1	Letter of Interest (LOI)	AEDB
2	Land allocation for wind farm	AEDB
3	Feasibility Study	n.a.
4	Generation license	NEPRA
5	Tariff Determination	NEPRA
6	Submission of Performance guarantee by the IPP	n.a.
7	Letter of Support (LOS)	-
8	Energy Purchase Agreement (EPA)	NTDC
9	Implementation Agreement (IA)	AEDB
10	Financial Close	n.a.

Presently five wind power projects are operational with a cumulative capacity of 255.4 MW. Nine wind power projects of 479 MW are under construction. Various projects are under way in the Gharo-Keti Bandar wind corridor with a collective capacity of 1050 MW [10].

5.1 Operational Wind Power Projects in Pakistan:

With an investment of $134 million, FFC Energy Limited FFCEL has developed Pakistan's first 49.5 MW wind power project at Jhampir, in Sindh. This wind farm is now

connected with the national grid. It consists of 33 individual wind turbine generators (WTGs).

Zorlu Energy wind turbine farm in Jhampir lies 25 Km Southeast from Nooriabad Industrial area. Wind turbine farm by Zorlu Energy spreads over an area of 1,148 acres. Zorlu Energy is a subsidiary of Turkish firm Zorlu Enerji. Zorlu Energy started with five turbines in 2009. It then expanded to 33 wind turbines with $36.8 million loan from Asian Development Bank (ADB) and credit from some other banks. This wind farm is now operational and it has the capacity of 56.4 MW.

49.5 MW wind farm of Chinese hydropower developer China Three Gorges Corporation in Jhampir is operational since December, 2014. This wind farm consists of 33 wind turbines with 1.5 MW capacity per turbine.

Located in Gharo, district Thatta, Sindh, wind power project of M/s Foundation Wind Energy-I limited is operational since January 2015 with the total capacity of 50 MW. This wind farm consists of 20 Nordex wind turbines with a capacity of 2.5 MW per turbine.

Two wind farms have been developed at Gharo by M/s Fauji Foundation. Project of M/s Foundation wind Energy-II limited is also operational since January 2015 with a total capacity of 50 MW. It has 20 Nordex wind turbines and each turbine has a capacity of 2.5 MW.

6. NATIONAL POWER POLICY OF PAKISTAN 2013

A power policy has been developed by the Ministry of Water and Power and it is hoped that this power policy will turn out to be successful, will show some very positive results and will help to solve the energy crisis being faced by Pakistan.

6.1. Goals of National Power Policy 2013:

- To generate electricity to meet up with the energy needs of the country.
- To provide cheap and affordable electricity to the end consumer.
- To generate cheap electricity using local resources such as Thar coal and hydel.
- Improve the power transmission and distribution system in Pakistan and minimize line losses.
- Reduction in theft of electricity.
- To make public aware of energy saving methods.
- Improvement in the governance of the related departments.
- Check and reduce fuel adulteration.
- Improve the financial efficiency.

6.2. Targets of National Power Policy 2013:

National Energy Policy has the following targets:

- To decrease the shortfall of electricity that is today to 0 MW by 2017.
- To ensure a decline in the electricity generation cost from Rs 12/unit to Rs 10/unit by 2017.
- To minimize the transmission and distribution losses from 23-25% to 16% by 2017.
- Improve the financial collection system and ensure growth in collection from 85% to 95% by 2017.
- To speed up the decision making process by the Ministry and the related departments.

6.3. Strategies for Overcoming Power Crisis:

Supply Strategy: The supply strategy is focused on attracting local n foreign investors towards rapidly expanding the power generation capacity.

Demand Management Strategy: This strategy discourages electricity use during peak hours. Peak hours are charged higher than the off peak hours. It applies timing restrictions on evening commercial activities. For neon lights, street lights and electronic billboards, use of solar energy will be encouraged.

Affordable Power Strategy: The affordable power strategy focuses on use of low cost energy source like coal, hydel, nuclear and biomass energy and make energy affordable for everyone in the country.

