Prevailing Energy Crisis in Pakistan

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Abstract: - Pakistan is facing severe energy crisis since 2007 and deepened in 2010 in spite of the fact that nature has blessed Pakistan with enormous energy potential. Short fall of electricity supply in the country is increasing and has been reached to 21000 MW. A broad review of Pakistan's energy sector is presented in this paper. Energy potential and major issues of energy sector are discussed. Issues like poor management, combined cycle capacity, low hydro power share, circular debt and energy security have been covered. Energy potential assessment includes hydro solar, wind, coal, nuclear, hydrogen cells, geo-thermal, ocean resources and bio mass.

Key-Words: - **FATA Federal Administrative Tribal Areas, Azad Jammu and Kashmir**

1 Introduction

Adequate availability of energy is the pre-requisite and lifeline for sustained economic growth of a country Zaleski (2001). Pakistan is endowed with enormous potentials of energy and natural resources like abundant water, variety of mineral resources and divergent terrain. Unfortunately these resources have not been fully exploited to meet the energy requirements of the country. As a result, today the country is facing acute energy crisis, affecting almost all spheres of national life either it is the industrial sector, agriculture or the social life. The growth of economy coupled with high population growth rate and rising urbanization has outpaced the stagnant energy sector in the country, stretching the available energy resources to the limits. Inadequate institutional framework, financial constraints and high costs of developing new power projects resulted in stagnation in growth of this vital aspect of national life Andrews (2005). However lack of attention and focus of successive governments is the single most glaring reason for the present state of affairs.

The neglect of develop power sector is evident from the fact that it took us twenty five years after Tarbela, to construct Ghazi Barotha Power Project. Pakistan as a result faced acute shortage of electrical energy in eighties resulting into long periods of load shedding seriously disrupting the economic and industrial activity. In order to meet the growing demand, a number of thermal power plants in private and public sector were constructed in mid-nineties World Bank Report (2005). We did manage to overcome one evil but faced many more. As of today, despite being surplus in electricity, the cost has become unbearable for the domestic and commercial users alike. Resultantly, the domestic consumers are under heavy burden of electricity charges, industries are facing closure, national economy even reached bankruptcy, and WAPDA is still paying billions of dollars to Independent Power Producers (IPPs). Even today there are millions of people in Pakistan without electricity and many millions more for whom the electricity consumption is not more that a light bulb.

All this is happening in a country, that has abundant water resources with an estimated potential of 35000 MW of electricity and vast reserves of natural gas and coal which if properly utilized can help in generating sufficient electricity to meet our requirements for years to come Pakistan Energy Year Book, (2005).

2 Prevalent Energy Crisis in Pakistan

Pakistan, with untapped hydroelectric resources of about 50,000 megawatts (MW), has been short of electricity for over two decades, which has been further compounded by a severe water shortage for the last three years. Over 40 per cent of the population is still without electricity whereas those fortunate enough to have electricity have to bear the escalating costs of consumption beyond their economic means.

Pakistan is a developing country of approximately 181.3 million people and is facing acute energy shortage. In 2010, it had to import 21.64 MTOE of energy in order to fulfill its primary energy requirement of 63.09 MTOE. Short fall of electricity supply in the country is increasing with demand and has been recorded up to 4522 MW in 2010 for many times of year. This deficit reached to 7000 MW in May, 2011. The Gross Domestic Product (GDP) growth has fallen sharply from 3.8%

in 2010 to 2.4% in 2011 whereas the inflation rate in the country has risen from 10.1% to 13.7% during the same period.

Furtherer more, limited natural gas supplies to domestic and industrial users, has intensified the severity of the energy crisis. In 2010, the indigenous oil and gas production was 64,948 Barrels/day and 4,063 Mcft/day respectively. According to Hydro Carbon Development Institute of Pakistan (HDIP), the balance reserves of oil and gas by ending June 2010 were 41.13 MTOE and 498.70 MTOE

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According to Hydro Carbon Development Institute of Pakistan (HDIP), the balance reserves of oil and gas by ending June 2010 were 41.13 MTOE and 498.70 MTOE respectively. If the demand and supply remains unchanged, it can be calculated that the known oil and gas reserves will exhaust in nearly 13 and 16 years respectively Pakistan Energy Year Book, (2013).

