Paper No. 261

INTRODUCTION OF NEW TECHNOLOGIES FOR RENEWABLES AND DEMAND SIDE MANAGEMENT IN THE POWER SECTOR IN PAKISTAN

By

Prof. Dr. Zahir Ahmad Fikri

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ABSTRACT

One of the key areas where large scale effort will result in immediate elimination of power shortages in Pakistan is the application of demand side management concepts. Major loads in the domestic, commercial and industrial sectors are heating and cooling. In the agricultural and industrial sectors, another major load is the electric motors. An area where considerable savings can be achieved is the utilization of non-conventional sources of energy at the customer level, using decentralized generation. Nine areas offer great potential for introduction of renewables and demand side management in Pakistan: (1) use of the fiber optic cable based lighting from sunlight, (2) building integrated photovoltaic panels, (3) cyclic temperature variations during day and night, (4) combining dehumidification with evaporative cooling (5) solar collector based heating and absorption cooling (6) insulating the building envelope (7) integrating energy efficiency and conservation in building design, (8) using phase change materials for thermal energy storage for heating and cooling and (9) Computer Based Energy Management and Control Systems. This paper reviews recent research and development in this field and suggests a research and demonstration program at the company and university level. Mature technologies for immediate commercial applications have been suggested.

1 INTRODUCTION

Considering the precarious power supply situation and bleak prospects of immediate resolution of the power shortages situation in Pakistan, Demand Side Management offers an attractive solution to the Power Crisis problem. Demand Side Management has the following objectives:

- Reducing power demand
- Reducing energy consumption
- Shifting time of use to off-peak period
- Avoiding the demand
- Increasing the overall utilization of system capacity by increasing the load factor
- Maintaining power quality and reliability

2 ANALYSIS OF ENERGY CONSUMPTION AND DEMAND

Review of existing customer profile of the entire WAPDA (now PEPCO) system shows that the share of different customer categories [1] in the overall power consumption is as under:

- Domestic : 44 %
- Commercial: 6 %
- Industrial: 24 %
- Agricultural: 12 %
- Other: 14 %

As may be seen, the domestic and industrial sectors account for 68 % of the total consumption. The ‘other’ sector includes traction and bulk supply customers.

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On 31 January, 2008, the entire PEPCO system had [2] 17.6 million customers. Of these the domestic category was about 84.7 %. Commercial customers constituted only about 12.5 % of the total. The industrial customers were 1.4 % of the total number of customers. Agricultural customers were also 1.4 % of the total. Thus, from the network configuration view point, the predominant categories were domestic and commercial, 97.2 % of the total.

Looking at the contribution of different categories of customers to Energy Consumption and Power Demand (Fig. 1), it may be noticed that that the domestic customers consumed 44 % of the energy and accounted for 51.7 % of power demand. The industrial customers used 24 % of energy against 21.8 % power demand. The agricultural sector used 12 % energy against 12.9 % power demand. The situation of the 'other' sector including bulk supply was similar to the industrial sector. The commercial sector used energy in the same proportion as the power demand. From the demand management view point, the domestic, industrial and agricultural sectors offer maximum prospects of reduction of demand as well as reduction in energy consumption.

Overall coincident electric power demand per customer is estimated at about 1 kW per customer at the generation level. A target of about 20% reduction of demand means that demand per customer should be reduced by about 0.2 kW. This is not a difficult target to achieve provided suitable control strategies are used.

In the case of new construction, it is possible to integrate renewables and energy efficiency in the building design. Such buildings could be restricted to about 20% to 30% of the power demand of similar buildings without energy efficiency measures.

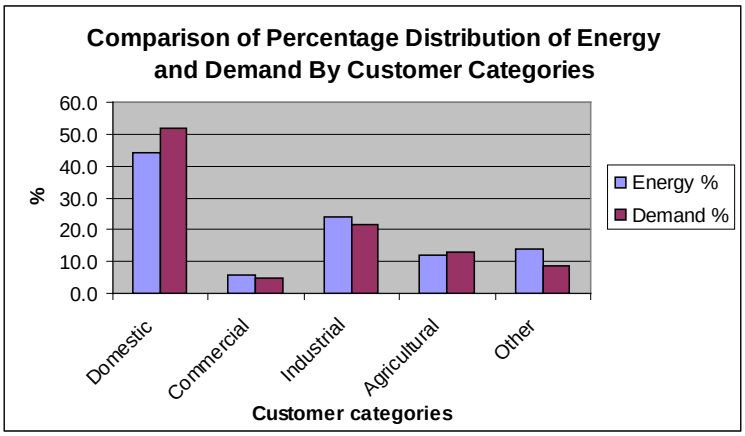


Fig. 1: contribution of different categories to energy consumption and demand

3 DEFINING DEMAND SIDE MANAGEMENT

The main objectives of a Demand Management Program can be summarized as under:

- Reducing power demand
- Reducing energy consumption
- Shifting demand to off-peak period
- Avoiding demand
- Controlling demand

4 ANALYSIS OF LOADS

Major loads can be categorized as (1) Lighting, (2) Heating, (3) Cooling, (4) Appliances, (5) Motors and drives, (6) Fans and (7) Auxiliary equipment and devices to support a successful operation of the electric system.

4.1 Lighting

The biggest gain would be to convert existing incandescent to energy savers or fluorescent lamps. Existing incandescent and fluorescent lighting in corridors or storage areas can be converted to LED lighting that uses only a fraction of the original load. In offices, the concept of work oriented lighting could be used. New skylights may be incorporated to replace artificial lighting by daylight. Lighting layouts should include presence sensors for immediate switching off lighting, in case there are no occupants in the room. Conversion to fiber optic based lighting systems, using sunlight as the source of light, could drastically reduce the electric demand of lighting.

4.2 Heating

Present heating in Pakistan consists of inefficient gas fired heaters. In view of lack of insulation and air infiltration, the overall efficiency of a heater is not high. No data is available on this subject. Even conventional water heaters use steel tank and pipes without insulation. The house has to be heated over a period of time before the desired temperature is achieved. Just-in-time gas heaters have become available and offer sizable savings in gas consumption while meeting the hot water requirements.

4.3 Cooling

Most of the existing installations are without insulation. Only clear and single glass windows, without proper shading, are being used. As a result most of the air-conditioning systems are oversized and inefficient. The building construction as well as architectural plans is not made to meet the energy efficiency requirements. Only air born systems, without any substantial heat recovery systems are used. Water born systems are very rare. The entire cooling sector needs a very close look to identify opportunities for demand side management.

4.4 Appliances

Due to lack of standardization and energy labeling, the customers are not aware of the opportunities of demand side management in this sector. Use of energy efficient appliances is yet to be recognized as an opportunity.

4.5 Motors and Drives

Selection of wrong size of motor is a universal problem. Furthermore, the motors are not always run at full load. Consequently, the overall efficiency and power factor of the motors is reduced, thus leading to substantial waste of power system capacity as well as technical losses. The tubewells in the agriculture sector face problems of wrong delivery sizes and changing water levels. This problem is especially acute in Baluchistan and other areas, where the water table depth is high. After failures, the rewound motors show even worse performance as the quality of copper used and rewinding techniques are poor. In the industry, variable drives are used to some extent to match the load with torque. The entire motor sector needs a proper review and suitable solutions need to be found.

4.6 Fans and Evaporative Coolers

Most of the fans are made from sheet of poor quality. The basic design of the wings is not optimal. Tests of consumption of different types of fans have shown a wide variation in demand and consumption. The fans for large air handling units have large motors, generally without any speed control. This sector needs a very detailed review as millions of fans are already installed in the premises of over 18 million customers.

In the recent years, evaporative coolers have become widespread in the local market. The quality of fans motors and water pumps in these coolers also varies. Most of the coolers use poor quality fans and pumps. This manufacturing sector requires detailed studies and surveys.

4.7 Auxiliary Equipment and Devices

To run a water supply system in a household, normally single phase motors are used. The sizes and quality of these motors vary considerably. There is no matching of size with demand.

5 NEW TECHNOLOGIES FOR DEMAND SIDE MANAGEMENT

Demand side management is a vast area and there are many technologies already in use. The most important load that needs demand side management is the cooling load. As such, this paper focuses on new technologies that can help in reducing the demand and energy consumption of cooling in buildings in all the sectors of the economy.

5.1 Building construction

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) have published handbooks for design calculations for both heating and cooling. The relevant tables have been published in different text books on Air Conditioning Principles and Design. ASHRAE has standardized construction into three categories: Light weight (1" wood floor), Medium weight (2" to 4" concrete floor) and Heavy weight (6" to 8' concrete floor). The Cooling Load Factor (CLF) for a typical hot day varies from 0.98 for Light weight, 0.94 for Medium weight and 0.87 for Heavy weight construction. Thus, choice of type of construction has significant impact on cooling loads.

5.2 Shading Coefficients

In the case of 'No Shading' of window glass, the value of shading coefficient [4] is 0.94, in the case of single clear glass window, and 0.81 for double glass window. If Venetian Blinds of light material are used with single clear glass window, the shading coefficient is 0.74. This is further reduced to 0.62 in the case of clear double glass window. If Roller Shades of opaque light colour are used for single clear glass window, the shading coefficient is 0.39. In the case of clear double glass window, the shading coefficient is 0.35. In case heat absorbing glass is used with single glass window and roller shades, the shading coefficient is reduced to 0.3. For the double glass window, this value is further reduced to 0.22. It may be seen that the selection of suitable glass and shading can reduce the shading coefficient from 0.94 to 0.22 (reduction by 76.6 %).

5.3 Wall Insulation

A 4" brick wall without insulation has an overall heat transfer coefficient U of about 0.24 BTU/hr-ft sq.-F. Application of 2" to 2.5" insulation results in a U value of 0.09. A 3" – 3.5" insulation further reduces the U value to 0.07. This is a reduction of 70.8 %. This is a typical example. In all cases, where wall insulation is used, the U value is reduced dramatically.

5.4 Roof Insulation

In the case of a 6" heavy weight concrete deck, the U value without insulation is 0.28 BTU/hr-ft sq.-F. Application of 1" and 2" insulation reduces the U value to 0.16 and 0.11 respectively. This means a reduction of 60.7 % in the case of 2"insulation.

5.5 Sunlight Reflecting Paints

Roofs have conventional black roof shingle with a reflectance of 0.04. Researchers [5] are developing cool-coloured materials for concrete tile and metal roofs. The solar reflectance of these products has increased to 0.45. A reflectance of 0.6 was expected to be achieved in the near future. Use of cool roofs can result in reduction of major solar heat loads from the roofs.

5.6 Variable-speed Centrifugal Chillers

Variable speed centrifugal chillers offer the possibility of more flexible control of air conditioning in large commercial buildings.

5.7 Variable Supply and Ventilation Air Fan Controls

Normally ventilation air fans in buildings run on constant speed. Introduction of variable air supply as well as speed control can reduce the demand and consumption of fans.

5.8 Occupancy Sensors

Occupancy sensors can be used for lighting, heating and cooling systems. Sensors in combination with intelligent controls can result in sizable savings of demand and consumption.

5.9 High Efficiency Gas and Water Heaters

Existing energy efficient gas fired heaters, water heaters and boilers offer overall efficiency ranging from 90 to 98%. Existing efficiencies need to be determined through market surveys and testing.

5.10 Efficient Building Envelope

The concept of efficient building envelope can result in drop of perimeter heating and cooling. The building envelope includes walls, windows, roof and floor. Putting emphasis on selecting the right insulation, type of windows, shading and other techniques described above can lead to substantial energy savings. Investments in improvements of building envelope should be evaluated on the basis of life cycle costs. There are a number of considerations for evaluation of windows, skylights, doors, vestibules, overhead doors, foundations and floors, roof and ceiling, infiltration, exfilteration, and building pressure [7,8].

While evaluating windows [8] the considerations include:

- Single/Double glazing
- Frame type
- Operable windows
- Estimated % of gross wall area
- Daylighting
- Glazing orientation and cooling zones
- Glazing coatings
- Cracked or broken panes
- Alignment of operable windows
- Weatherstripping condition
- Skylights

While evaluating roofs and ceilings for adequate insulation [8], considerations include:

- Type, thickness, and location of the existing insulation
- Age and condition of roof
- Damaged or wet insulation
- Insulation voids
- Proper attic ventilation
- Space available for additional insulation
- Color of roof membrane

5.11 Skylights throughout the building

A central atrium can run through the building so that skylights can provide most of the lighting. Daylight sensors in the skylights and at the lowest floor can collect data, so that lights can be controlled according to the amounts of natural light from the skylights.

5.12 Daylighting by Fiber Optic

A Master's Thesis, in 2002, reviewed concepts of daylighting by Fiber Optic [9]. Many different types of techniques exist for using daylight for lighting. Many installations are already in operation.

5.13 Light Emitting Diodes

Light Emitting Diodes (LEDs) can be used throughout a building as an accent. LEDs basically use no energy. They have a life expectancy of 30 years. Lighting could be organized in LED clusters. If fluorescent lamps are used, the same result would require 10 times that wattage for the same amount of light.

5.14 Rope Accent Lighting

Rope Accent Lighting is an extension of LED lighting. This kind of lighting is already being used in restaurants and public places in Pakistan.

5.15 Heat Recovery in Air Handling Units

Heat recovery can be used to recycle hot or cool air in both air and water born systems. The overall efficiency of the Heating, Ventilation and Air-Conditioning (HVAC) System. This sector needs to be mapped in all industrial and commercial installations. Heat recovery should be made mandatory for all HVAC units.

5.16 Evaporative Cooler in Combination with Exhaust Fans

Existing windows can be used to install exhaust fans in each bedroom and a cooler in the lounge. The exhaust fans can be made reversible so that when the outside air has lower temperature than inside temperature, the exhaust fans can supply fresh air to the building. When the inside temperature is lower than outside air, then the exhaust fans can be used to remove hot air from the building. The cooler can send fresh cool air to each exhaust fan. The combination of cooler and exhaust fans can result in achieving the average of outdoor and indoor temperature. Due to evaporative cooling, very comfortable conditions are achieved. Only in exceptionally hot conditions, there will be need for using an air conditioner.

A centralized evaporative cooler with ducts and Exhaust fan could be set up on top of the roof. Individual rooms could be provided with valves to control the air flow. PCMs in combination with the above outlined system could further improve the overall performance of such systems.

5.17 Dehumidifier-cum-Evaporative Cooler

A combination of dehumidifier and evaporative cooler in combination with a chiller on rooftop could offer a solution, where most of the time, the evaporative cooler and exhaust fans are used. Under high humidity conditions, the dehumidifier could be used. In situations, where the desired temperature is not achieved, the chiller circuit could be used. Such units are already being used in certain parts of USA. Large scale industrial dehumidifiers are already being used in Pakistan. This technology requires dehumidifier motors and cooling pads to manufacture the units. Design technology and tools are already available.

5.18 Ground Water Heat Pump

Ground water heat pumps are used to store heat or cold in the aquifer. During summer, the heat pump extracts heat from the ground water and pumps the chilled water to the building whereas during winter, it supplies the building with heat, while the chilled water is stored in a well. This technology is very widely used. Already there are 1 million ground water heat pumps installed in the USA. This solution can be used in combination with lake or sea water for free cooling. This type of cooling is being used in city of Stockholm and other parts of Sweden. This solution can be considered for coastal areas specially city of Karachi.

5.19 Solar Windows and Roof

Windows with built-in Photovoltaic cells are available in the market. These panels are also available as roof modules.

5.20 Thermal Storage using Phase Change Materials

Using Phase Change Materials (PCM), it is possible to store thermal energy in solar heating and cooling systems, off-peak electricity, industrial waste heat etc. Two aspects are important in these applications: Choice of the PCM and Heat Transfer Mechanism.

Many companies are already developing such systems for different applications. One application [11] is to encapsulate PCMs in building materials such as concrete, gypsum wallboard, in the ceiling or floor, to increase their thermal storage capacity. PCM retrofitted building envelope could be used to store cooling from the ambient during the night when temperature is cooler than that during the day. During the day, the PCMs would release stored cooling to the conditioned space. Research in using PCM wall boards showed that under California conditions, the cooling requirement could be reduced by 28%.

PCMs offer an attractive solution to thermal storage for heating and cooling. Low temperature solar heat based absorption cooling in combination with PCM based storage offers an attractive solution for Pakistan.

5.21 Other Technologies

Other technologies include Solar Panels for Hot water heating, Gas or Ethanol Fired Generators for Houses, Roof top Wind Generators, and Roof Slabs with holes for cooling of structure etc. Integration of different technologies is yet an area of research and development.

5.22 Power Sector Related Solutions

This paper has not focused on Power Sector related technologies as these are already well known. For the sake of completeness, the following solutions may be mentioned:

- Load controllers
- Current Limiters in combination with Capacity tariff.
- Use of off-peak tariff.
- Introduction of controllable loads with remote control using Ripple Control.
- Introduction of electricity connections based on current limiter/fuse and Ampere rating.
- Balancing of customers load by phases.
- Customer education.
- Residential single-phase unit transformers starting from 1 kVA.
- Conversion of LT lines to HT.
- Introduction of larger number of smaller size grid stations.
- Construction of heavy backbone system to allow smart shifting of load.

6 RESEARCH AND DEMONSTRATION PROGRAM

Poor progress in the past in harnessing new technologies for energy efficiency improvements and conservation is a result of lack of fully functional research and demonstration projects. Most of the work in this area requires input from researchers at the university level. It is, therefore, suggested that the utilities as well as the donor agencies support the development and monitoring of a research and demonstration programme at the University level. Many of the research questions could be the subjects of Masters and Ph.D studies.

A special study should be carried out to develop such a Research and Demonstration Program.

7 FINANCIAL SUPPORT PROGRAMMES

For technologies that are ripe, there should be financial incentive program with grant of 50 % of the investment cost, as in other countries. For technologies, where, there is need for development, a number of research and demonstration programs should be sponsored with 100 % grant-in-aid funding.

8 EDUCATIONAL PROGRAMMES

Suitable Educational Programmes should be encouraged at the university level. This is an important area. Both Bachelors and Masters Programs should be considered.

9 CONCLUSIONS

This paper has briefly analysed the Demand Side Management issues. Analysis of data has indicated that the Domestic and Industrial sectors are the two most important sectors where demand side management is badly needed. The domestic sector used more demand than its share in energy consumption. The industrial sector uses more energy than its share in demand. Other sectors are using demand in relation to their share in consumption.