Supply Chain Strategy: When gap between supply and demand of electricity will be decreased to a great extent, fuel supply will be shifted to efficient IPPs from inefficient GENCOs. This strategy can save up to Rs 3 billion per month and can generate additional 500 MW of electricity. Performance contracts will be signed between Water and Power Ministry and GENCOs, PSO and fuel transporters. Stealing and quality of oil will be checked and the responsible authority will be accountable for it.

Generation Strategy: The goal of the generation strategy is to promote power generation efficiency. According to this strategy, fuel will be provided to efficient plants. And efficiency of these plants will be monitored continuously. All this will be made online for public. This strategy demands for the privatization of GENCOs.

Transmission Strategy: According to this strategy, transmission will be optimized and losses will be monitored. The national grid will be redesigned by building future plants close to load centers to reduce losses, extending high voltage transmission lines further north and strengthening 220 KV rings around big cities to reduce losses. Private sector will be given incentives for making investment in transmission for power plants that are not near the grid or in the area where the grid is weak.

Distribution Strategy: The goal of the distribution strategy is to make the distribution system efficient. This strategy focuses on signing performance contracts with the heads of the DISCOs ensuring decrease in distribution losses due to theft and technical reasons. Smart meters will be installed to monitor electricity distribution online and XEN will be held accountable for profit and loss accounts at feeder level. This strategy calls for the privatization of DISCOs.

Financial Efficiency Strategy: According to financial efficiency strategy, the private defaulters will be punished. The electric connection of such person will be disconnected after 2 months of non-payment. Cash flows by the external collection agencies will be improved. There will be more load

shedding in the areas where electricity theft rate is very high and finance collection rate is low.

Governance Strategy: The goal of the governance strategy is to upgrade the governance by bringing in order all the ministries involved in the energy sector. This strategy calls for an official coordination committee, which will ensure information integration between Ministry of Water and Power, Ministry of Petroleum, Ministry of Finance and Ministry of Planning and Development. It will help in decision making for issues related to the energy and formulation of energy policy. The structural and regulatory aspects of NEPRA and OGRA will be rectified. Ministry of Water and Power will be organized so that its functionality expertness can be strengthened [11].

7. RECOMMENDATIONS FOR ENDING ENERGY CRISIS IN PAKISTAN

Use of Renewable Energy Resources:

Wind, solar, hydro and biomass energy can be used in Pakistan to generate electricity instead of fossil fuels. Renewable energy resources can meet 17 to 30% of the energy needs of Pakistan by 2030. Generating electricity through these sources is much cheaper than generating electricity through fossil fuels. A possible energy solution is wind energy. There will be certain challenges to generate 7000 to 10,000 MW of electricity from wind towers, but all the solutions are within Pakistan's grasp. We need not to depend on foreign assistance for generating electricity from wind power. India is manufacturing wind turbines domestically and Pakistan can also get and master this technology. Pakistan can also import wind turbines from its neighboring country India to reduce the cost of import of wind turbines. The areas where wind turbines are installed, there free electricity should be offered. In return of providing free electricity, villagers should be asked to ensure the safety of these wind turbines. Wind turbines have a long life up to 50 years.

Using Hydro Power To Generate Electricity: In Pakistan, the potential of generating electricity using hydro power is 40,000 MW but currently only 6500 MW of electricity is being produced using hydel energy. Geography of Pakistan supports hydel power generation at a large scale. The price for electricity produced using hydroelectric power is Rs 2.5/KWh, natural gas is Rs 7.5/KWh, Diesel/furnace oil is Rs 12/KWh and by IPPs is Rs 14-18/KWh. It takes some years to construct a dam, but it has a life of about 100 years. It has no pollution. To provide cheap electricity, Pakistan must build Kalabagh dam and Bhasha dam. It must also speed up in completing the following ongoing hydel power projects: NeelumJehlum project, DiamerBhasha dam, Kohala hydel project, Bunjidam and Dasu hydropower project.