2.1 Supply vs Demand of Electricity

The effects of current energy crisis on the national economy cannot be over emphasized. Pakistan having being endowed with large indigenous hydropower resources has recently suffered a rapid switch over to expensive thermal power, which has caused a significant rise in tariff for consumers. The ratio of hydel vs thermal power generation was about 60:40 in the sixties which has now reached 38: 68 due to non-development of any new hydel power project and commissioning of a large number of thermal power plants in mid-nineties Pakistan Energy Year Book (2005) Consequently, the economy of the country had to suffer not only in energy sector but also significantly in agriculture and industrial sectors Vahidi and Fesharaki (2002). Moreover, due to drastic rise in tariff, major consumers started to generate their own energy resources depriving WAPDA of its revenues.

2.2 Poor Power Planning

WAPDA and KESC are two major organizations for power distribution in the country. The total capacity of WAPDA's power system is 9,945 MW (hydel 4,825 MW and thermal 5,120 MW), excluding 1735 MW capacity of KESC1. The maximum computed demand in the country is 8,825 MW, excluding export to KESC. If included, the maximum computed demand is 9,165 MW2 indicating approximately 800 MW of surplus generation capacity. Despite being surplus in electricity generation, WAPDA has to purchase 3,771 MW of electricity from HUBCO, KAPCO and other IPPs under the power purchase agreements with these IPPs.

2.3 Effects of IPPs

In the mid-nineties, The then Government, under its controversial power policy, signed Power Purchase Agreements with 18 power projects having a total capacity of 5816 MW including KAPCO (1621 MW) and HUBCO (1292 MW)3. Under these agreements, WAPDA had to purchase a fixed percentage of the installed capacity regardless of the demand at highly unfavorable rates, causing severe economic crisis not only for WAPDA but also for the nation as a whole.

The concessions given to these IPPs put WAPDA under lot of financial strain. If the problem of high tariff is not addressed immediately then in next ten years, WAPDA and KESC will have to pay $12 billion in capacity payment and $15 billion in energy payments to 21 IPPs.

2.4 Lack of Development in Hydel Power Projects

In Pakistan, initially more than 60% electricity was generated from water. Under the Indus Basin Treaty, two major dams/reservoirs were built for water storage and hydel power generation at Mangla and Tarbela. Over a period of time, the storage capacity of these dams is being reduced due to natural silting. According to an estimate, by the end of year 2000, one-fifth capacity of these reservoirs has been lost. Besides silting, lack of water during winter and need to store water for irrigation also badly affects the electricity generation (Sen, 2000).. As a result, it is necessary to back up the hydel generation with thermal generation to meet the consumers' demand in winters. Unfortunately, no

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new dams or hydel power plants have been built, resulting in increased dependence upon thermal power sources to meet the growing demands.

2.5 Power Losses

2.5.1 Transmission/Distribution Losses

A substantial quantity of electricity is lost during the process of transmission and distribution. WAPDA is facing major problem due to its 41905 kms long transmission lines, which connect national grid with hydel stations located in north and thermal units installed mostly in the center and southern parts of country. WAPDA suffers 11% losses due to high voltage transmission4. Besides transmission losses, WAPDA also suffers heavy losses during distribution. In 1997-98, distribution department was supplied 47,718 million units of electricity, of which 29,422 million units were billed for showing loss in distribution of 8,296 million units or 15.6% of gross generation of 53,259 million units5. As per World Bank standards, only 10-15% line losses due to technical reasons are acceptable, whereas for WAPDA, distribution losses alone are 15.6%.

2.5.2 Power Theft

Besides transmission/distribution losses, WAPDA also faces electricity losses due to theft. Every year 11-12% of total generated electricity is being lost due to theft. According to a report issued by the Army in July 1999, theft losses in first six months of 1998 were 11.1% whereas in 1999, during same period, it had reduced to 0.6%. Although, after the Army took over WAPDA in 1998, the situation has improved yet persistent efforts are still needed to curb this menace Akbarzadeh, (2003).

2.6 Electric Supply to FATA and AJK

WAPDA is supplying subsidized electricity to FATA and AJK. Additionally, tribal consumers do not pay the bills to WAPDA. Army report published in July 1999, indicates that out of total dues of Rs. 2.94 billion, FATA paid only Rs. 0.113 billion and AJK paid Rs. 0.772 billion out of Rs. 4.968 billion Luft, 2005a; Alexander's Gas and Oil Connections, (2006).