There is a large variety of technologies that may be used. Some of the most important ones are: use of evaporative cooler in combination with exhaust fans, use of insulation, cool-roofs, proper orientation of building and use of light roller shades. LED lighting and skylights are important solutions. All systems must use heat recovery systems.

Ground water heat pumps with aquifer storage systems can be developed on short term basis. Necessary technologies should be acquired and disseminated through universities. Use of lake of sea water can provide free cooling. Thermal storage using PCMs is an important area for research and development. In combination with free heating or cooling from the ambient, PCMs can offer an attractive solution to demand side management.

Power sector related solutions must introduce a suitable two part capacity tariff with current limiters. Two connections should be offered to all customers, with one connection remotely controlled. New connections should be given on the basis of current rating in combination with current limiters or fuses. Load controllers should be introduced.

Demand Side Management is a very vast area. The utilities must get directly involved in it. A number of demonstration systems should be installed, monitored and displayed.
Technology is developing at a very fast rate. Regular technology roundup is therefore necessary.

REFERENCES

[1] Power & Alternative Energy Sectors of Pakistan. Retrieved on March 21, from http://www.powerasia.com.pk/introduction.htm

[2] Power Distribution As on 31-08-2008. Retrieved on March 21, from http://www.wapda.gov.pk/htmls/pdistribution-index.html

[3] Countrywide load-shedding from today. Dawn International. Retrieved on March 21, 2008, from http://www.thenews.com.pk/print3.asp?id=5058

[4] Pita, E.G. Air Conditioning Principles and Systems. An Energy Approach, Fourth Edition, Pearson Education, ISBN 81-7758-549-5, 2006.

[5] Cool colors. A Roofing Study is Developing Cool Products for Residential Roofs, ECO-Structure, September/October 2004, pp. 50-56.

[6] Piette, M.A. Learning from Experiences with Controls to Reduce Electrical Demands in Commercial Buildings. CADDETT Analyses Series No. 7. Center for Analysis and Dissemination of Demonstrated Energy Technologies, CADDETT Analysis Support Unit, 1991, pp. 1-85.

[7] Gonçalves, M. D. Insulating Solid Masonry Walls. Building Envelope Forum. Retrieved on March 25, 2008, from http://www.buildingenvelopeforum.com/Masonrywall.htm

[8] Younger. The Building Envelope. Retrieved on March 25, 2008, from http://www.healthgoods.com/Education/Healthy_Home_Information/Building_Design_and_Construction/building_envelope.htm

[9] Andre, E. & Schade J. Dalighting by Fiber Optic. Masters Thesis, Department of Environmental Engineering, Lulea University of Technology, Sweden, 2002:60 CIV.

[10] Sharma, S.D. & Sagara, K. Latent Heat Storage Materials and Systems: A Review, International Journal of Green Energy, 2: 1–56, 2005

[11] Bruno, F. Using Phase Change Materials (PCMs) for Space Heating and Cooling In Buildings. AIRAH performance enhanced buildings environmentally sustainable design conference, 2004.

[12] Stetiu C. & Feustel H.E., Phase-Change Wallboard and Mechanical Night Ventilation in Commercial Buildings, Lawrence Berkeley National Laboratory, (1998)

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GENESIS OF POWER CRISIS AND ITS MANAGEMENT IN PAKISTAN

By

Amjad Agha

GENESIS OF POWER CRISIS AND ITS MANAGEMENT IN PAKISTAN

By

Amjad Agha*

1. Abstract

The country is presently facing a huge electricity crisis. The crisis appears insurmountable in the near or even long term future, unless proper understanding and correct implementation is undertaken on priority basis. The whole country is undergoing extended load shedding; in the large cities for 10 – 12 hours every day and even longer in the other parts.

The current power crisis which is very acute has been caused due to very little increase in the new generation capacity during the last 10 years and primarily because of extra ordinary increase in the cost of furnace oil in year 2008. The crisis is not easy to overcome as no affordable solutions are available in the near future. Policy orientation needs to be thoroughly modified and reliance has to be shifted to the indigenous resources like Hydel, Coal and Gas. It appears that for the present high Government subsidy will be required for this sector or the electricity tariff may be increased by 25 percent to balance the books. Details of the Power crisis and its short term and long term scenarios are discussed in this paper.

2. Present Capacity and Lack of Development

At present the total power production capacity in the country is about 19500 MW out of which Hydel Power is 6,500 MW and the balance of 13000 MW is thermal using Natural Gas or Furnace Oil. Small capacity of 450 MW is nuclear and only 150 MW is through coal. Although Gas is to be provided for 5800 MW to various thermal plants, but in actual fact much less gas is being made available. The deficiency if is to be filled would require more furnace oil.

For the last 8 – 10 years very little was accomplished in increasing the electricity generation capacity and only 2000 MW was added in this period. As per demand forecast at least 8,000 to 10,000 MW should have been increased. One factor behind this was that the Government took a decision 10 years ago, that in future power plants would be established by the Private Sector, and WAPDA was not allowed to set up new plants, particularly in the thermal sector. This policy was flawed since Private Sector was asking for very high price which WAPDA could not afford to pay. For instance WAPDA was able to set up thermal plants at a price of about 700,000 to 800,000 dollars per MW, but the private sector was asking for over 1.2 Million dollar per MW. The failure to take no remedial action was a big set back. In order for the private sector to be more competitive, WAPDA should be allowed to simultaneously continue its generation program. Three years ago the Government agreed as a special dispensation for WAPDA to set up three thermal plants of total 1800 MW capacity, but WAPDA was stopped even after they had made all arrangements including financing.

3. Effect of Oil Prices

The question which however crops up is that last year with the same supply level, load shedding was much less, why it has suddenly increased so much. The reason for the sudden debacle is the extraordinary increase in the cost of furnace oil in the year 2008. The price of furnace went as high as Rs. 60,000 per ton. In 1999 this price was only Rs. 3,000 per ton. Due to the high price of furnace oil the existing thermal plants were forced to reduce their plant factory drastically.

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It is very important to understand the consequence of the prevailing situation. The price of furnace oil in the Year 2008, went as high as Rs. 60,000 per ton. At an average, one ton of furnace oil will produce 4000 kWh of electricity. Thus the cost of furnace oil for generating one unit of electricity was Rs. 15/-. On top of this is the cost of thermal plant and after adding the transmission and distribution costs including losses, the total price of electricity produced through Furnace Oil worked out to be over Rs. 20/- per kWh. The price of furnace oil has now come down to about Rs. 25,000 per ton, but even this price means that Rs. 6 worth of oil is required to produce 1 kWh of electricity and the total cost of this electricity is still about Rs. 11 per kWh. WAPDA is selling electricity at Rs. 5 per kWh. If WAPDA is to balance its books, it would require an annual subsidy of Rs. 200 -300 Billion. This subsidy is somewhat reduced due to cheap power produced through hydel energy and natural gas, but the deficit cannot change substantially unless bulk of electricity is produced through hydel energy and natural gas. Obviously the current deficit is not sustainable. The Government has no resources to pay such huge subsidy, it is also not possible to increase power tariff so much. Therefore the power crisis is much greater than what is being perceived. In the absence of a subsidy, WAPDA is delaying payments to IPPs who are unable to pay to the oil companies. WAPDA is also not paying the oil companies which provide oil to WAPDA's own thermal plants. WAPDA is not receiving payments of electricity it provides to KESC. The circular debt has now reached over Rs. 400 billion as reported in the press. The result is that IPPs as well as WAPDA's own thermal plants are now producing much less electricity than their capacity.

The oil prices are not likely to remain at present level, in fact some forecast indicate that by 2010 they will go high again. Therefore it should be obvious to any planners that the country cannot afford electricity produced through imported oil. Indigenous fuels like coal, gas and atomic will have to be developed and developed fast. The development of hydroelectric renewable energy should however be back-bone of all future planning.

4. Current Hydro - Power Capacity

It should be understood that hydel power is maximum in wet season and less in winter. For instance in our system the maximum hydropower is about 6500 MW and in the winter it goes down to less than 2500 MW. Therefore the gap of 4000 MW will have to be picked up by thermal plants in the winter season and the required capacity will have to be supplemented through thermal plant. . As far as the energy is concerned hydropower still produces about 32 billion kWh which is about 36% of the total energy produced in the country. This percentage can increase substantially if more hydropower plants are installed. The construction of large dams has been stalled due to narrow minded bickering for the last decades, and now their costs have become enormous, recent estimate for construction of Basha Dam has reached a level of about 12 - 14 billion dollars. Obviously to find funding for such a huge amount will not be easy.

5. Way Forward: - Conservation in electricity Use

It is obvious that affordable electricity cannot be produced in the short term. The shortages have to be somewhat managed. The immediate action which can give some relief is the conservation of electricity. The Government has announced certain measures and estimated 1500 MW will be saved, but very little action has been seen in implementing those measures. In order to implement the conservation measure the Nazims and Deputy Nazims should visit the areas and try to convince and negotiate with people, shops etc., and request them to cooperate in the overall interest. Bill boards and hordings are still blazing at night, shops and marriage halls use excessive lights which can be conveniently reduced. A suggestion that cities be divided in

zones, and markets on these zones be closed on different days can save peak time energy usage.

- Improving the Utilisation of Existing Generation Capacity

At present the IPPs and WAPDA owned thermal plants are averaging about 40 to 50% plant factor. The reason for IPPs low plant factor is that PEPCO is not paying them for the oil which is a pass through item. WAPDA's owned plant factor is low because most of their plants are old, inefficient and poorly maintained, and thus waste large percentage of the costly fuels. Most of these plants were designed and manufactured according to the technology that was developed when fossil fuels were very cheap and WAPDA preferred inefficient cheaper plants. The furnace oil prices in the 1970 – 90 was only Rs. 2000 per ton which meant fuel cost of Rs.0.5 for producing one kWh of electricity as compared to present fuel cost of Rs. 6 or more per kWh.. For the purpose of reducing the cost of thermal electricity it is now necessary to replace the old inefficient plants with gas fired combined cycle power plants capable of achieving 60% efficiency. For example Units 1 – 4 of Guddu Thermal power station are conventional gas fired steam turbine generators which were commissioned between 1974 – 1985. These units had a combined installed capacity of 640 MW which is now reduced to 430 MW. Their efficiency has dropped below 30% and they have become fuel guzzlers and the worst emitters of greenhouse gases. Their peak performance was in the year 2005 when they burned over 42 billion cubic ft. gas and generated only 3 billion kWh of electricity. If these plants are replaced with the efficient combined cycle plants then with the same quantity of natural gas they will start producing 6 billion kWh of electricity and their MW capacity will also go to 800 MW. Similarly other old and inefficient power plants in PEPCO system where gas supply is being made available, should be replaced with more efficient combined cycle plants. It is anticipated that by modernising existing plants, PEPCO can double its thermal generation capacity and energy production. It is very important that Government should give particular attention in replacing the old inefficient gas fired units with more modern combined cycle plants. New thermal plants in the private sector are also in urgent need, but most of these plants will use furnace oil as their fuel and thus will be very expensive to run. The so called rented power plants appears a desparate choice, since the cost of electricity produced through these plants is about Rs. 12 to 14 per kWh at bus-bar. How will these costs be sustained.

6. Measures for Near Future

- For short term measure apart from conservation of consumption, adequate subsidy will have to be provided to WAPDA to utilize the existing capacity to the maximum. The circular debt has to be addressed on priority basis. The economic loss to the industry and inconvenience to the public if not halted soon, would create chaos and unrest.

- All Contractors who are presently constructing power plants be offered suitable incentive in the form of Bonus for early completion.

- The conditions for construction of Power Plants only by private sector be waived and WAPDA is also allowed to construct generating stations, at least for some short period.

- Captive power owners be allowed to sell extra power to neighbouring organizations at mutually agreed rates.

7. Mid and long Term:

All efforts are needed to stay away from oil. For thermal plants generation should be diversified, coal, natural gas and Nuclear power should be used. Vast deposits of coal exist at Thar but it is unconceivable why the mining of this coal has not yet started. There are number of new gas fields discovered but their development has been put on a back burner. The existing gas fields

require additional pressure and better transmission, the work on that sector should be started immediately. The gas purchase agreement with Iran be finalized immediately even without India. In addition agreement with Kazakistan be persued diligently for import of gas. Purchase of electricity from Iran should also be explored. The option to use imported coal should also be fully examined.

The existing old WAPDA thermal plants, particularly for those where gas is readily available should be modernized and converted into combined cycle.

8. Heavy Line Losses in Transmission and Distribution

Currently the country loses 29 billion units of electricity annually due to heavy losses in the system. All efforts must be applied to reduce these losses since these losses also have a substantial pilferage element. The reduction in these losses will greatly help in reducing or even eliminating the subsidy.

9. Hydro Power

For hydroelectric projects the large ones can be built on Indus river, where not only hydroelectricity can be produced, highly needed water storage can also be developed. In Pakistan out of the total flows of 145 MAF, the storage capacity is only 13.6 MAF which is only 9% of the total annual flows. As compared to this India has a total storage of 245 MAF, which is 32.6% of their annual flows, this storage is being increased through construction of 970 more dams. The disparity of water requirement and availability in the Rabi crop can only be removed if the 35 MAF of water which is being allowed to go to the sea is at least partially stored. Both Kalabagh and Basha dams will store above 12 – 13 MAF. Some legitimate objections on the environment and social impact of large dams are valid, but the solution of such objections can be satisfactorily found. The will of government leaders is needed and the matter can be resolved. Experts from various Provinces can get together and whose task should be put forward solution for mitigating the objections. Such proposals should be discussed in the Provincial Assemblies to satisfy the elected representatives explaining that objections can be satisfactorily mitigated.

There are number of other attractive run of the river hydel projects which are being offered to the private sector. None of these projects have yet started because the tariff etc. is still not finalized. With high financial losses being accumulated in the thermal plants, it is strange that the hydel projects in the private sector are not being encouraged. In the present circumstances, a rational and market oriented policy is to be adopted, hopefully the present government will immediately look into this. The ratio of hydel-thermal mix can be easily restored to 50 : 50.

10. Concluding Remarks

A major factor for the current electricity crisis is the very high oil price and the country has to prepare itself atleast for the next several years to somehow cope with this crisis. It has been a big set back that for last 10 years hardly any new power project, have been undertaken. The policy orientation needs drastic modifications and indigenous resources like hydel energy production as well as development of coal mining and new gas fields should be the top priority. Efforts should also be made to set up more and larger atomic plants with the help of China, who have now developed capability to manufacture 900 MW capacity atomic plants. We have delayed construction of Kalabagh Dam for so long that now both Basha and Kalabagh must be built and built fast.

Other forms of renewal energy like solar and wind energy also be given due attention.

There does not seem to be any affordable solution to the Power Crisis in the near future. No large hydro project even if started on priority basis will be available in the next 8 – 10 years, Start of coal mining at Thar and setting up a large plant there will also take 6 – 8 years.

It appears that if the current shortages have to be met then for the present expensive oil based plants will have to be depended upon. Consequently a heavy subsidy from the Government will be needed for the next several years to provide affordable electricity to the Industry and public. Other option is to increase the tariff by 20 – 25 percent. If any of these steps are not taken, the load shedding will get even worse. A solution to reducing subsidy is to manage transmission and distribution losses and control the pilferage.

Paper No. 262

POWER CRISES, CAUSES AND MANAGEMENT

By

Engr. Riaz Ahsan Baig

POWER CRISES, CAUSES AND MANAGEMENT

By

Engr. Riaz Ahsan Baig*

1. BACKGROUND

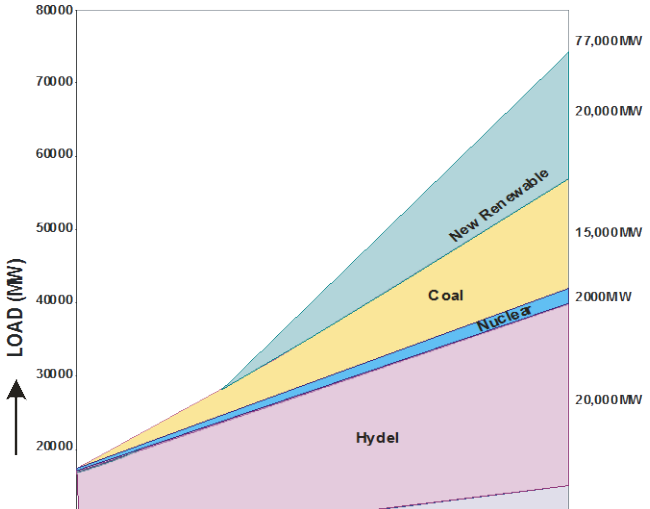
1.1 Today no one can deny that GOP has failed to meet the power requirements, so badly needed for economic growth of the Country halting agriculture and industrial development. Without an efficient energy sector, there can be no development of industries and increase in agriculture output. There seems to be no lack of planning since the power requirements and available indigenous sources were identified well in time but we lacked in implementation of the Projects, the reasons of which shall be discussed in this paper.

2. AVAILABILITY OF INDIGENOUS SOURCES AND ITS UTILIZATION

In brief our power growth rate on the average is about 8% per annum and we ought to add at least 2000 to 3000 MW of power every year. To give an idea of load requirement by the year 2030 and probable sharing of indigenous resources are given in Fig-1 taking into account a rational figure of declining growth rate from 8% to 5% per annum as base for total installed capacity is broadened. If we assume a uniform growth rate of 8%, a installed capacity of 124,000 MW is estimated by the year 2030 as shown in Fig-2. We shall be requiring at least additional 60,000 MW of energy over the next 20 years. This will give us an idea to what extent we can meet our power demand from the indigenous resources and the sectors where development is required to meet the shortfall. To achieve the target GOP needs to streamline its policies with consistency and determination, otherwise we will continue to pay huge price by halting wheel of industry and agriculture.