Using Coal to Generate Electricity:

Coal is one of the solutions for ending the electricity crisis in Pakistan. In Sindh are found the largest coal reserves of Pakistan, which are approximately 184.623 billion tonnes [12]. In Punjab the coal reserves are 0.235 billion tonnes, in Balochistan 0.217 billion tonnes, in KPK 0.091 billion tonnes and in AJK 0.009 billion tonnes. So the total coal reserves in Pakistan are 185.175 billion tonnes.

In January 2014, construction work on a $1.6 billion coal fired power plant has been started in Thar by the government. Government has also plans for constructing 660 MW coal fired power plant in Gadani, Balochistan and a 600 MW coal fired power plant in Jamshoro.

Using indigenous energy resource such as coal is a very good step in solving energy crisis in Pakistan. We should ramp up the production and use of coal to generate electricity. Government of Pakistan should activate Thar Coal Projects.

Circular Debt:

Because National Power Regulatory Authority being ineffective in monitoring generators and utilities, Pakistan has a circular debt in electricity generation worth $ 5 billion. A strong regulator check and balance is required. Regulatory commissions should be led by energy specialists. Government of Pakistan should select some energy specialists and send them to study regulatory mechanism from the west. Then after when their study is finished, they should be allowed to set up regulatory commissions which function without fear and favor.

Smart Metering:

Half of the electricity generated in Pakistan is lost because of theft and is unpaid. Smart meters should be installed to restrict the theft of electricity and to curb electricity bills. Currently a single smart meter costs Rs 10,000. It can return the investment made in them in about a year.

Gas Pipeline Projects in Pakistan:

Renewable energy resources alone cannot provide for all the energy needs of our country. We still need fossil fuels for our energy needs. Pakistan has four options for meeting energy demand in the country:

- Iran, Pakistan Gas Pipeline (IP)
- Turkmenistan, Afghanistan, Pakistan, India Gas Pipeline (TAPI)
- Pak Qatar Gas Pipeline
- Import of liquefied Natural Gas (LNG)

IPI and TAPI gas pipeline projects are likely to bring great benefits to all the countries that are participating in it. Ways and means should be found to complete these projects. Because America has an interest in TAPI project and it is financing it also, therefore this project seems to starts and complete more quickly than the IP project. With these two pipelines, Pakistan's energy crisis seems to end.

Power Policies:

Energy crisis requires short, medium and long term measures. New and improved power policies should be made. Governance should be improved on the basis of merit.

Conservation of Energy:

By conserving energy, we can add a great amount of energy to the energy supply of our country. The existing energy should be brought into efficient use. Wasteful internal use of electricity should be eliminated. Measures should be taken to

educate public about energy conservation through public awareness programs. Media, universities and think tanks can play an important role in this regard.

Energy Efficiency Improvement:

Energy should be saved and conserved domestically, commercially and in industries. The following energy saving activities can be adopted:

- Use of compact fluorescent lights instead of incandescent light.
- Properly insulating roof, walls, pipes and ducts in a building.
- Using glazed glass at building elevation.
- Using automatically controlled lights shut off.
- Install occupancy sensors.
- Use solar water heating and cooling instead of conventional methods used for heating and cooling [13].

8. CONCLUSION

A lot of countries in the world are working towards resolving the energy crisis. What we need to do is to use the existing energy resources wisely and keep on exploring new sources of energy for future energy needs. Pakistan is blessed to have both renewable and non-renewable energy options available. Conventional energy sources alone cannot provide for the energy needs of Pakistan. We need to add energy from renewable energy resources also to fulfil our energy needs. Wind energy is fastest growing energy resource these days. It can play a very important role in overcoming the energy crisis in Pakistan. It is important to mention here that no single renewable energy resource is enough to provide for all the energy needs of the country, but a combination of multiple renewable energy technologies is required. New and improved power policies should be made in Pakistan and the governance should be improved on the basis of merit.

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