2.7 Construction of New Dams

Since the construction of Mangla and Tarbela, over two decades ago, no major hydel power project has been undertaken in the country, baring a few small hydel projects at Dargai, Shadiwal, Nandipur, Kurram Garhi, Renala and Chitral. Only recently, Ghazi Barotha Power Project has been undertaken. Moreover, due to silting, the capacity of Mangla and Tarbela dams is reducing continuously, necessitating construction of new dams. Kala Bagh Dam could have met the growing demands of water storage and electricity generation if completed as per schedule by year 1998. However it became the victim of political expediency, despite its technical and economic feasibility ready since 1975. As a result the nation has been deprived of 3600 MW of cheap electricity besides other benefits in economy and agriculture.

2.8 Reliance on Thermal Power Generation

As already highlighted, persistent negligence towards development of new hydel power projects, a serious short fall of electricity was experienced in mid eighties resulting into long periods of load shedding, both for a domestic and commercial consumers (Luft, 2005b). In nineties, the situation assumed crisis proportions. Therefore, in order to meet the increased demand, the only option left was to construct thermal power projects, seriously altering the accepted balance between hydel and thermal generation, besides huge impact on financial health of WAPDA and national economy. At present 32% of total generated electricity is obtained through hydel and 68% through thermal power plants (Luft, 2005b)

2.9 Consumers

The number of consumers has increased markedly as a result of rapid urbanization, extension of electricity facility to un-electrified area and village electrification programs run from time to time, reaching a figure of 10.55 million by March 1999. Annex B shows electricity consumption by economic group since 1991 up to march 1999 Pandian, (2005). The consumption of electricity by economic group identifies domestic group as the largest consumer of electricity accounting for 42.52 % of total consumption followed by industrial group

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25.94 %, agriculture group 15.57, bulk supply & public lightening 11.29%, commercial group 4.6% and traction 0.04% (Alexander's Gas and Oil Connections 2006).

3 AVAILABLE POTENTIAL FOR FUTURE POWER GENERATION

Major sources of energy in Pakistan consist of oil, gas, petroleum products, coal and electricity. Until few years back Pakistan used to get half of its electricity from hydel power and remaining from thermal generation. Over the past few years, thermal capacity has more than doubled including about 5000 MW from IPPs. Efforts are going on to regain hydel-thermal synergistic balance by exploiting the large untapped hydel potential (Ryoichi, 2005).

3.1 Hydel Energy

Pakistan has a potential of at least 35000 MW of hydel power still waiting to be harnessed on the main rivers and another approximately 10,000 MW on the side valleys/streams. In addition to this high head potential in the mountainous areas, there is another 550 MW of low head potential in the plains on existing canals and barrages. However, this vast energy potential is presently not being developed. There is a definite need to streamline the development of hydropower in Pakistan. Presently, the total storage capacity of existing dams and lakes is 17.1 million-acre foot (MAF) with generation capacity of 4722 MW. The estimated power potential of River Indus and its tributaries is about 13070 MW. The need is to realize the importance of the crisis and the exploitation of the available cheap hydel resources.

3.2 Other Sources of Power Generation

Despite the fact that hydel and thermal are two main sources of power generation, however, there is a limit to the extent of exploitation of hydel resources as well as thermal power plants due to environmental and other concerns (Salameh, 2003). To meet the growing demands there is a need to explore and develop other forms of electricity generation which can supplement hydel and thermal power generation. Nuclear, solar, Biomass and wind energy, are the few other means which have little received little or no attention.

3.3 Nuclear Energy in Pakistan

Presently, USA is generating about 20% of its electricity using nuclear energy, France 78%, and Belgium 60%. Pakistan is only producing 0.03% electricity by two units located at Karachi and Chashma.

Though, Pakistan has made good progress in the nuclear field but still dependent on developed countries for reactors and its components. These countries by no means are willing to provide the reactors which are suitable for generation of cheap electricity (Edwards, 2003). Pakistan Atomic Energy Commission has developed a fairly large infrastructure, which is capable of manufacturing large mechanical equipment and components for power and process plants. It is hoped that the day will come in near future, when Pakistan will be manufacturing and installing its own reactors to overcome the shortage of energy.

3.4 Coal

Estimated reserves of coal in the country are 185 Billion Tons, which includes 175 billion tons of Thar coal fields, the world's largest coal reserves. The production of coal is still stagnant, as no demand has been created for coal consumption. Presently, only 9% of total coal production is being utilized for power generation. Recently, an agreement has been signed with China to develop the Thar Coal Fields. Planning is in hand, and this vast reservoir of energy will be utilized to meet the future needs.