Fig-1

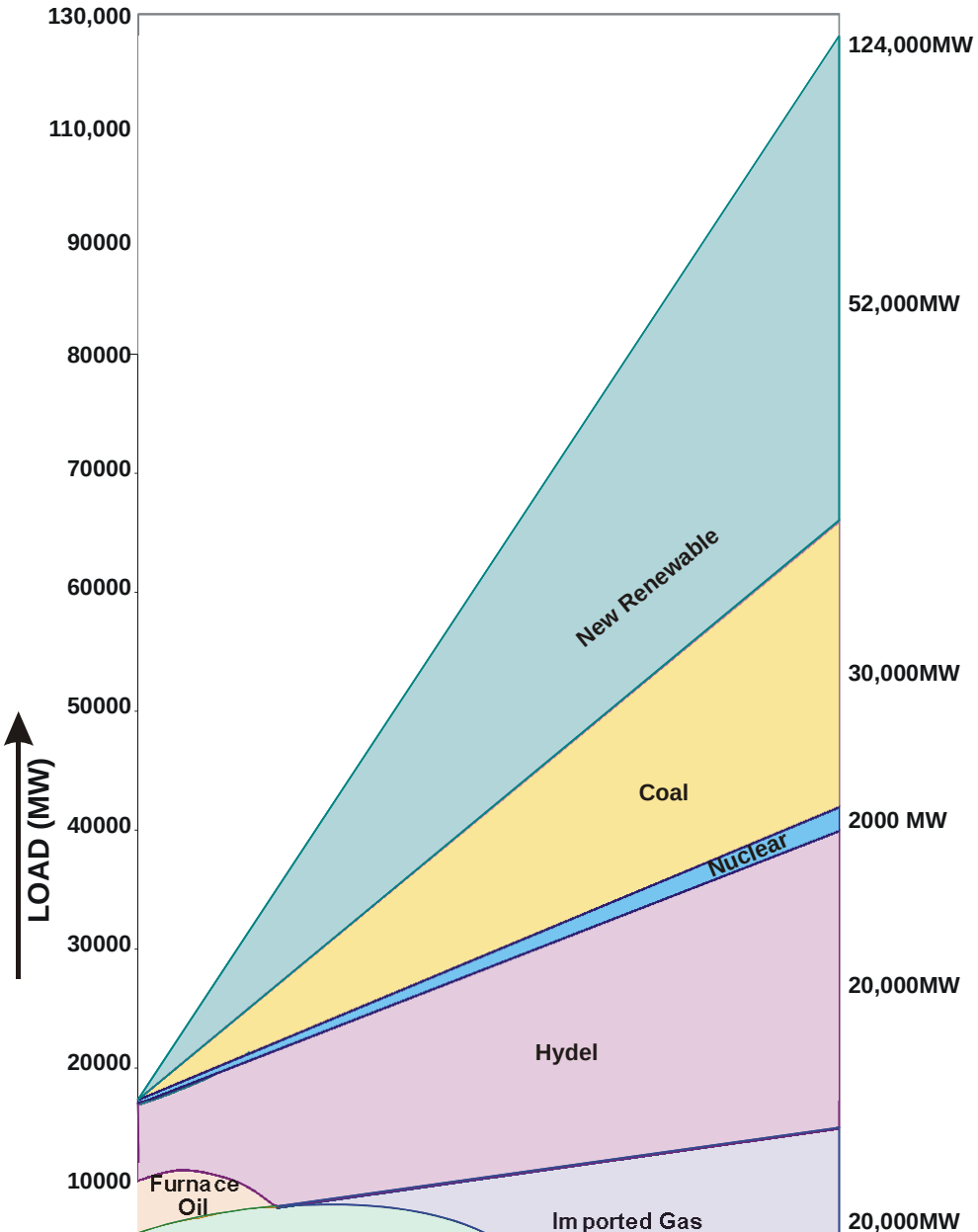
DIVISION OF ENERGY RESOURCES FOR PRODUCTION OF POWER BASED ON DECLINING GROWTH RATE OF 8 % TO 5%



*Vice President IEEEP

Fig-2

DIVISION OF ENERGY RESOURCES FOR PRODUCTION OF POWER BASED ON UNIFORM GROWTH RATE OF 8 %



Herein I will give a brief account of indigenous resources available and possible import of fuels to meet the short fall before discussing reasons for failure and remedies thereof.

2.1 Hydropower

2.1.1 Hydropower Development is one of the sector of energy, which Pakistan need to harness at a faster rate. It's a non-polluting renewable sources of water for agriculture and energy. It is pity that over the last sixty years Government of Pakistan has not paid due attention to harness this available potential. Over this period we have just added 6,463 MW of Hydle Generation against 41,000 MW power of estimated hydropower potential available in the country.

Government should realize that without affordable energy sector there can be no progress in the country. Under vision 2025, only 769 MW of power generation is planned to be added by the year 2010, which Projects are also not running according to schedule and have been delayed from 2 to 4 years.

The management has always been based on ad-hocism in absence of an effective system. Over the last one decade no major break through was achieved Inspite of big claims as most of the Projects were confined to pre feasibility or Feasibility Studies.

2.1.2 Unfortunately our technocrats have mixed the priorities of power generation from "big multi-purpose water reservoir dams" with **"run of the river"** generation. The main purpose of former is irrigation and the power generation is its by product while the later is purely used for power generation, and as such their priorities need to be separately identified based on power requirement. We have given priority to Kalabagh, Basha and Akhori Dams, which became hostage to political issues ignoring run of the river hydle generation projects. Power generation from **"run of river"** projects is low cost and its completion schedule is short compared to big water reservoir dams. Based on **"Run of the River"** Hydle Projects, a substantial power generation capacity of about 20,000 MW in northern areas is available, which should be given priority and completed within the next 4-5 years. A brief account of major hydropower generation available on **"run of river"** is as under:

Sr. #	Name	Generation Capacity (MW)
1	Pattan (Indus)	2800
2	Thahkot I & II (Indus)	2500
3	Dasu (Indus)	3700
4	Bunji (Indus)	5400
5	Munda (Swat)	740
6	Suki Kinari (Kunhar)	650
7	Azad Pattan, Karot, Mahl (On Jhelum)	700
8	Naran Patrind (Kunqar)	350
9	Naleem-Jehlum	970
10	Kohala	860
	Total	**19570**

2.2 Thar Coal

2.2.1 The coal reserves of Pakistan are estimated at over 183 billion tons while present rate of excavation is only 3.2 billion tons annually. Due to lack of planning, poor management and inefficient controls, Pakistan reserves could not be exploited. The details of coal reserves are as follows:

- Sindh has a very large coal resource potential outlined in and around Lakhra, Souda Jherruck, Thar and Badin Coal fields. Sindh has measured reserves of 734 million tons, while annual output is 1 million tons.

- Balochistan has a source potential of 194 million tons with measured reserves of 52.5 million tons while average annual production is one million tons only.

- Punjab has a coal reserve of 234 million tons with drill proven reserves of 43 million tons and annual production is 0.45 million tons.

- Proven recoverable resources of coal in Pakistan are 2265 million tons while production is 3.2 million tons annually only against its massive estimated potential of 183 billion tons.

2.2.2 The situation on coal production is not very encouraging. Inspite of huge reserves of coal our Government has failed to harness God gifted potential for benefit of its people as coal mining remained at low priority and techniques used are primitive

2.2.3 The vast reserves of coal have failed to benefit Pakistan in any meaningful way particularly as the least inexpensive fuel for generation of electricity. The majority of coal produced in Pakistan is of sub-bituminous quality which has a higher moisture and sulphur content. Although coal requires special technology to be used in power generation yet it will still be cheaper compared to other technologies available at present.

GOP need to streamline its long term policies to use abundant indigenous coal reserves to reduce dependence on imported fuels. GOP has recently signed an MOU with China to mine Thar Coal and to generate 600 MW of electricity, although a small utilization of Thar potential, we can say is a step forward in the right direction.

2.2.4 Recently Prime Minister of Pakistan has constituted the Thar Coal Authority while abolishing all other agencies. This may be step forward for good governess as according to Provincial Government, sources of problem have been the Federal Government bodies that have consistently created hindrances in the way of investment.

2.3 Wind

There is 10,000 MW to 15,000 MW of wind energy potential available in Sindh which Government of Pakistan has failed to harness, due to inefficient, inapt approach to tackle the problems. Over the last one decade dozens of Letter of Intent were issued by PPIB but to no avail, clearly indicating inefficiency of this organization.

Pakistan energy needs are immediate. Best option is exploiting wind energy in short terms because wind projects can be commissioned in two to four years. Wind energy is fastest source of power in the world. Global energy production from wind has risen from 20,000 MW in the year 2001 to 70,000 MW in 2006. China, Germany and USA are the main countries exploiting this indigenous source of energy in their own countries. 20,000 MW of wind turbines have been installed in Germany alone.

Wind energy is fastest growing and most potent source of renewable electricity although its application is limited to corridors where sufficient wind velocity to run the turbines is available.

2.4 Solar Energy

Solar cell energy is emerging as most potent source of renewable energy in the new future, which is available in plenty. This source of energy still requires research and development to reduce its cost and size to acceptable limits.

During the year 2006, 750MW of solar cell systems were installed in Germany alone in remote areas where grid supply was not available. For an average house with required capacity of 4kW, Surface area of 35 Sqm to 40 Sqm, preferably on roof top is required which is on higher side and needs to be reduced through Research and Development. GOP should provide assistance to Engineering Universities for establishing solar cell research Laboratories and students given the assignment to carry out research as a Project or thesis.

The cost of solar cells will be drastically reduced when developed and produced locally. It is estimated that by the year 2020 solar cell will be one of the major source of energy in the World.

3. IMPORTATION OF GAS

Due to limited gas resources in Pakistan importation of gas from the neighboring countries is inevitable to meet the growing demand of energy Gas importation projects envisage about 1500 KM to 2000 KM long pipeline connecting regional gas supply sources such as Turkmenistan, Iran and Qatar to domestic pipeline network bringing in more than 1.5 billion cubic feet of gas per day. The most viable available source is from Iran where sufficient proven gas reserves are available to provide us energy for another 100 years. Importing of gas from Turkmenistan is not safe and reliable while from Qatar it will be more expansive and perhaps not available over a long duration. Government of Pakistan over last one decade has failed to materialize any Project.

United States has been supporting import of natural gas from Central Asian States as an alternative to import of gas from Iran as a part of its strategy to isolate Tehran, the future of gas imports from Tajikistan would hang in balance because of security situation in Afghanistan. We as a nation should watch our own interest rather than pleasing foreign agencies

4. IMPACT OF FAILURE TO MEET THE POWER DEMAND

Due to failure to timely implement the Projects to produce electricity from the available indigenous resources over the last one decade, we are today facing unprecedented power shortage stalling business, industry and agriculture output and causing national loss of billions of dollars. As a result all consumers have to bear the continuous rise in electricity tariff for an unlimited period in the foreseeable future due to increase in oil prices. This time bomb is ticking for unparalled hike in gas and electricity prices and to meet the demand, we have made no attempt to reduce reliance on fuel based thermal electricity rather rented thermal generators are imported to fill the gap whose cost of generation is very high. How this is going to affect cost of industrial production, exports, commercial activities agriculture output, could be any body's guess, resulting in billions of dollars of unimaginable loss.

5. FAILURE OF MANAGEMENT

5.1 Background

5.1.1 Unfortunately every Project which is in the national interest is sabotaged. PPIB has not delivered although hundreds of investors have shown their interest for investment in

Pakistan. This evidently shows inefficiency and anti national approach to resolve the issues. Previously pre-feasibility of Thar Coal was conducted by Shenwa, a state owned Chinese Company. They gave a bid of 5.75 cents per kW but some Government agencies insisted to lower the cost and ultimately negotiations failed and instead invited IFC and US investors, the costs of which are very high and no progress is made for harnessing Thar Coal reserves so far. Today we are buying power from hired gas generators at a much higher cost shutting down our own power plants due to shortage of gas supply, which in my opinion was a tactic used to accommodate foreign investor for vested interests. Same is the case of Gas Pipeline Project from Iran. To please USA, we have already delayed this Project for more than 2 decades and started looking for other alternatives under his direction which are neither safe nor reliable. Similarly under vested interests, we failed to award a single Windmill Project inspite of interest of several investors. At the end of the day we boost of our achievements by placing 170 million of our country men under misery and distress. We call ourselves Muslims having faith in Quran and Day of Judgment. We sell our conscious and country for sake of our Promotions and higher positions which they usually get under the directions of their Masters.

5.2 Causes

5.2.1 The answer to the question 'Why We Failed" to meet the requirement can be learnt from examples of failure of Argentina and success of Singapore. In case of Argentina for economic debacle one can fix the blame on the 'poor governance by a series of successive governments coupled with poor national discipline. On the other hand brilliant economic success of Singapore is attributed is to the 'excellent governance" and to the "Superb discipline". It is a fact that poor governance and poor national discipline are the major factors of economic misery of the Third World and unfortunately Pakistan is one of them. In my opinion one of the major factors resulting into poor national discipline and bad governance is **corruption**.

5.2.2 Corruption, a major factor for our failure as a state

i. A European writer on Asia, Tibor Mende says, no other symptom of Pakistan public life has contributed more to demoralization of the 'common man' than corruption. He further adds that illicit practices had reached such proportions that effects would likely wipe out whatever benefits new economic projects might have secured. In this regard Transparency International says 'The continuing high levels of corruption and poverty plaguing many of the under developed World's societies amount to an ongoing humanitarian disaster and slaughter of poor human beings and this calls for more focused and coordinated approach to strengthen institutions for governance.

ii. With passage of time, the atmosphere conducive to corruption has been building up in the country ever since. One does not need to wait long to find out how the network seems to multiply by leaps and bounds from top to bottom for making personal rapid gains.

iii. Corruption manifests itself through many modes commonly known as Bribes, Patronage, Kick backs etc. such type of corruption practices are visible but we have another type of corruption which is not known to the general public and I have named it as **latent corruption**. At top levels, corruption has given birth to foreign influence and relation with foreign agencies, which has completely destroyed the country's freedom and economic development. This type of corruption has already penetrated in the blood stream of our top brass

bureaucrats, managers and politicians which is very dangerous and is responsible for disarray in our discipline and economic failure, and needs to be controlled with iron hands. Under the influence of foreign power's top brass positions in establishment are filled up, which look for their own interests under direction of foreign agencies and such covenants are signed which are detrimental to country economy's and existence.

iv. Pakistan has a history of external dependency, which has traditionally allowed foreign forces to dictate their agenda to Pakistani leadership. Our establishment is fully under influence of loan giving agencies which force our leaders to accept country's financial dependency. Our leadership is told if foreign multinational aid donors influenced by foreign powers, do not provide financial assistance, we are likely to be doomed and national security will be at stake and our financial rating will be down graded. Generally the political and financial dependence in foreign powers is due to personal concerns and benefits rather than national interest. So the political parties, civil and military bureaucracies and clergy are divided into groups to look for their personal interests, to please the foreign powers. Under this system our top brass tries to please the foreign powers by adopting their dictated policies to get maximum personal benefits at the cost of nation. Any nation, which allows foreign forces to intervene, so willingly as we are doing today, cannot produce sustainable development resulting in bad governance, poor performance and greater socio-political instability.

6. REMEDIES

6.1 Before recommending any remedies we need to improve our economic conditions without which foreign investment for development of energy sector can not be attracted.

6.2 Due to changing political situation and war on terrorism, economic conditions of our country have deteriorated. Our foreign exchange reserves have fallen from US$ 16 billion to less than 9 billion and Pak Currency has slided from Rs. 61 to Rs. 78 to a dollar over the last eight months. Hundi System is in force and dollars in market are freely available for transfer to foreign countries with total lack of control over the worsening situation. Any vision to address to economic issues in the near future by the present government is totally missing. By all means, we call the present situation, a worst example of bad governance and financial controls. Inspite of all this one fails to understand how such a sound economy which was built over the last one decade has dwindled in few months when new Government has not taken any mega projects. It seems that it was again a hand picked of economists who were beating trumpet on the advice of some international financial agencies and economy was never on a sound footing.

To improve economic health of the country GOP must move fast and take measure to control flight of wealth to foreign countries, and improve balance of payments by exporting more and restricting imports. It will not be out of place to mention here that China even today is supporting its industry by giving 20% incentive at cost of all value added export products.

6.3 In addition GOP need to change the priorities of Projects. According to our understanding Projects with shorter implementation period and easier to construct should be taken up first. Under Hydel Projects Pattan, Thahkot and Dasu should be given priority. In my opinion Basha is not a priority Project. Its cost along with approach

highway will be more than US$15 billion spread over a period of 10 to 12 years. In its place Kala Bagh Dam and Akhori Dam should be given priority which can be constructed in half the time and cost. As stated earlier we have plenty of indigenous resources, which must be exploited for healthy development of economy without further waiting in addition to gas importation from Iran. Following are the priority Power Projects, which may be taken up in the near future:

Type of Energy	**Available Power Potential**	**Implementation Period**
1. Wind Mills	10,000 MW	3 – 5 years
2. Hydle Projects on Run of River – Phase-I: Thakot, Pattan, Dasu & Bunji etc. – Phase-II: Other Hydle Projects on "Run of the River"	 10,000 MW 10,000 MW	 6 – 7 years 7 – 15 years
3. Thar Coal Phase-I Thar Coal Phase-II	5,000 MW 50,000 MW	5 years 5 – 15 years
4. Import of Gas from Iran	10,000 MW	7 years

6.4 The broader question, however, "how to cope with corruption which has engulfed every phase of life in Pakistan" is still to be answered. In my opinion we need to change the culture of corruption by punishing bureaucrats, technocrats and economists who are responsible for creating this situation of power crises and dwindling economy. Justice should prevail at every door step.

7. RECOMMENDATIONS

7.1 As stated above Government of Pakistan needs to review its priority for Water and Power Projects. Projects with shorter implementation periods, lower cost and easier to construct Must be taken up first. Following are the recommendations:

i Wind Mills

All the available potential should be exploited within next 3 to 5 years of time instead of 15 years plan as presently envisaged.

ii Hydle Power Project

a) Run of River Projects

Hydle Power Projects on Run of rivers which includes Dasu, Thakot, Pathan, Bunji etc should be given top priority and commissioned by the year 2015. Dasu with a generation capacity of 4000MW is nearest to the load centers and should be completed first followed by others power projects in sequence.

b) Water Reservoir Projects

Construction of Kala Bagh Dam and Akhori Dam should be given priority being low cost and having shorter period of Construction compared to Basha Dam.

iii Coal

Indigenous Coal Power Project instead of Power Projects based on Imported Coal should be given priority.

iv Gas

Gas Pipeline Project from Iran instead of Turkmenistan, which is neither safe nor reliable is the only solution to meet the energy gap.