3.5 Potentials of Solar Energy in Pakistan

Pakistan lies within the tropical latitude of about 23-37 degree north, longitudinal stretch across 61-75.60 degree east. A dry climate, with low rainfall and rigidity prevails over major parts of the country. Physically, Pakistan has a diversified land relief. About 60% of the total land is mountainous terrain and the remaining 40% presents a flat and graduated surface. The geographical location, topography and local climate, place the country among the most favored regions for solar energy utilization. The main features of development in the field of solar power are:-

a) Pakistan Atomic Energy Commission (PAEC) initiated research and development work in the late sixties. In recent past National University of Science and Technology (NUST) has also carried out considerable research and development in this field.
b) The electronic division of PAEC has developed solar cookers, solar water pumps

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for irrigation, solar water chillers, and solar vegetables.
c) A solar energy desalination plant was put up in Gawadar which is producing 5000 gallons of water per day since 1972.
d) Several Television / telecommunication booster stations, located in remote areas, are being powered by solar panels.

In addition to economic considerations, there are number of other factors which serve to increase the attractiveness of solar energy use in Pakistan to varying degree. Some major advantages favoring use of solar energy for power generation are:-

a) Ideal for remote areas with scattered habitat.
b) Ample sunshine.
c) Unattended system operations.
d) Low operational and maintenance cost.
e) Environmental friendly.

3.6 Prospects of Biomass Energy in Pakistan

Biomass resources in Pakistan are mostly used for community cooking and heating. Availability of Biomass resource on a massive scale would be required for any sizeable power production. This does not exist at present in Pakistan. In early 80s an effort was made at government level to construct 55 Biogas plants for the small villages. However after a lot of publicity in the media, the project was abandoned for unknown reasons making no further progress.

Pakistan being an agricultural country has a reasonable amount of livestock in rural areas. Even in urban towns, large, although scattered, farms of cattle are there primarily for supply of fresh milk. In Karachi alone there is a huge cattle colony which serves the whole population of over 15 million. With little effort, the huge amount of animal waste can be utilized for electricity generation, albeit at a smaller scale, for domestic or community use at the same time solving the waste disposal problem.

3.7 Prospects of Wind Energy in Pakistan

Pakistan fortunately has good wind power potentials. Its coastline and mountainous region provide ideal locations to site windmills. Similarly the wind flow patterns in the plains during the monsoon and the winter anticyclone winds can provide economically feasible power. The UNDP and the Economic Affairs Division of the government of Pakistan have agreed on a feasibility study for a large-scale wind power project along the Makran Coast. The project, coat is $ 471,000. Some of the advantages of windmill generation are:-

a) Low lead times to install and commission.
b) Less capital intensive.
c) Very less operational cost.
d) No environmental concerns.
e) Coastline provides ample sites for large scale windmill installation.

Windmill generators though, technologically complex can be developed indigenously, especially through reverse engineering with the expertise available.

4 Recommendations

Fortunately, WAPDA's 'Vision – 2025' was announced during the compilation of this paper. As already discussed, although ambitious, yet it is the only solution to the "clear and present danger", the nation faces in the water and energy sector. The Government of Pakistan and WAPDA have realized the gravity of the situation and chalked out the strategy to overcome the crisis before it is too late. The programme has addressed most of the recommendations naturally emerging out of this study in a comprehensive manner. Few additional recommendations suggested by the panel are as under:-

4.1 Formulation of National Energy Policy

The present situation in the energy sector is the manifestation of lack of foresight, planning and attention to this vital aspect of national life. There is therefore a need to formalize the planning process in energy sector so that our energy needs are met in time in a most efficient and economical manner. It is therefore recommended that a National Energy Policy be worked out under a constitutional framework to regulate and plan the energy sector in future. The salient of the energy policy dealing with electricity generation are:-

a) Establishing targets for development of power sector vs projected demand.
b) Determination of guidelines for hydel and thermal power generation and other power generation sources like nuclear, solar, wind and other unconventional means.

Establishment of a national body to resolve political issues/controversies related to construction of dams.

4.2 Exploration of Power Generation Potential

Continues studies and research be undertaken by WAPDA, Ministry of Water and Power as well as Ministry of Science and Technology to explore the power generation potential of rivers, streams and

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canals, in addition to those already identified in Vision 2025. This will enable us to plan for our energy needs beyond year 2025. For this purpose, feasibility projects be undertaken by engineering universities and foreign/domestic consultants. As an incentive some percentage of revenues be fixed as royalty to the consultants, as and when the project is commissioned.