7.2 Short Terms Measures

i. Under short term measures, we have no alternative except to fill the gap by adding thermal power generation based on furnace oil. To have healthy competition and competitive prices, it is proposed that WAPDA/PEPCO and IPP's should share this generation capacity equally.

ii. GOP has adopted policy to hire generators on rental basis instead of installing own Thermal Power Generation, which is going to increase cost of Electricity tremendously, affecting cost of industrial production, exports, commercial activities and agriculture output. We need this additional thermal generation on permanent basis to meet with the short fall of generation to fill the gap of hydle generation during lean water season. GOP needs to correct its policy by installing its own thermal power generation rather than hiring generators on rent.

iii. Power conservation and reduction in losses is another important area which GOP should give priority, by encouraging use of more energy savers, installation of capacitors on distribution feeders to improve power factor, and rehabilitation of distribution feeders to reduce line losses. In addition 70% of energy can be saved if buildings are properly insulated for transfer of heat and cold from outside. GOP needs to formulate policy for construction of buildings which should be mandatory for all agencies responsible for planning, design and construction of buildings.

iv. To further reduce expansive generation on Furnace oil , GOP may also consider to switch over street lighting to solar power system if viable.

ANNEXURE-I

STATUS OF HYDROPOWER PROJECTS UNDER CONSIDERATION

1. Projects in pipeline at this time (Magnitude of projects and required investment, brief description, expected period of commissioning).

1.1 Public Sector Hydropower Projects;

A. Under Construction:

Sr. No.	Name of Project	Capacity (Mw)	PC-I Cost (Rs In Million)	Expected Commissioning Date
1.	Pehur	12	753	Feb 2009
2.	Khan Khwar	72	5363	Sep 2009
3.	Jinnah	96	13597	Feb 2010
4.	Allai Khwar	121	8578	Sep 2010
5.	Duber Khwar	121	8578	Oct 2010
6.	Gomal Zam Dam Multipurpose	17.4	62553	Oct 2010
7.	Kurram Tangi Dam	83	17205	Sep 2011

	Multipurpose			
8.	Neelum Jhelum	969	84502	Jun 2015
	TOTAL	**1500.4**		

B. Ready for Implementation:

Sr. No	Name of Project	Capacity
1.	Golen Gol	106 MW
2.	Basha/Diamer Multipurpose Dam	4500 MW
	TOTAL	**4606 MW**

C. Under Studies: (Major Projects)

Sr. No	Name of Project	Capacity
1.	Dasu	4000 MW
2.	Keyal Khwar	130 MW
3.	Spat Gah	545 MW
4.	Palas Valley	386 MW
5.	Bunji	5400 MW
6.	Kohala	1100 MW
7.	Akhori Multipurpose Dam	600 MW
8.	Munda Multipurpose Dam	748 MW
	TOTAL	**12909 MW**

2 Private Sector Hydropower Projects

A. At Tariff Negotiation Stage

Sr. No.	Name of Project	**	Capacity (Mw)	Estimated Cost (US$ in Million)	Tentative Commercial Operation Date (COD)
1.	Matiltan	1996	84	160	Dec 2012
2.	Kotli	2003	100	178	Jan 2012
3.	Rajdhani	2002	132	171	Sep 2012
4.	New Bong Escape	2006	84	160	Dec 2011
5.	Gulpur	2006	100	200	Nov 2011
6.	Patrind	2007	150	241	Jan 2013
7.	Suki Kinari	2008	840	1139	Apr 2016
	TOTAL:		**1490**		

** Feasibility completion year

None of the above project has so far achieved the financial closure although the LOIs for New Bong Escape HPP, Rajdehani HPP and Matiltan HPP were issued under 12995 Power Police

B. Under Studies:

Sr. No	Name of Project	Capacity
1.	Gabral-Kalam	101 MW
2.	Asrit-Kedam	209 MW
3.	Kalam-Asrit	197 MW

4.	Madyan	148 MW
5.	Azad Pattan	222 MW
6.	Karot	240 MW
7.	Sehra	65 MW
8.	Sharmai	115 MW
9.	Chakothi Hattian	139 MW
10.	Kaigh	548 MW
	TOTAL	**1984 MW**

Paper No. 263

SELF GENERATION TO COMBAT POWER CRISIS

By

Dr Engr Javed Yunas Uppal

SELF GENERATION TO COMBAT POWER CRISIS

By

Dr Engr Javed Yunas Uppal*

ABSTRACT

Global energy game, appearing in the last 3 decades, has a particular context; while the resulting scenario in a country like Pakistan has taken its own shape. In Pakistan, the single largest emerging issue, has been the ghastly and acute crisis of power which unfortunately has been unintentionally or intentionally gravely mishandled. Alarm has been given on restoration of democracy, fighting terrorism, removing pollutions of all kinds, against which huge sums of foreign money has been spent, but very little has been said or done about the deplorable starving energy conditions in which people have been forced to get into. All governmental planning, mitigating actions, and privatization, have backfired. Technological solutions have not worked; because it is not the dearth of technology, it is the incompetence and wrongful doing on the part of earlier governments, which has brought people in the state in which they are now. The only way to reverse the power crisis is to let people produce their own power from whatever sources that are available to them, and to see that the money is not sucked out from them, and rather to divert some of it to improve the generating capacity of a community. It is in this direction, that the government effort and the foreign assistance programs should concentrate. Once the economic inflows and out flows from a system are controlled, the people will have improved generating capacities and they will themselves be able to take not only their own load but to support the government. Elimination of bottlenecks and putting people on self generation is a complex matter by itself. The quickest approach is building up systems for self generation through disbursement of technology and development of entrepreneurship. Participative mechanisms need to be formed in which an integral effort is done at the house holds, small communities, and industries while, need analyses, design development, development of tools and plant, management, micro-credits, and marketing functions are performed by professional bodies and volunteers in the respective fields after receiving suitable training. Although no efforts in the power field have been done on the above lines, positive efforts have been done on the above lines in the field of poverty alleviation. This paper describes the efforts being carried out by a number of persons including the author's team in this area.

The results of the pilot projects are very encouraging. The experience is expected to set the ball rolling. More people get into this kind of activity, better it will be and quicker will be the results. It is hoped that, soon after, a self growth path will be picked up by many, and expanded to national level. Ultimately, it is hoped that the back lash of poverty that reflects badly on the well being of people ends.

DETERIORATION OF POWER CONDITIONS

Pakistan's current total installed capacity of WAPDA and KESC amounts to 19,500 megawatts. Almost two third of this power comes from thermal power plants (fossil fuels), one third is generated by water and about 2% comes from nuclear power plants.

The demand for electricity in Pakistan during the winter months actually goes down and this winter has not been an exception. Throughout the month of December, the electricity consumption in Pakistan hovered around 11,000 MW, down from the peak levels of 17,500 MW seen in summer. This demand was well within the installed capacity of WAPDA & KESC yet they were only generating a meager one third (6500MW) of their maximum capacity during this period leaving a huge gap between supply and demand.

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From the failure to build new dams and the Government's inability to add even a single megawatt of new power to the grid during 9 years of its rule, it seems that the present crisis is a result of bad management and the lack of foresight.

The power crisis that the nation is facing is the cumulative effect of incompetence, and greed, on a massive scale. Since 1990, all the successive governments stressed the necessity for speed, so that the planning and execution of new projects should be completed before the shortages took on a pandemic form. Entrepreneurs were lined up to fund the start-ups and they came forward in droves. Deals were struck, kickbacks were negotiated and added to the project cost to be repaid along with the capital cost of the machinery. By none other than the consumers paid for the crafty work.

The oil companies have played a role to keep their considerable interests protected, by ensuring that the other options to generation of power be put on the back burner, then never to see the light of day.

The KESC and PEPCO owe more than Rs. 10b to the independent power producers (IPP) and paying them will help bring them into full operation and ease the crisis at least partially.

Pakistan Electric Power Company (PEPCO) blames independent power producers (IPPs) for the electricity crisis, as they have been able to give PEPCO only 3,800 MW on average out of 5,800 MW of confirmed capacity. Most of the IPPs are running fuel stocks below the required minimum of 21 days. IPPs complain that they are not being paid on time by PEPCO.

More strange incidences have been happening. On September 15, 2008, the Unit no. 5 of the Bin Qasim Power Plant, which normally generates 1185 megawatts tripped after developing some technical fault. The Plant could churn out only 560 megawatts with the suspension of electricity to the metropolis of Karachi.

The Korangi Thermal Power Plant which supplies 180 megawatts. Due to some unknown reasons dropped its production to 50 megawatts rather than its usual capacity of 180 megawatts.

Power transmission from Tarbela, Ghazi Barotha broke down on Sep 24, 2008, which caused black out to several cities and districts following another major power breakdown struck across Pakistan due to a fault in the national electricity transmission system.

There is no alternative but to resort to hours of load shedding. In June 2007, the power cuts in Pakistan lasted no more than 3 or 4 hours a day. This year, in extremely hot weather, Pakistanis

have to endure without electricity for 8 to 10 hours a day. Industrial production is suffering, exports are down, jobs are being lost, and the national economy is in a downward spiral. By all indications, the power crisis in Pakistan is getting worse than ever.

If almost a third of the people of the world will live in power less conditions 30 years from now as the latest report of the UN Habitat projects, (1), how many more in Pakistan are already languishing in such horrid living conditions which are springing up all over the country?

Pakistan, which already faces this problem in a large dimension have to stand up and think.

ALTERNATIVE SOURCES OF POWER

Large hydro power generation projects involve a number of social, political and technical issues. Despite the government's intensive campaign, it has failed to remove the fears of Sindh and NWFP on the issue of the Kalabagh Dam. Also, the construction of barrages and dams upstream on Indus has degraded the Indus delta. The promises of cheap hydro energy from large dams, if analyzed from a sustainable development prism, are not reliable because of two reasons; first, there is a vocal demand to include the social displacement and environmental degradation costs in the up-front capital costs of such projects.

Financing of such mega projects remains the most important aspect of this problem. Funding from international donors for such a project is difficult to receive, considering their commitment to facilitate investments in private thermal based power plants.

Second, even if the government arranges funding for such projects, the outlays involved in resettlement compensations are huge. For example, the government intends to spend Rs2.025 billion on the resettlement issues of the Kalabagh Dam by constructing 20 model and 27 extended villages.

Wind Source:

Near Islamabad, the wind speed is anywhere from 6.2 to 7.4 meters per second, while near Karachi, the range is between 6.2 and 6.9. There also exists a corridor between Gharo and Keti Bandar that carries regular wind of sufficient speed. The Alternative Energy Development Board (AEDB) was created in 2006 to pursue renewable energy. In Mirpur Sakro, 85 micro turbines have been installed to power 356 homes. In Kund Malir, 40 turbines have been installed, which power 111 homes. AEDB has also issued a letter of intent Makwind Power Private Ltd for the setting up of 50MW wind farm at Nooriabad in Sindh. An Indian company, Suzlon, has developed wind turbines, those start to turn at a speed as low as 3 meters per second. India now has the world's fourth largest number of wind turbines that have a capacity of 7,000 MW. The cost of wind power in India, however is between 2 and 2.5 cents per kilowatt hour while in Pakistan, the cost is 7 cents.

Solar Power:

Pakistan is an exceptionally sunny country. Impressed by advantages of solar power, National Institute of Silicon Technology (NIST), the Pakistan Council of Appropriate Technology (PCAT) and the Solar Energy Research Centre (SERC) and the Pakistan Council of Scientific and Industrial Research (PCSIR) were created to develop affordable means of solar power. Two decades after spending millions of rupees on the establishment, capital and operational cost on these institutes, NIST and the PCAT have been wound up and a new organization namely the Pakistan Council for Renewable Energy Technology (PCRET) has been established to further spend capital resources on failed and uncompleted projects of NIST and PACT. The directorate of renewable energy of the Ministry of Petroleum and Natural Resources has been closed after the failure of the project on solarization of some villages.

Small Hydro Electric Power:
However, small hydropower plants have emerged as a desirable option, especially for hilly terrains where natural and manageable waterfalls are abundantly available. Being environmentally benign and having a small gestation period, small hydro resources receive worldwide attention both in developed and developing countries to augment energy generation. Small hydro plants offer a wide range of benefits, especially for rural areas.

Development of small hydro power plants (SHP) around the world has increased substantially. There are over 420 small projects producing 1423 MW in India

Coal Power:
Pakistan has the fifth largest coal deposits in the world. The negative environmental effects of coal burning can be mitigated by making use of the latest clean coal technologies that limit noxious gas exhaust into the atmosphere.

Traditional Sources:
Traditional energy sources are firewood, animal dung, and bagasse (residue left-over from crushed sugar-cane) still make up more than half of all energy consumed in the rural areas.

INDIAN MODEL FOR RURAL POWER
India has embarked upon a Clean Development Mechanism (CDM) with a target to supply the 87,000 non-electrified rural villages in the first phase.

Participatory energy planning:
A participatory rural energy project involves project stakeholders—individuals or organizations who have an interest in developing an energy system or are significantly affected by its impacts—in all stages of the project. Communities play a key role in selecting, purchasing, operating and maintaining their own system. Communities have to attach energy system with greater goals of income generation, employment or basic infrastructure.

Decentralized energy planning:
Villages rely on energy sources that are locally available, rather than receiving electricity from a remote power plant. The use of local energy sources facilitates reliance on traditional ecological knowledge and reinforces the capacity of communities to manage their own energy supply.

The incumbent rural energy framework is centered on biomass, which is inherently decentralized in nature. Extending this paradigm from its current focus of household biomass combustion to an integrated energy supply model that includes community electricity generation would improve the quality of life of rural people and be more economical than extending the central electricity grid.

Nature of Projects: Six of these projects fit the rural energy model described above, as they are based on renewable energy technologies and could be implemented in a decentralized fashion using participatory methods:

- ☐ Small hydro power generation
- ☐ Biomass power generation
- ☐ Solar photovoltaic cells
- ☐ Improved cookstoves

- ☐ Residential solar cookers
- ☐ Residential biogas plants

The "ecosystems approach" has been adopted for rural energy promotes ecological conservation and rural development through the appropriate management of environmental and social resources. This methodology is based on a decentralized biomass model and incorporates local knowledge and conditions into the project design.

COMMUNITY POWER GENERATION EXPERIENCES IN PAKISTAN

In fact, Pakistan Council of Renewable Energy Technologies (PCRET) has implemented 290 micro-hydro power (MHP) schemes in FATA and the northern areas with a total capacity of 3.5MW, ranging from 3-50kW per plant, with the participation of local community. All of these plants are run-of-river type in the low (four meter) to medium (30 meter) head range.

Similarly, Aga Khan Rural Support Programme (AKRSP) has constructed 171 micro-hydel units providing electricity to around 17,000 households in the remote and isolated region of northern Pakistan, and currently provides 11,000 households with electricity in very remote locations.

Once the plant is installed, the local community takes the responsibility of operating it. These plants provide electricity mainly for domestic purposes. Local people have installed agro processing plants for flour grinding, rice husking, lathe, in the power house. Such units are run during the day time, directly from the turbine shaft. The electricity produced through micro hydropower in the country is in the range of 5-50 kW.

A major advantage of micro hydro is that it can be built locally at a considerably less cost. For instance, imported turbine sets generating up to 50 kW cost approximately Rs30,000-60,000 per kW, while the local manufacturers located in Taxila, Gujranwala, Lahore, Karachi offer facilities for turbine manufacturing at Rs10,000-15,000 per kW, with marginally reduced turbine efficiencies. The cross flow turbine used by PCRET and AKRSP is manufactured in local workshops.

EXAMPLES OF WHAT CAN BE PRODUCED WITHIN THE COMMUNITY

Micro Hydro power systems:

Not everyone is lucky enough to have a source of running water near their homes. But for those with river-side homes or live-on boats, small water generators (micro-hydro turbines) are the most reliable source of renewable energy available. One relatively small water turbine will produce power non-stop, as long as running water is available, no matter what the weather.

Fig.-1: Immiscible Stream Power Generator

Micro Wind Power Generator:

A robust micro wind power generator is a tower mounted unit. It has low maintenance, and has automatic operation in adverse weather conditions. It can be favorably manufactured by many homeowners and professionals. It is particularly suitable for villages and remote stations. With only a few moving parts and heavy duty construction, it has no scheduled maintenance. It can either be battery charging and grid-connected. It is normally rated at 10 kW. The turbine is aligned into the wind by a tail assembly. The tail boom and and integrated rotor/alternator assembly attach to the mainframe assembly, which incorporates the yaw-axis slip-rings and the



tower interface. The geometry of the mainframe creates the passive high wind speed protection. The mainframe offsets the rotor and yaw axes such that rotor thrust produces a furling moment about the yaw-axis. The weight and inclined pivot of the hinged tail provides a preset resistance to the rotor furling moment. Over speed control is initiated at a limited speed when rotor thrust overcomes the tail resistance and restoration is caused by gravity as the wind speed subsides. There is no shut-down wind speed. The turbine can be manually shut-down using a furling winch installed at the base of the tower.

Battery charging can be supplied with outputs of 48, 120 or 240 VDC. They are well suited for large rural homes, remote villages and facilities, eco-tourism resorts, and larger telecommunications sites.

Connection to the grid, can provide most of the electricity for an average total electric home at moderate wind sites. An inverter is added for grid connection.

Fig.-2: Wind Power Generator

Solar Photovoltaic Cell Modules:

Electricphotovoltaic modules are designed for both commercial and domestic applications and are suitable for grid connections. Polycrystalline PV modules can give desirably high power output. Cell strings are protected by sheets of ethylene vinyl acetate (EVA) and laminated between a weatherproof backing film and a highly transmittive, highly impact resistant, tempered glass and light can be effectively converted to electricity by using an anti-reflection coating.





Fig.-3: Photovoltaic Cells Module

Parabolic Solar Water Heater:

A simple or articulated parabolic water heater can raise sufficient temperatures that can greatly reduce the steam turbine effort. it can be assembled only with nut-bolts and other activities like forming a parabola at the site. The efficiency could be improved by 'enclosing' the boiler vessels. It can non-tracking which means that the geometry is such that it may not require constant viewing towards sun.



Fig.-4,5: Parabolic Solar Water Heaters

Garbage Power

Plasma arc garbage plants can burn any waste with minimal or no pretreatment; and they produce a stable waste form. The arc melter uses carbon electrodes to strike an arc in a bath of molten slag. The consumable carbon electrodes are continuously inserted into the chamber, eliminating the need to shut down for electrode replacement or maintenance. The high temperatures produced by the arc used to run steam turbines. Power plants run on garbage are functioning in a number of countries, such as Japan and China

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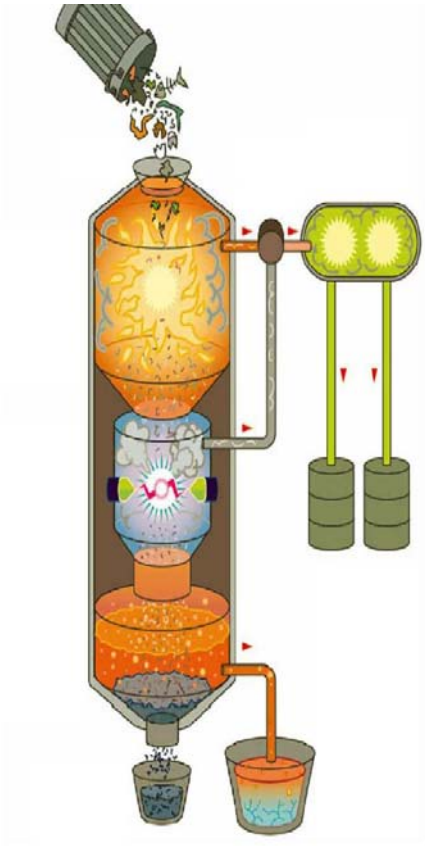


Fig.-6: Garbage Power Plant

PARTICIPATORY SELF GENERATING SYSTEM

Objective

The only way to provide power and improve living conditions on a mass scale, is to look at a locality as an economic system and to see what are the inflows and the out flows, and to divert some of them to be allocated to power generation there. This can be done only when their stocks are enhanced, and there is surplus to spend.

The power generation is not stand alone. It has to be integrated with the overall enhancement of the capital circulating within the community as described on Fig: 7, generating capacities of small businesses, workshops and households in poor areas through technology additions and entrepreneurship development, by establishing and running participative cell system.

Cell System

Cell System is a system of independently working individuals, who are interlinked with each other, through specific give and take mechanisms, and are geared towards the common broad objective, as regulated by a central coordinated unit.

Central Coordination Unit

Central Coordination Unit is a group of highly devoted resource persons whose function is to:

(i) train the trainers,
(ii) coordinate the activity,
(iii) to ensure quality, and
(iv) to disburse the Central Fund.

Individual Cell Units

1. **Design Developers:**
   These are engineers and technologists, who develop plants and technology.

2. **Factories:**
   The generators, gadgets, tools, and plants, will be manufactured by the factories, who agree to participate for these purposes.

3. **Trainers:**
   The professional bodies raise trainers who go around in the communities to train people.

4. **Creditors:**
   Credit is arranged from the creditors, so that the communities can get the machines, gadgets, tools, and plants made, as well obtain the raw materials and working capital.

5. **Marketers**:
   The Marketers identify appropriate power generators, and market them.

CONCLUSION

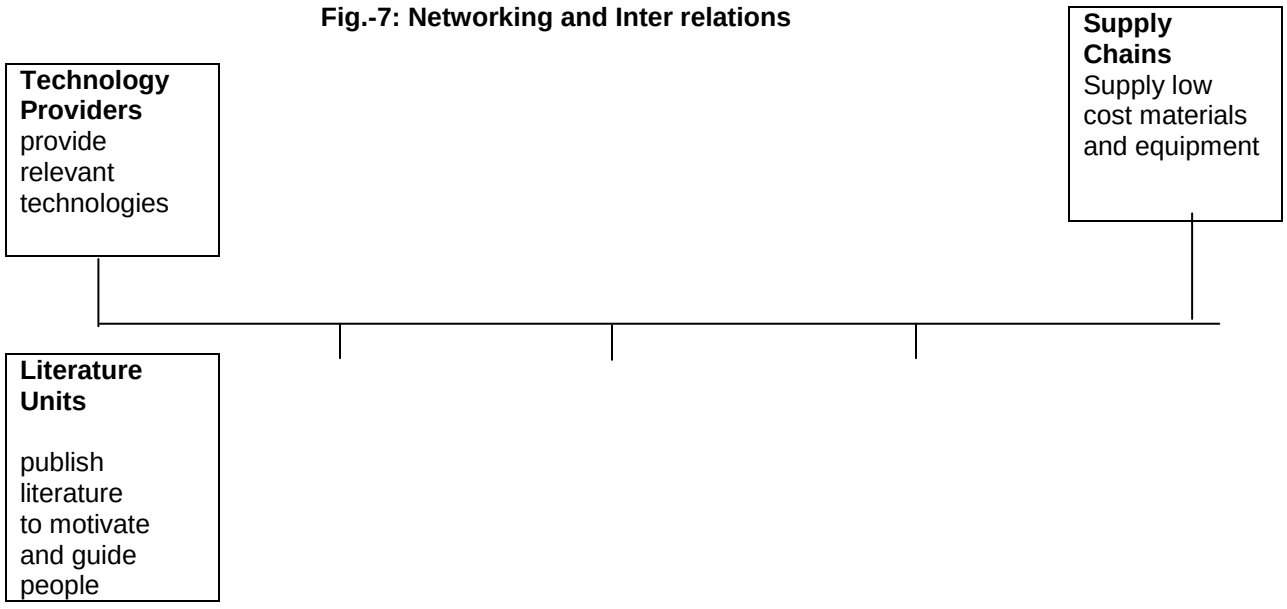
A severe issue, in Pakistan today are the ghastly devastating power conditions which unfortunately has been totally mismanaged. The only way to come out of this difficult situation is to resort to self generation within communities integrated with positive steps towards building of the earning capacities of the people. Participative mechanisms need to be formed in which the power production is done at the community level, with need marketing, design development, development of tools and plant, production management, micro-credits, and marketing

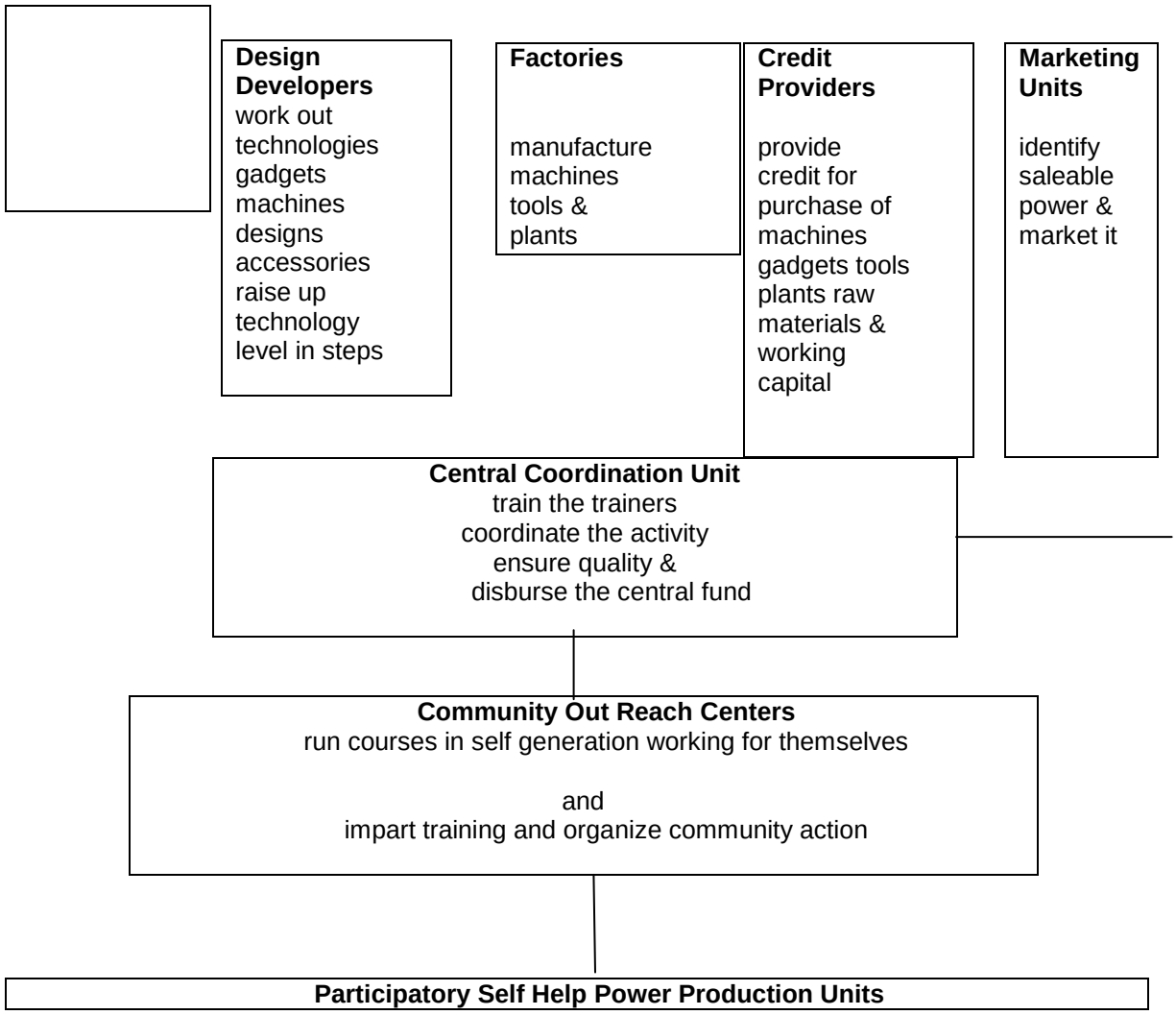
functions. The experiences of the exercises conducted in limited areas are very encouraging. The effort is expected to set the ball rolling. More people get into this kind of activity, better it will be and quicker will be the results.

REFERENCES

1. United Nations, ' World Habitat Project Report', 1999, New York
2. United Nations Commission on Sustainable Development Fifth Session, ' Pakistan- Country Profile, Review of Progress Made Since the United Nations', Conference on Environment and Development, 1992, New York
3. Uppal, J. Y., ' Participative Paradigm of Development', 1st International Conference in Civil Engineering, Institution of Engineers Pakistan, Karachi, Mar 2003.
4. Anil K Gupta,'Organizing and Managing the Poor Client Oriented Research System',Centre for Management in Agriculture Indian Institute of Management - 380 015 August 1987 Vastrapur, Ahmedabad India
5. System Thinking Resource Guide, MIT System Dynamics Group. (1992).
6. Acharya, S. R. and K. Saeed 'An Attempt to Operationalize the Recommendations of the 'Limits to Growth' Study to Sustain the Future of Mankind.` System Dynamics Review 12(4): 281-304. (1996).
7. Akkermans, H. A. and J. Bosker 'Design Guidelines for Participative Business Modeling.` 1994 International System Dynamics Conference, Sterling, System Dynamics Society. (1994). Scotland,
8. Bakken, B. E. 'A System Dynamics Approach to Group, Formation and Productivity. International Conference of the System Dynamics Society, International System Dynamics Society. (1987). Shanghai,
9. A User's Guide to the CDM. The Pembina Institute, Drayton Valley: 2003.
10. Asia Least-cost Greenhouse Gas Abatement Strategy: India. Asian Development Bank, Manila:1998.
11. Chatterjee, K. "Climate Change Mitigation Projects in India: Incorporating sustainable development concerns." Development Alternatives, New Delhi: 2000.
12. "Government of India interim approval criteria." Ministry of Environment and Forests, Government of India, 2003. [Online] http://www.envfor.nic.in/cc/cdm/criteria.htm
13. Malhotra, P., Dutta, S., and Ramana, P. V. Participatory Rural Energy Planning: A Handbook. Tata Energy Research Institute, New Delhi: 1998.

Fig.-7: Networking and Inter relations




Design Developers
work out
technologies
gadgets
machines
designs
accessories
raise up
technology
level in steps
Factories
manufacture
machines
tools &
plants
Credit Providers
provide
credit for
purchase of
machines
gadgets tools
plants raw
materials &
working
capital
Marketing Units
identify
saleable
power &
market it
Central Coordination Unit
train the trainers
coordinate the activity
ensure quality &
disburse the central fund
Community Out Reach Centers
run courses in self generation working for themselves
and
impart training and organize community action
Participatory Self Help Power Production Units

Paper No. 264

GENESIS OF POWER CRISES & ITS MANAGEMENT IN PAKISTAN PUBLIC PRIVATE PARTNERSHIP TO MITIGATE POWER CRISIS

By

DR. ALLAH BAKHSH SUFI, ZAHID HUSSAIN KHAN & M. JAVAID IQBAL

GENESIS OF POWER CRISES & ITS MANAGEMENT IN PAKISTAN PUBLIC PRIVATE PARTNERSHIP TO MITIGATE POWER CRISIS

By

DR. ALLAH BAKHSH SUFI[1], ZAHID HUSSAIN KHAN[2] & M. JAVAID IQBAL[3]

ABSTRACT

It is now widely accepted that the 21st century needs a mix of public private partnership strategies. Developing societies need to inject private initiatives with doses of public action that encourage economic restructuring and technological advancement. A public private dialogue (PPD) will help in opening channels of communication between the government, the private sector, donors and other concerned parties. The concept of private public partnership is about

how different stakeholders can use PPD to promote private sector development and reduce poverty.

To meet the ground requirements of the increasing population and to sustain the development in different projects, the need for improving management is recognized and these institutional changes are considered in compatible in Pakistan's environment. It is recognized that further and greater participation in different managements is of considerable value and needs to be persuade. In Pakistan people's participation to mitigate power crises can be achieved through a gradual and phased process.

1-INTRODUCTION

Energy is the lifeline of a nation. The economic engine and the wheels of industry, agriculture and business need energy to move forward. On the social aspect energy consumption per capita is a key indicator of the quality of life of the citizens and community. Pakistan economic, industrial and social growth has been greatly constrained due to an increasing gap in energy demand versus capacity. By involving public private partnership the energy crises in Pakistan can be mitigated to some extent.

The infrastructure sector in Pakistan comprises power, telecommunication, roads, ports, railways, air transport, water supply, waste management, information technology, and industrial estates. The public sector has remained the main provider of basic infrastructure. However, the large fiscal deficit has limited the Government's capacity to meet growing infrastructure requirements. Countries, such as Pakistan, that for a long time have financed infrastructure projects directly from fiscal budget allocations often lack the necessary institutional and regulatory capacity to facilitate private sector participation in infrastructure provision.

Infrastructure financing will have to rely more on private resources. The opportunities for developing and financing public private partnerships in Pakistan are considerable. There is proven demand for new projects in the **water, power, wastewater, solid waste, and transportation sectors.**

2-CONCEPT OF PUBLIC PRIVATE PARTNERSHIP

PPPs involves the investment of Private Capital to design, finance, construct, operate and maintain a project for Public use for specific term during which a private investment consortium is able to collect revenue from the users of the facility.

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Privatization represents a takeover of publicly owned entity. For the state the main attraction is that the Private sector can bear part of the financial burden of investing in infrastructure. Since the private sector is expected to be more efficient than the state in running certain concerns and is also likely to charge actual costs of services from customers, the burden of subsidies can be minimized. The other attraction is that state resources can be freed to provide funds in areas and sectors needed for the socio-economic uplift and stabilization of the less advantaged citizens. The state thus can retain to its core business of providing good governance enhancing knowledge and skills and providing basic needs for its citizens. For this, it is necessary to restructure the role of government so that operation can be separated from policy and independent regulatory authorities can be established.

The Government has set up the Infrastructure Project Development Facility (IPDF) under the auspices of the Ministry of Finance (MOF), to generate PPP projects with public sector institutions (line ministries, provincial Governments, local bodies, state owned enterprises etc.)

3-POLICY ON PUBLIC PRIVATE PARTNERSHIPS

The Government recognizes the importance of improving and expanding infrastructure services for sustaining economic and social development in its Medium Term Development Framework (2005-2010) (MTDF). Improved quality and service coverage in power and water supply, transport and logistics are vital for Pakistan's economy and the livelihood of its people. The Government estimates that less than 50% of the infrastructure investment needs can be covered by public funds under the MTDF. A combination of policy reforms, institutional support, incentives and financing modalities is required to encourage private-sector participation in financing, constructing and managing infrastructure projects.

Various governments around the world as a service delivery tool have adopted PPPs. Instead of the public sector procuring a capital asset and providing a public service, the private sector creates the asset through a business (usually designed, financed, built, maintained and operated by the private sector) and then delivers a service to a public sector entity/consumer, in return for payment that is linked to performance. PPPs permit the public sector to reduce their capital expenditure (and redirect to promote urgent social needs) PPPs allow each partner to concentrate on activities that best suit their skills.

The following sectors need to be focused by Public Private Projects.

i) **Small Scale Energy Projects** hydroelectric and captive power generation projects – other than those being facilitated by Private Power infrastructure Board (PPIB) and the Alternative Energy Development Board (AEDB).

ii) **Mass Urban Public Transport** including buses, and intra and inter-city rail.

iii) **Transport and logistics** including provincial and municipal roads, rail, seaports, airports, fishing harbors as well as warehousing, wholesale markets, slaughter houses and cold storage.

iv) **Municipal Services** including water supply and sanitation; solid waste management; low cost housing, and health/education facilities.

Although, PPPs will become an integral component of the Government's overall strategy for the provision of public services and public infrastructure across all sectors, this does not imply they are the preferred option for improving the efficiency of services delivery but that they enjoy equal status among a range of possible service delivery options available to the Government. Sector specific policies may be developed as necessary to provide more detailed guidance.

4-ROLE OF PPPs TO MITIGATE POWER CRISES IN PAKISTAN

Electricity is one of the important sources of energy. On the eve of independence in 1947, Pakistan inherited only 60 MW of power generation capabilities. In 1958, when WAPDA was formed, this capacity had increased to 119 MW. WAPDA was formed to accelerate the development of Water and Power resources of the country. It rose to 7,000 MW due to completion of mega projects i.e. Tarbela and Mangla, hydropower projects and thermal power projects at Guddu, Faisalabad Kotri, Muzaffar Garh and Ghazi Barotha (Hydro Power) etc. Total installed generation capacity in Pakistan is around 19,560 MW The distribution of hydel, and nuclear installed capacity in Pakistan produced by public and private sector as given in Table 1.