4.3 Prioritization of Future Power Projects

Since Vision 2025 deals primarily with the water management and development of hydel power generation, Ministry of Water and Power in consultation with WAPDA should set up policy guidelines for the development of future power projects in other categories, by setting up mandatory percentages for each category to achieve a balance mix as per accepted standards/trends:-

a) **Thermal:** Further thermal power plants are allowed keeping in view the accepted balance in hydel and thermal ratio. As such increase in the hydel power generation as a result of Vision 2025, would allow setting up of new thermal power plants keeping the balance within limits.
b) **Nuclear:** Since Pakistan has attained reasonable expertise and capability in military nuclear programme, there is a great prospect now for using the same for peaceful utilisation. Pakistan Atomic Energy Commission and KRL in collaboration with China must focus on the development of a nuclear reactor for power generation so that the country becomes self-sufficient in this field and meet our vital energy needs.
c) **Wind:** Setting up of wind driven power plants especially along the coastline by local or foreign private investors. Subsequently the development and manufacture of wind generators be undertaken indigenously with the help of DESTO, Pakistan Aeronautical Complex Kamra.
d) **Solar:** Solar energy should be utilized for power generation on local scale especially in sunshine rich areas of Southern Punjab, Balochistan and Upper Sind.
e) **Bio Mass:** Biogas energy be utilized for power generation in agricultural areas of Punjab, Sind and NWFP. For this purpose, Ministry of Science and Technology and National University of Science and Technology (NUST) should undertake pilot projects in co-operation with private sector. Moreover subsidies and tax concessions be provided for import of machinery and equipment for setting up Biogas power plants in private sector.

4.4 Utilization of Indigenous Natural Resources

a) In order to make use of vast natural gas and recently discovered coal reserves in the country, existing thermal power plants running on imported and expensive Furnace Oil be converted onto natural gas in first step. Subsequently efforts be made to convert the same on to coal.
b) To make our industries competitive, feasibility of running heavy industries on locally available coal fired power plants be examined, as a cheap alternative to expensive furnace oil
c) All new thermal power plants be run on natural gas or locally available coal reserves found in Thar.

4.5 Private Sector Contribution

To meet the financial cost of Vision 2025, private investment, both local and foreign be encouraged in the form of tax incentives, to set up small and medium scale hydel power plants on the sites identified in the programme. Similarly, option for allowing big industrial units to have their own electrical power plants is also explored.

4.5 Resolution of Kalabagh Issue

This vital project appears to be on a lower priority in the vision 2025 due to obvious reasons. Concerted efforts are undertaken to resolve the political controversies related to the Kalabagh Dam issue. Aggressive media campaign, seminars and technical literature are utilized to satisfy the opponents. If needed, minor modifications in design should still be incorporated to settle the objections. It is pertinent to mention that present government, being free from political compulsions is ideally suited to resolve the issue.

4.6 Review of Tariffs

a) **Tariff Disparity:** At present there is a large disparity between domestic and industrial/commercial consumers on electricity. As a result, the industrial and commercial users are facing higher production costs, lack of competitiveness

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and above all are reluctant to use electricity. The electricity tariffs be so revised to reduce the difference to offset the negative implications at the same time encouraging increased productive use of electricity.

b) **Reduction of Electricity Cost:** Higher cost of electricity has resulted in reduced consumption by the consumers. The electricity rates be revised downward so as to encourage increased consumption. This will not only increase the revenues but will also help in raising the overall living standards of the society.

5 Conclusion

Energy is the basic ingredient to the process of economic development and social prosperity. Per capita energy consumption of a society is a major indicator of overall socio-economic development. For a energy deficient country like Pakistan, endowed with vast energy resources in the form of abundant water and rich minerals resources, breaking the status quo and embarking upon the journey to self-sufficiency in energy sector and electric power can no longer be postponed. The dream no doubt is difficult but it is by no means as elusive as it appears. Given the resolve, determination and pragmatic planning as evident in the Vision 2025 programme there is no reason that we do not overcome the odds.

In order to benefit from the variety of resources and advancement in technology, there is also a need that other sources of electricity generation are also explored to supplement the hydroelectric potential of Vision 2025 programme. Already a lot of opportunities and time has been wasted and any further delay in this direction will have catastrophic consequences for the future of this nation.

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