Table 1: Installed Power Generation Capacity of Pakistan

Sr. No.	Description	Capacity (MW)
1	WAPDA's Hydel Power Plants	6,463
2	WAPDA's Thermal Plants	4,834
3	IPP's Thermal Plants with WAPDA/KESC	6015
4	Nuclear Energy	462
5	KESC System including IPP's	1,756
6	Hydel Power Plants in Azad Kashmir	30
	Total	19,560

The power generation is highly capital-intensive investment. In Pakistan the equilibrium of demand and supply of power could not sustain due to increase in the pace of power demand in Pakistan. This resulted into severe load shedding and blackouts in the country. In order to bridge the power supply-demand gap, the government decided to mobilize private sector resources in the power sector.

The national demand for electricity has been raised and would keep on growing rapidly. Based on the present generation capacity, the hydel: thermal mix in the country is 33:67 which is almost the reverse of an ideal hydel-thermal mix, which should be 70:30 for overall economic development of Pakistan. Though induction of thermal generation through IPPs initially helps in overcoming load shading, it resulted in substandard increase in power tariff. Therefore, a sizeable injection of cheap hydropower through multipurpose storages is a viable option to keep the cost of electricity within the affordable limits of the consumers.

In Pakistan extensive private sector participation is envisaged in building additional power generation capacity of 7100 MW to meet the physical targets of power sector as given in Table-2.

Table 2: Core Projects to be commissioned during 2005-10

S.No.	Name of Project	Type	Capacity (MW)
	Public Sector		
1.	Allai Khawar	Hydel	121
2.	Khan Khawar	Hydel	72
3.	Dubair Khawar	Hydel	130
4.	Keyal Khawar	Hydel	130
5.	Jinnah Low Head	Hydel	96
6.	Golan Gol	Hydel	106
7.	Malakand Hydro	Hydel	81
8.	Pehur	Hydel	19
	Private Sector		
1.	New Bong Escape	Hydel	79
2.	Rajdhani	Hydel	132
3.	Gulpur	Hydel	60
4.	Small/Low Head	Hydel	50
5.	Matiltan	Hydel	84
6.	Kotli	Hydel	97
7.	Lakhra	Coal	450
8.	Thar Coal Chinese	Coal	300

9.	Dadabhoi	Coal	150
10.	Faisalabad	C.C.Gas	450
11.	Balloki	C.C. Gas	400
12.	Oil Based Power Plant	Oil	160
13.	Gas Based Power Plant	Gas	3100
14.	Renewable (Wind)		800
		Total	7100

5-OBJECTIVES

The Government's objectives in promoting PPPs are to provide:

- **More services**, as there is a huge backlog in basic services such as water and sanitation, solid waste management, transport and rural electricity. Not only do we need to catch up with the backlog, we need to start building infrastructure for future needs as well.

- **Better services,** as the quality of existing services is deteriorating due to lack of incentives and funding for infrastructure maintenance and up-gradation. The result is unclean water, unhygienic living conditions and inability to provide proper health care and education.

- **Affordable services,** as certain segments of the population cannot pay cost recovery tariffs, whereas the private service provider needs to recover costs in order to sustain operations. In such cases the Government will provide targeted (to low income consumers), explicit (not hidden as budget support) performance based (only provided once the service – such as 24 hour clean drinking water to the consumer's dwelling – is actually delivered).

- **Timely services,** as the Government do not have the capacity or the fiscal space to meet the immediate service demands of its citizens.

6-CONCLUSION

While Pakistan has demonstrated some pioneering experience with attracting private sector investment into the energy and telecommunications sectors, there has been very little progress in the key urban and municipal infrastructure related to water, wastewater, solid waste management, urban transportation, and roads. The core impediments include:

- The policies at National, Provincial, and local Government levels do not fully support PPPs as a viable options for delivering services in urban and local services;

- The laws that allow Provincial and local governments to contract out the development and operation of urban and local services to qualified private sector firms are not clear and supportive;
- Lack of institutional capacity within Provincial and local government departments to successfully identify, analyze, structure, tender, evaluate, contract, and regulate PPPs;

- The application of technical models and toolkits lack in Provincial and local government officials to use when analyzing PPP projects, conducting public sector cost comparisons, preparing RFPs for qualified contractors, drafting PPP contracts, evaluating bids, and regulating tariffs and responding to disputes with PPPs;

- Limited funds to hire experienced and qualified specialist to conduct pre-feasibility studies and prepare PPP transactions for local infrastructure projects that Provincial and local Government officials have identified;

- The long-term local currency, fixed rate debt financing is quite insufficient in Pakistan's capital markets which is needed for the sustainable financing of local infrastructure investments; and

- Inadequate legal authority, human capacity and toolkits to regulate the post-transaction performance and the price-adjustment reviews for PPP infrastructure and utility sector investments.

7- RECOMMENDATIONS

- The training for human resource development to oversee and manage the process of PPP project preparation and development is directly needed;

- Exploitation of renewable energy resources available in the country i.e. wind energy, solar energy, bio-fuel energy etc.

- Adequate and effective participation of the Private Sector.

- Utilization of our own huge coal reservoirs of about 184 billion tons for generation of electricity.

- Injection of cheap hydropower through construction of multipurpose storages dams with the effective participation of private sector to meet with the energy and food crisis.

- Fast track projects in pipeline be commissioned according to schedule.

- Appropriate of conservation measures, load management and public awareness is required to be adopted to improve the critical situation of power.

References

- WWW. Public Private Dialogue.Or/Public Private Partnership Strategies.html

- Public Private Partnership for Infrastructure Development and ADB's Role-ADB. Org.

- Pakistan Policy on Public Private Partnerships.

- WAPDA Annual Report, 2007.

Paper No. 265

GENESIS OF THE POWER CRISES AND IT'S MANAGEMENT IN PAKISTAN!

By

Engr Tahir Basharat Cheema

GENESIS OF THE POWER CRISES AND IT'S MANAGEMENT IN PAKISTAN !

By

Engr Tahir Basharat Cheema*

Pakistan, at present, is facing a severe power crises – considered to be the worst of the four such crises it has faced since 1974-75 onwards. Incidentally, the present crisis which is carrying on since the last twenty-four months is even greater than the one faced by the country during the eighties which gave birth to the concept of the IPPs etc.and which in a way changed the whole complexion of the power sector once and for all. Actually, it used to be only shortage of power during the earlier three crisis periods, while this time around it is energy shortage for twenty-four hours and that too of the highest order. The continuing negatives of the situation have now engulfed the national economy in a stifling embrace. Industrial productivity has gone down and the situation portends badly for exports and the ensuing balance of payments. Although, serious thoughts have been given by the Government for amelioration of the current problem and hopefully the power deficits of today would be contained by 2009-2010, but still the stranglehold of today may have far reaching implications for all of us. As a consequence, the instant study would strive to unlock the mysteries and the genesis of the crises and also detail out both the supply side and demand side measures in the offing as management of the crises.

Power sector, as a rule, has always been finance intensive. It is large investments that make the sector move-over to the next generation of technologies – incidentally a must for any standard system. On the other hand, the returns are also large and many an investment has been returned to investors within the year. The experts are of the opinion that without new investments and heavy outlays on operation and maintenance of power systems, the sector will simply stagnate. Besides, it is of utmost importance that new and needed technologies must be inducted as a necessary tool from time to time. Actually, the transaction from one step to the next should be visible for all. Apt example would be the communications sector and its entry into the 3-G technologies since long. Unfortunately, the Pakistani Power Sector comprising of the twelve PEPCO managed companies in the public domain and the KESC in the private hands is seen to have stagnated. This is also the reason for continuing trite operations and the difference seen between the sector under study and the communications sector leading the way in Pakistan. Once in a while, the pundits do try to compare both these sectors, but are unable to draw conclusions.

A little insight into the Pakistani power sector reveals that it was firstly dealt with a severe blow in the late 1980s and mid 1990s when the so-called WB led reform process was taken-up through vertical de-bundling of WAPDA's Power Wing and the lackluster corporatization of the same. The sad process in fact has been the start of the decay and a major cause of the present crises. It has then been neglected over the years and in fact has been deprived of badly needed investment during the last 15 years – actually, the last one decade has been debilitating. The solely legislated Water & Power Development Authority (WAPDA) set-up under the WAPDA Act of 1958 had been relegated to the back-burner, while new entities headed mainly by generalists had been tasked to come-up to the expectations and power requirements of the people. The Private Power & Infrastructure Board (PPIB), Alternate Energy Development Board (AEDB) and such like small and nearly non-professional bodies can be quoted in this context. Strangely, infrastructure building was delegated to the private sector through these bodies leaving WAPDA all dressed up with no way to go. The later had just the

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gigantic Tarbela to speak about, which it had completed way back in 1976. Taking no chances, the GoP's one page notification of 1987 sealed Wapda's fate to the effect that all new thermal power would only be set-up by the private sector under the auspices of the so-called one window facilitator known as the PPIB – thus in a de-facto manner denying the Country any chance of enjoying the fruits of competition between the public and the private sector – a necessity in order to contain the run-away profiteering of the private sector and to also ensure supremacy of the auditability and accountability of the public sector. This step alone led to the debacle of today and the tainted proposals of the private sector and the delays in acceptance of the same by NEPRA. WAPDA could work on hydel projects, including those coming under the ambit of hydro generation, and nothing else. As consensus could not be reached by the federating units of Pakistan in this regard, atrophy set and one fine morning it transpired that time had left the once glorious edifice unable to do anything. Instead of correcting the rot, WAPDA was declared beyond local repairs and we saw sprouting-up of new organizations (surely baptized in order to arrange employment for the favourites) with stupendous agendas to fulfill. That one such organization viz the Sind Coal Authority (SCA) is still groping in the dark while another Board (TCEB) is being built is a story needing separate space to dilate upon. However, as the prerequisites to creation of new public sector entities have been conveniently ignored most of the times, the various stakeholders need to sit together and reconsider things – otherwise very soon the things would further rot.

Coming back to the past investment in the power sector, we see that the only worthwhile outlays were under the heading of IPPs, when over USD 6.5 billion were invested on[1] arranging for 5728 MW of power during the period 1994–1996 (evident in shape of shining but tainted power stations seen during 1996–1999). It is also a fact that instead of arranging power on the as and when required basis, the whole chunk of nearly 6000 MW of power came on bar in a very short span of 24 months or so. This led to issues of handling the surpluses against the earlier shortages – specially when the IPPs had ostensibly come into being without even a tacit approval of acceptance from WAPDA and its management, which had never planned to handle such a huge chunk of power and that too at higher rates (also not backed-up by compatible tariff increase etc) . As WAPDA was by then under soldierly control, the poor Khakis were at the greatest of loss to utilize the newly inducted generation. They tried to sell-off some of the huge surplus (according to them un-sellable) to India, but couldn't get past the first of the posts. Additionally, they also had to bite the dust by accepting all and sundry of the IPPs as pure and pristine to the core, not withstanding some squeaks from the NAB (surely a sick person whoever coined the acronym). This management was also responsible for convincing the then President that the actual issue was the sale of surplus power and not any shortage around the corner (probably, one of the reasons for the tardy progress afterwards).

In hindsight, we see that the issue of corruption in IPPs was wrongly tackled during 1997–2001. Instead of being able to catch hold of the corrupt, arrange matters so that there would not be repeats etc and to thereafter use the shade and space created by 5728 MW of power and in the process start projects enabling production of cheap power by 2005–06, the last decade was wasted by simply crying foul and that WAPDA's (non-professional) management could not sell the excess IPP power – that the IPP rates and surpluses were the greatest of negatives to contend with is indeed the truth. However, the experts then and even now consider non-introduction of innovative tariffs and other such solutions to ameliorate the assail of the whole new concept and the inability of the concerned then to have arranged for a better deal as it happened in Bangla Desh, as poor management. All this, besides leading to the crises being faced now, also acted as a means to scare private investment (specially foreign investment)

away from the country. That seemingly the negatives seen in the IPPs set-up under the 1994 Power Policy are still evident in the current IPPs is again a wonder to reckon with.

The situation would have not been that problematic and grim, had the Pakistani power customer contained itself to the normal load growth of 2-3% year instead of breaking all barriers and reaching a whooping figure of nearly 14% during 2006-07 (**Table-I**). This unprecedented load growth according to experts was spurned on account of the consumption led growth adopted by the then government against the development / production led structures. The situation was compounded by easy availability of the hitherto unknown consumer finance. So much was the hype that even grade-IV employees of the government ended up with more than one consumer loan and access to home appliances acquired on installments. Unfortunately, because of all this Pakistan became a importing nation, a dumping ground for energy in-efficient goods, a country which changed its life style in quantum terms and the ensuing consumption avarice that burdened the economy beyond relief. The details of seven type of home appliances added to the power system during 2005-06 and 2006-07 are available with this paper as **Table-II** & **III**. Perusal of the data leads us to the conclusion that all of a sudden the Pakistani living standards artificially improved and up to 40 million appliances may have been added to the power system in the last five years alone. As this affluence was not backed by real economy, the country was hit by a double whammy.

[2] [3]

Table-I
HISTORICAL PEAK DEMAND / GROWTH RATE (2002-2008)

Year	WAPDA		KESC		COUNTRY	
	Demand MW	Growth Rate	Demand MW	Growth Rate	Demand MW	Growth Rate
2001-02	10,109	4.02%	1,885	1.34%	11,875	3.59%
2002-03	10,481	3.68%	1,973	4.67%	12,330	3.11%
2003-04	11,078	5.70%	2,073	5.07%	13,021	6.35%
2004-05	12,035	8.64%	2,197	5.98%	14,091	8.22%
2005-06	13,212	9.78%	2,223	1.18%	15,282	8.45%
2006-07	15,138	14.58%	2,349	5.67%	17,314	13.33%
2007-08	16,838	11.23%	2,443	4.00%	19,090	10.26%

Table-II
DETAILS OF HOME APPLIANCES ADDED TO POWER SYSTEM (LOCALLY MANUFACTURED/IMPORTED) 2005-2006

Sr No	Appliance	Numbers	Percentage		Power requirements MW	Expected growth then in sales for 2006-2007. over the figure of 2005-2006.
			Local	Imported		
1.	Refrigerators	1,100,000	90%	10%	110	15%
2.	Deep Freezers	200,000	100%	-	60	15%
3.	Air Conditioners	500,000	60%	40%	1000	20%
4.	Microwaves Ovens	400,000	50%	50%	800	15%
5.	TVs	1,200,000	85%	15%	120	15%
6.	Washing	600,000	94%	6%	180	10-15%

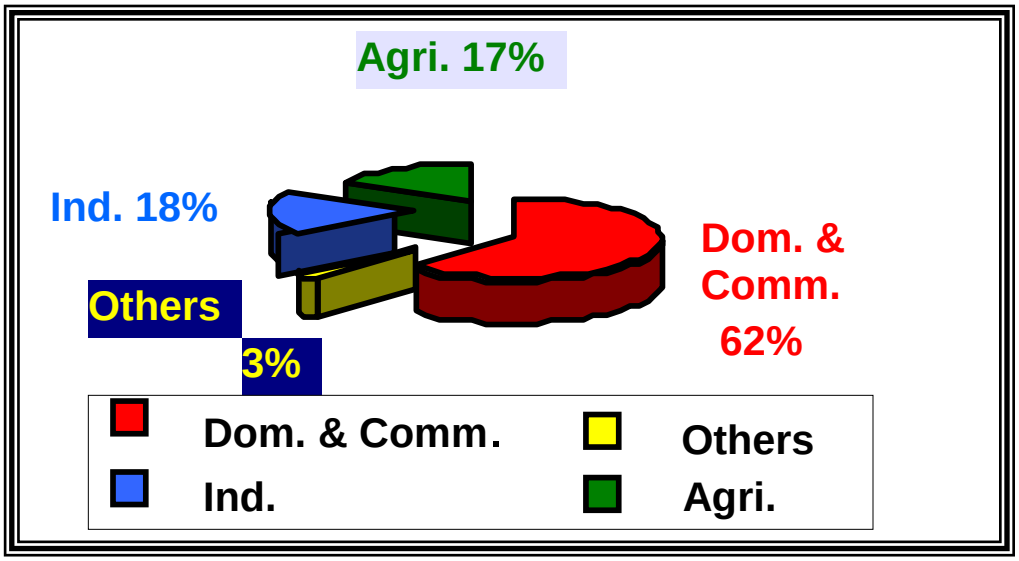
	Machines					
7.	Fans	3,500,000	100%	-	280	15%
Total		**7,500,000**			**2550**	

Table-III
DETAILS OF HOME APPLIANCES ADDED TO POWER SYSTEM
(LOCALLY MANUFACTURED/IMPORTED) 2006-2007

Sr No	Appliance	Numbers	Percentage		Power requirements MW	Expected growth then in sales for 2006-2007. over the figure of 2005-2006.
			Local	Imported		
1.	Refrigerators	12,50,000	90%	10%	125	10% - 15%
2.	Deep Freezers	2,50,000	100%	-	75	25%
3.	Air Conditioners	7,50,000	60%	40%	1500	50%
4.	Microwaves Ovens	5,50,000	50%	50%	1100	35%
5.	TVs	12,00,000	85%	15%	120	-
6.	Washing Machines	7,00,000 to 8,50,000	94%	6%	210 to 250	15% to 30%
7.	Fans	50,00,000	100%	-	400	45%
Total		**98.0 to 99.5 lacs**				**3530 to 3570**

Further study revealed that the power consumption in the country was totally skewed towards wasteful use. 62% growth was evident in the domestic and commercial sectors alone, while 18% and 17% of the total growth was seen in the industrial and the agricultural sectors respectively. In other words, growth in power usage for the industrial sector was only one forth of the increase in usage in the domestic and the commercial sectors. The pie chart depicting the power consumption patterns is available with this paper as **Table-IV**.

Table-IV
LOAD GROWTH AS %AGE OF VARIOUS SECTORS !



Not to be left here and as a logical sequel, we see the situation aggravating with the country currently experiencing power shortages of 5000 MW in the summers. To explain the matter, it is seen that no worthwhile investments were being made in the sector (in other words no generation was added the earlier tally – rather 450 MW of old plants were retired in 2001 – 03), while demand was growing at 14% per year and it was considered enough to once in a while require both PPIB and the AEDB to speed up the things on paper. We would also see a few press items telling us about the fast incoming thousands of mega-wattage of power and the hundreds of LOIs issued by the PPIB and the AEDB. During this period, the situation became bad to worse due to the poor hydrological conditions of the calendar years 2007 and 2008, lesser supply of gas and the constrictions in fuel oil supplies and lastly on account of financial constraints due to huge receivables of the power utilities and high cost of production compared with the sale rate. With this, we saw load shedding firstly in 2002-03 and thence regularly from 2005-06 till date. The yearly / monthly supply and demand position for 2001–02 till today is available with this paper as **Table-V** & **Table-VI** [5]. It would, however be in the fitness of the things to explain that the public forgets the past quickly and the load shedding of 2006 – though tangible, was easily swept under the carpet to be followed by another such shortage in 2007 and so on.

Table-V
LOAD SHEDING A PERENIAL PHENOMINA

YEAR	WAPDA/PEPCO SYSTEM		
	Supply	Computed Peak Demand*	Surplus/ Shortfall
2001-02	10894	10459	435
2002-03	10958	11044	-86
2003-04	11834	11598	236
2004-05	12792	12595	197
2005-06	12600	13847	-1247
2006-07	13292	15838	-2546
2007-08	12442	17398	-4956

*** Figures include load shedding and export to KESC**

Table-VI
MONTH-WISE DEMAND & SUPPLY POSITION (MW) 2007–2008

MONTH	PEAK DEMAND *	CORRESPONDING SUPPLY	SURPLUS/DEFICIT
Sep-07	16056	13644	-2412
Oct-07	13737	14092	355
Nov-07	12401	11590	-811
Dec-07	12154	9679	-2475
Jan-08	12255	9104	-3151
Feb-08	12123	10122	-2001
Mar-08	13682	9845	-3837
Apr-08	15124	11568	-3556
May-08	16649	11195	-5454
Jun-08	17398	12442	-4956

Jul-08	17715	12822	-4893
Aug-08	17272	12751	-4521
Sep-08	17852	13637	-4215
Oct-08	14231	10174	-4057
Nov-08	11098	10057	-1042
Dec – 08	11069	9188	-1881

What is the way out? How can the situation be managed. According to experts, we would have to undertake both supply side and demand side measures as soon as possible. The supply side measures would include installation of rental power plants in private sector (able to join in six to nine months against three years for a traditional thermal power plant), expeditious installation of IPPs already contracted by the PPIB and struck-up in the myriad in-competencies of that organization, (at least it was so then), installation of new power plants in public sector, induction of fast-track generation capacity by PPIB, rehabilitation of GENCOs existing plants and utilization of redundant capacity of captive power plants. The public sector would have to re-position itself and come into competition with the private investors to ensure affordability of power tariff etc. The demand side measures include reduction of demand through energy conservation and load management, as a MW saved is, in fact, better than a MW generated. For this too massive awareness campaign has to be funded and more so, because the cost to the nation for non-supply of electricity is up to ten time of the cost of one unit of power.

The present government has taken up provision of new generation very seriously with six rental power plants totaling 1002 MW planned for Faisalabad, Guddu, Sialkot, Multan and Quetta planned to start producing power by June 2009 (**Table-VII**). Similarly, an addition of 502 MW of hydro power to the system is seen by 2011 (**Table-VIII**). So as to further improve upon the ante, 22 IPPs with a grand total of 4608 MW are on the anvil for joining in by June 2012 (**Tables-IX).**[6]

Table-VII
POWER GENERATION ADDITION RENTAL PLANTS

Sr No	Name of Project	Fuel	Capacity (MW)	Expected COD
1.	Rental Power Plant, Faisalabad	Oil	150	Mar 2009
2.	Rental Power Plant, Guddu	Gas	110	Mar 2009
3.	Rental Power Plant, Sahuwala, Sialkot	Oil	150	Mar 2009
4.	Rental Power Plant, Multan	Oil	192	Apr 2009
5.	Rental Power Plant, Satiana Road, Faisalabad	Oil	200	May 2009
6.	Rental Power Plant, Sheikh Manda, Quetta	Oil	200	Jun 2009
Total			**1002**	

Table-VIII
POWER GENERATION ADDITION WAPDA HYDRO PROJECTS

Sr No	Name of Project	Type	Capacity (MW)	Expected COD
1.	Khan Khwar	Hydro	72	Sep 2009
2.	Jinnah Hydro	Hydro	96	Feb 2010
3.	Allai Khwar	Hydro	121	Sep 2010
4.	Duber Khwar	Hydro	130	Oct 2010

5.	Kurram Tangi	Hydro	83	Sep 2011
Total			**502**	

Table-IX
POWER GENERATION ADDITION IPP PROJECTS

A.

Sr No	Name of Project	Fuel	Capacity (MW)	Expected COD
1.	Attock Power Project	Oil	165	Jan 2009
2.	Atlas Shirazi Project	Oil	225	Mar 2009
3.	Orient Thermal C.C.(Balloki)	Dual	225	Apr 2009
4.	Muridke Power Project	Dual	225	Jul 2009
5.	Fauji Mari Power Project	Gas	202	Sep 2009

B.

Sr No	Name of Project	Fuel	Capacity (MW)	Expected COD
6.	Engro Power Project	Gas	227	Dec 2009
7.	Sahiwal Power Project	Gas	225	Feb 2010
8.	HUBCO Narowal	Oil	225	Mar 2010
9.	Associated Technical Project	Oil	200	Jun 2010
10.	Nishat Chunian Project	Oil	200	Dec 2010
11.	Japan Expansion Project	Oil	101	Dec 2010
12.	Green Power Project	Gas	205	Dec 2010
13.	Bhikki Power Project	Dual	225	Dec 2010
14.	Liberty Power	Oil	200	Dec 2010
15.	PIE AmPower Project	Oil	390	Dec 2010
16.	Star Thermal Project	Gas	134	Feb 2011
17.	Bestway	Oil	200	Mar 2011
18.	Gulistan Project	Oil	200	Jun 2011
19.	New Bong Escape HPP	Hydel	84	Dec 2011
20.	UCH-2 ICB Power Project	Gas	450	Dec 2011
21.	Shahkot Power Project	Oil	200	Dec 2011
22.	Kotli HPP	Hydel	100	Jun 2012
Total			**4608**	

As power demand is growing at a fast pace viz 10.26% annually, which may be down from the high 14% of last financial year but still remains amongst the highest in the world, the government has further decided to take-up fast track projects through the PPIB. This concept is borrowed from the business plans conjured by leaders in power generation for Africa, which requires availability of power quickly and for small periods of use and does not possess an integrated power system like Pakistan. It is also in fashion for huge construction and other development projects which require quick power for limited time periods. These totaling 1366 MW include Walters Rental Project Karachi, Karkey Rental Project Karachi, Cavalier Energy Project Port Qasim (OC) Karachi, Progas Energy Limited Port Qasim (OC) Karachi, Ruba Energy Project (CC) Karachi and Progas Energy Ltd Port Qasim (CC) Karachi (**Table-X**).

Table-X
POWER GENERATION ADDITION PPIB FAST TRACK PROJECTS

Sr No	Name of Project	Fuel	Capacity (MW)	Expected COD
1.	Walters Rental Project, Karachi	RFO/HSD	205	Feb 2009
2.	Karkey Rental Project, Karach	RFO	232	Feb 2009

3.	Cavalier Energy Project, Port Qasim (OC)	LPG/HSD	156	Aug 2009
4.	Progas Energy Limited, Port Qasim (OC)	LPG	210	Aug 2009
5.	Ruba Energy Project (OC)	RFO	107	Dec 2009
6.	Cavalier Energy Project, Port Qasim (CC)	LPG/HSD	314	Apr 2010
7.	Ruba Energy Project (CC)	RFO	47	Dec 2010
8.	Progas Energy Limited, Port Qasim (CC)	LPG	95	Dec 2010
Total			**1366**	

In order to ensure that all possible facets of power generation are tapped, Pakistan Electric Power Company (PEPCO) mainly and to some extent the KESC have also added captive power to their generation capabilities. This has beefed up the present supplies by about 250 MW of badly needed power, while a potential of 1500 MW remains to be tapped. However, further additions will depend upon the provision of high pressure boilers along with corresponding turbines and generators at the various sugar mills of Pakistan[7] (**Table-XI**). It would also need the enactment of a law / policy allowing special benefits for such additions / investments – specially when the private sector has to be incentivized before it under takes any new venture.

Table-XI
MEASURES TO MITIGATE SHORTAGES
Supply Side Measures - Captive Power MW

Sr No	ITEM	Textile Mills	Sugar Mills	Total
1.	Connected and supplying power	127	14	131
2.	Contracted/Pipeline	31	57	88
3.	Potential	185	167	352
Total		**343**	**238**	**581**
Potential (if high pressure boilers alongwith corresponding turbines & generators are installed)			**1000 MW**	

However, in order to mitigate the present power shortages, PEPCO and KESC seriously need to take up demand side management and conservation, massive public awareness campaign through electronic and print media, closure of shopping centers / plazas after sunset, staggering of industrial holidays, interaction with industries for reduction of load during peak hours especially steel furnaces, induction of energy saver lamps(CFLs) to replace incandescent bulbs and tube lights, loss reduction by DISCOs through implementation of ELR Projects and by administrative measures, other conservation measures, switching of bill boards and alternate street light points and switching of unnecessary lights and appliances at peak hours voluntarily by the general public. All in all, the power utilities would have to take up the DSMs and specially conservation activity on a pro-active manner. These, incidentally are the only solution till new generation comes up and for the days to come when no one could think of wasting power. This is the way through which the country can breath at least while it awaits new generation.

Unfortunately, the above supply side measures though auguring well for the country, also contain certain inherent risks. These include the undue dependence of new generation on imported oil, the logistics nightmare in the making for feeding the tens of small IPPs/new plants, the likelihood of tariff increase in the immediate future, the possibility of break-downs in the

small size IPPs and danger to the power system as a whole because the scheme of things does not cater for many a contingency. As a consequence, the following is suggested to be taken up as a necessary requirement. It would be to the effect that WAPDA be fully re-positioned and then utilized for development of both water and power projects (being the only legislated body for the purpose) and this should be by giving it the original autonomous status. PPIB and AEDB be then merged with WAPDA and the later can thereafter arrange PPPs / JVs – both national and international. WAPDA can put up new generation through bridge finance and then arrange for subsequent disinvestment / IPOs. The IPP size should be extended to a minimum of 2000 MW for economy of scale etc. Incidentally, our neighbouring India facing an equally daunting challenge to contain it's runaway power deficits has upped the IPP ante to mega-projects of 4000 MW and above. In their case, the investors have to arrange for their own fuel viz cheap coal and gas with the infra-structure being built by the government / public sector. On the other hand, all newly created entities then need to be disbanded with the Thar Coal generation being handed over to WAPDA, while mining of the coal may be tackled by the Sindh Mines & Minerals Department and the PMDC – incidentally, the later is also dressed up with no where to go. Experts consider this as the only option, in case Pakistan wishes to utilize its own vast coal reserves of 184 billion tons. It is also considered that after the SOS has been heard and the present Supply and DSMs are taken up, we need to revert back to the earlier system of implementing planning strategies put forth by the Planning Commission of Pakistan on the five yearly planned basis. Additionally, the National Power Plan of 1995 needs to be updated and then followed as the bible for all new power additions.

As indigenization of fuel for power generation is of prime importance – also a part of any good energy security plan, the Country would have to work on conversion of existing generation from oil and gas to local coal. Alternate sources of fuel viz. wind and sun on the basis of an integrated energy plan would also have to be taken in to quick consideration. As this needs separate space, it is being left for a separate article.

In the end, it would be appropriated to suggest and also state that the above supply side measures are basically of immediate and short term nature that have to be necessarily followed by the medium and the long term projects, which basically would comprise of the two hydel projects underway viz the 970 MW Neelum Jehlum HPP and the 4500 MW Diamer – Basha HPP, the host of others in the pipe line, the Nuclear power plants being undertaken by the PAEC and possible gas and electricity imports from Iran (IPI), Turkmanistan (TAPI) and Iran (1100 MW of gas power) etc, notwithstanding the possibility of eventual blackmail as undertaken by Russia currently or by local LPG producers. Alternate energy through wind, bio-mass, solar and coal would also be supplementing the power acquisitions during the medium and long terms. As the potential of such power is phenomenal, the future should be bright provided we remain on the right track and that detractors of alternate energy too remain at bay.

BIBLIOGRAPHY

1. PPIB Web Site / WAPDA Planning Department's information.
2. WAPDA – GM Planning (Power)
3. Information received from the manufacturers and Importers of Domestic Appliances / Associations e.g PFMA and the Bureau of Statistics.
4. WAPDA Book of Statistics for 2007-08.
5. WAPDA – GM (Planning) Power / Director General EM&C Division PEPCO.
6. PPIB Web Site / WAPDA Planning Department.
7. WAPDA Planning Department.
8. Governor State Bank's statement reported in the daily "DAWN".

Paper No. 266

NATURAL GAS TRANSMISSION & DISTRIBUTION INFRASTRUCTURE DEVELOPMENT IN PAKISTAN & ITS ROLE IN POWER GENERATION

By

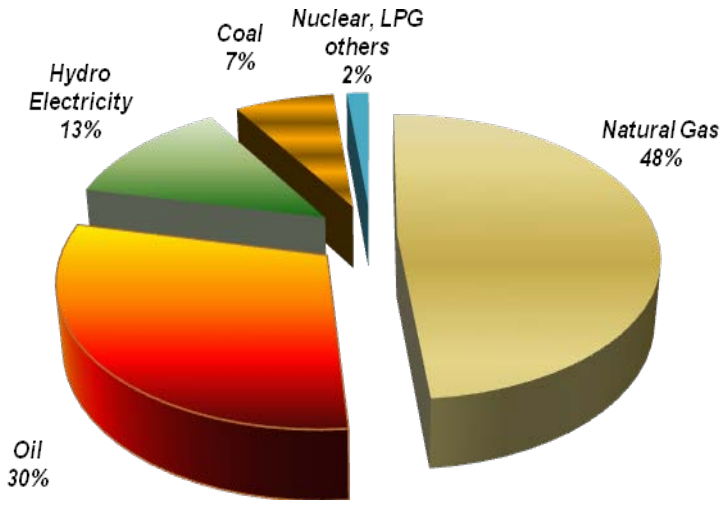
A. Rashid Lone

NATURAL GAS TRANSMISSION & DISTRIBUTION INFRASTRUCTURE DEVELOPMENT IN PAKISTAN & ITS ROLE IN POWER GENERATION

By

A. Rashid Lone*

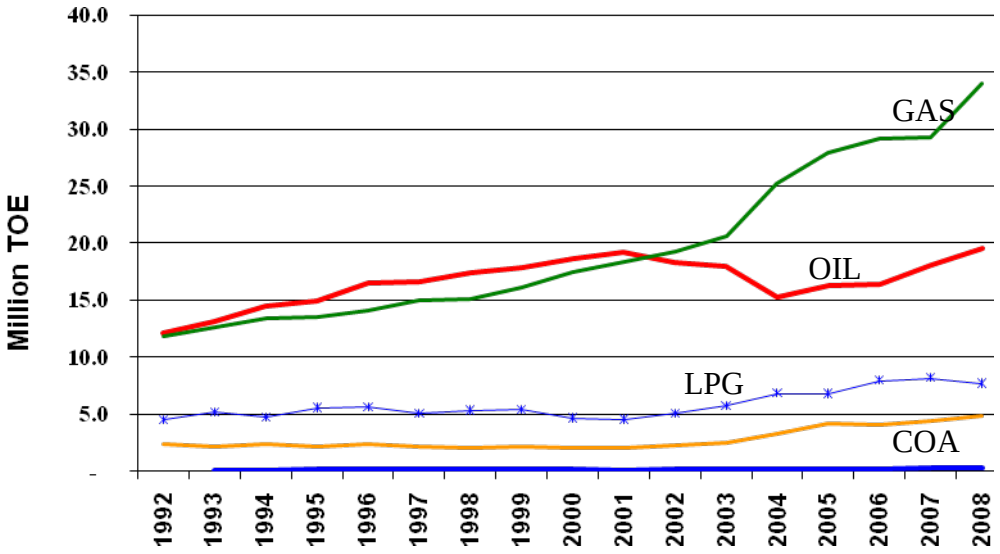
Pakistan is a country, blessed by diversified natural resources. Coal, Oil, Gas, Minerals, Stones and a number of other categories of ores are scattered in the wildernesses of Province Baluchistan, in the mountains of Province NWFP, in the planes of Province Punjab and in the rich basin of Indus. The country started from oil and coal as pre-dominant energy sources and soon switched to Hydral Power after construction of huge Hydral Power Projects and then after the discovery of Natural gas, the table was turned around. Today the natural gas claims one half of the share of energy market of the country and the economy seems to be revolving around it. The agriculture based economy of the country relies on availability of indigenously synthesized fertilizers manufactured from Natural gas, the turbines of power houses burn natural gas to run the wheel of industry, General Industry of the country fires this flexible fuel for boilers and heaters, the stove of common man is dependent on this gas and also the car of a mediocre person needs its fueling as CNG. In all these sectors these Natural Gas is serving the nation and bearing the major load of economy.



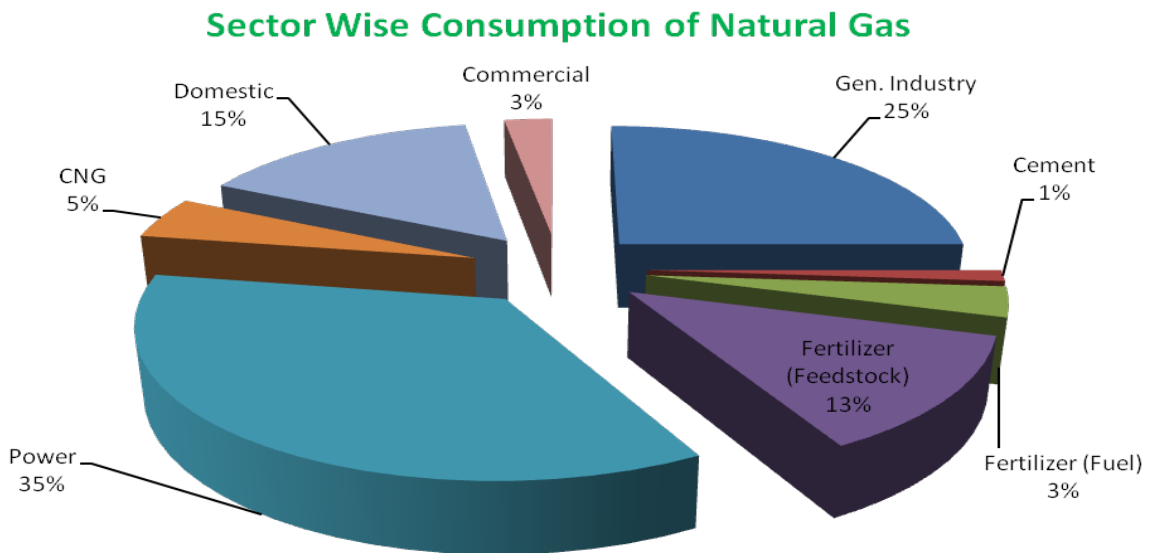
PAKISTAN ENERGY SUPPLY MIX 2007

The study of the energy supply mix of the country from 1992 to 2007 clearly indicates that the shift is towards the Natural Gas due to ease of combustion and cheaper price as compared to other domestic / industrial fuels.

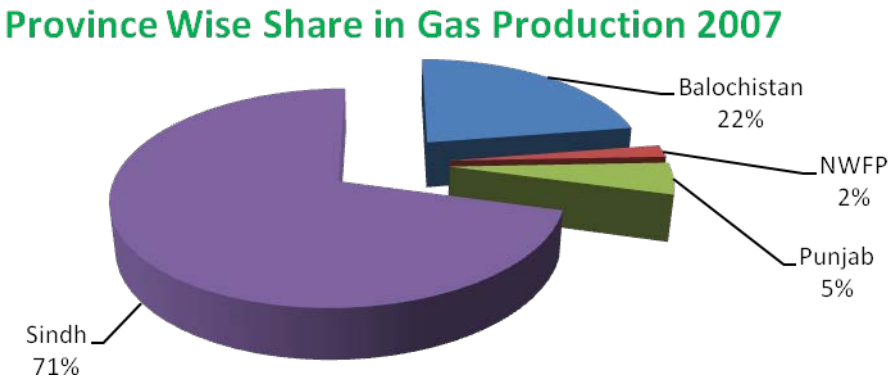
*Managing Director Sui Northern Gas Pipelines Ltd. PAKISTAN



The country offers huge oil and gas potential and vast relatively unexplored acreage, with historical exploration success ratio of 1:3.4. Natural gas was first discovered in 1952 at Sui in Balochistan province which proved the most significant and the largest gas reservoir. After successful exploration and extraction, it was brought to service in 1955. This major discovery at Sui followed a number of medium and small size gas fields in other part of the country. A normalized estimate of Natural gas reserves of Pakistan at 900 BTU/Cu.ft. is around 28.18 Trillion Cubic Feet (TCF) while the natural gas production during the year 2006-2007 was around 3.873 Billion CFT/Day. This consumption pattern of this Gas in different sectors of economy is as under:



All the four provinces have their contribution in the production of Natural Gas for the country. The province wise breakup of the production of Natural gas for the year 2006-07 is as under:

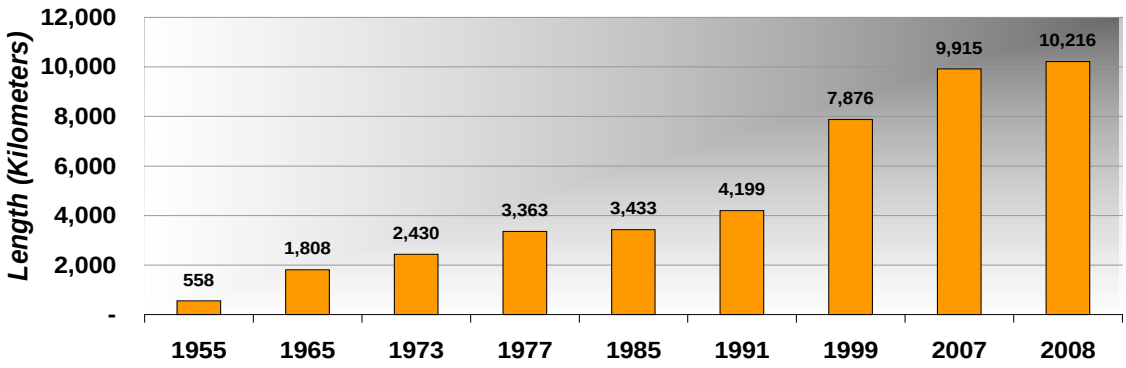


In 1964 an average daily sale of Natural Gas in Pakistan was around 47 MMCFD Day which presently goes as high as 3800 MMCFD. While fully recognizing the dynamics of the rapidly changing global energy scenario, the country has put strenuous efforts to establish and technological empowerment of a strong infrastructure for upstream as well as for downstream activities. Presently country has more than 10200 Kms. of Transmission Pipelines of diameters upto 36 inch and being operated at pressures as high as 1260 Psi bringing gas from far flung gas sources to the consumption centers. And further trough a distribution network of around 90,000 Kms., this gas is being served to more than Five Million valued customers.

	SNGPL	SSGCL	TOTAL
Transmission (Kms)	**7,016**	**3,200**	**10,216**

Distribution (Kms)	**59,951**	**29,832**	**89,783**
Compression (HP)	**185,000**	**62,900**	**247,900**
Towns Connected (Nos.)	**1,297**	**1,127**	**2,424**
Number of Consumers (Millions)	**3.19**	**1.90**	**5.09**

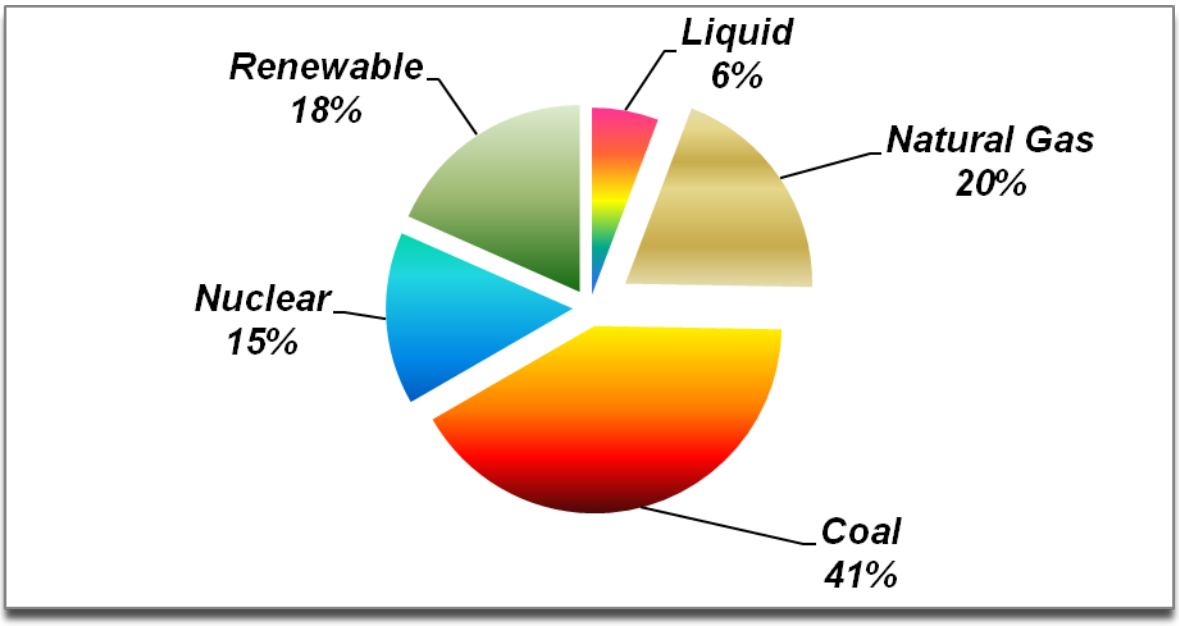
The Transmission and Distribution Networks have faced phenomenal growth in last few years owing towards rapid increase in the customers of gas.



TR

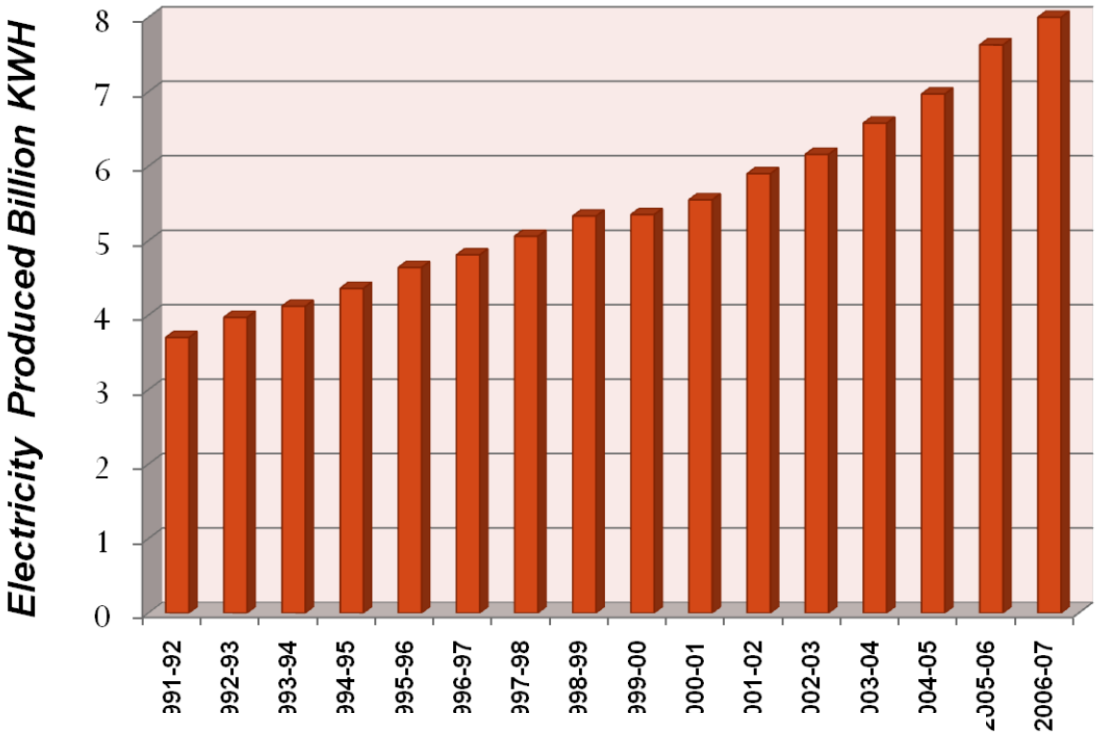
ANSMISSION NETWORK GROWTH 1955 TO 2008

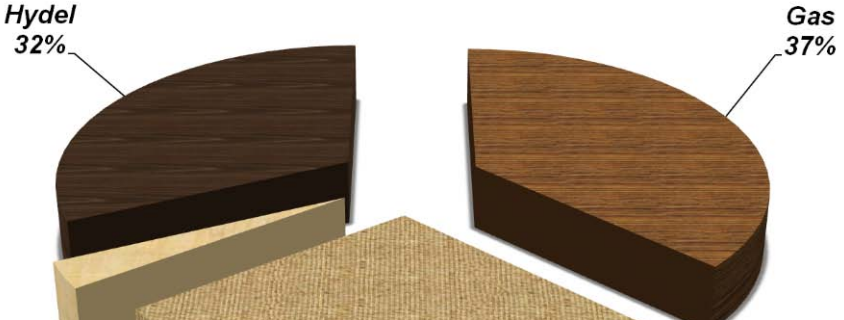
In the year 2007, the total Power generated of the world was around 17.3 Trillion Kilowatthours however an annual increase of 2.6% is expected in the coming years. The world power requirement is estimated to be around 33.3 Trillion Kilowatthours by the year 2030. No doubt the electricity is the fastest growing form of energy in the world while for generation of this electricity, the fastest growing fuel is Natural Gas. Internationally around 41% power is being generated by Coal.



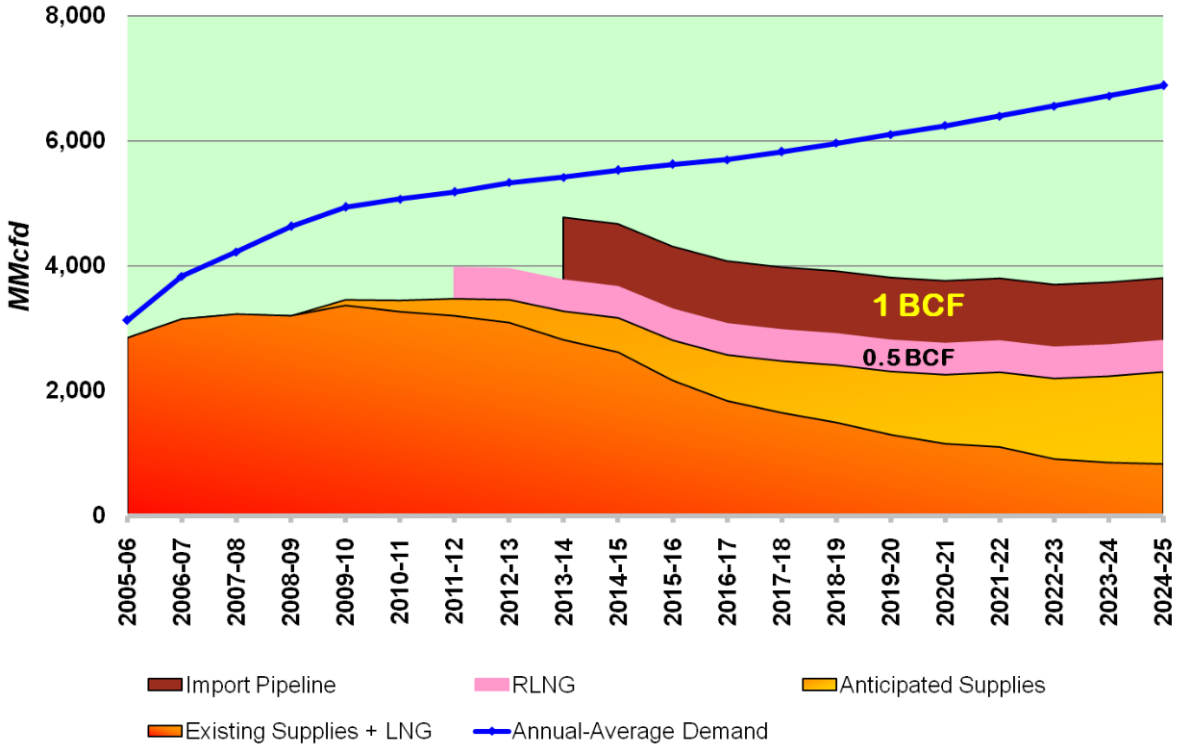
SHARE OF DIFFERENT FUELS IN POWER GENERATION (WORLD-WIDE, 2007)

However Natural Gas is becoming the fuel of choice for Power Generation due to its availability, Environment friendly nature and high efficiency of latest gas turbine based combined cycle equipments. The Power Generation is also increasing in Pakistan and it has almost doubled from 1992 to 2007.





A projection of total gas inputs, demand and committed sales of M/S. SNGPL has been shown in following graph:



Pakistan's Gas Demand and Supply Projections indicate a widening gap of approximately 1700 MMCFD by the year 2010. Any commitments of additional gas supplies to industries, power or fertilizer plants on a long term basis are therefore not possible, without confirmation of additional sources of gas supply. This may be possible through an import gas pipeline which shall take at least 4 to 6 years to supply gas. To cover this gap an alternate is the LNG import option which by current assessment will be able to provide gas by the year 2010/11 for which the planning of 3.5 million tons per annum (MTPA i.e. around 500 MMCFD) LNG import project with a re-gasification facility to be located in the vicinity of Karachi, the port city of Pakistan is under way. Government of Pakistan has already issued LNG policy in 2006 and has offered several incentives for LNG import through this policy.

Besides LNG project, the gas import projects are also moving forward but at a slower pace. The geographical, technical, economical and political factors are shaping the projects and

hindering the progress. However Pakistan has an excellent potential for foreign investment in any Gas import related project, as the country has a consistent increasing demand for gas and the utilization of existing gas infrastructure to distribute this gas shall maximize the profits.

CONCLUSION.

Pakistan has dependable and extremely efficient gas Transmission and Distribution networks belonging to two gas companies operating in the country. However, in order to meet the shortfall of gas for power generation and other industrial usage, it is imperative that gas should be imported on fast track basis either through Iran-Pakistan-India (IPI)/Turkmenistan-Afghanistan-Pakistan (TAP) or LNG. There is an urgent need for improvement in exploration activities and for increase in indigenous gas production.

References:

1. Pakistan Energy Year Book – 2007
2. Annual Report M/S. Sui Northern Gas Pipelines Ltd. - 2007
3. Annual Report M/S. Sui Southern Gas Company Ltd. – 2007
4. Data from Sales & Transmission Department M/S. Sui Northern Gas Pipelines Ltd. Till June, 2008
5. Data from M/S. Sui Southern Gas Company Ltd. Till June, 2008

Paper No. 267

BARRIERS IN RENEWABLE ENERGY DEPLOYMENT IN PAKISTAN

By

Syed Tahawar Hussain

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Overview (Brief history, current installed capacity, potential)

Pakistan is blessed with abundantly available and inexhaustible Renewable Energy (RE) resources, which if tapped effectively can play a considerable role in ensuring Energy Security and Energy Independence of the country. Sporadic efforts and initiatives have been undertaken by the Government in the past leading to lackluster results due to non-commitment, improper and disjointed planning and lack of focused, integrated efforts on part of the stakeholders involved.

Realizing the need to integrate the efforts for promotion and development of Alternative Renewable Energy (ARE), the Government of Pakistan established the Alternative Energy Development Board (AEDB) as an autonomous and the apex national organization in April 2005 with the mandate to undertake development of medium and long term national plans and policies, promotional and dissemination activities in the field of Renewable Energy Technologies; and to facilitate power generation through alternative or renewable energy resources by acting as a one window facility for establishing, promoting and facilitating alternative or renewable energy projects based on wind, solar, micro-hydel, fuel cells, tidal, ocean, bio gas, bio mass etc.

AEDB has been assigned the following targets by the Government of Pakistan:

- Development of wind and solar energy to ensure that at least 5% of total power generation capacity is met through these resources by 2030 (i.e. 9700 MW).
- Alternative Energy Development Board to ensure the installation of 700 MW of wind energy at Keti Bandar and Gharo, Sindh through the private sector.
- Solar products like solar lights, solar fans, solar cooker, solar geyser, etc. must be developed through private sector on top priority.
- Laws and taxes designed to encourage self energy generation by domestic sector like use of solar heating, solar geyser etc.
- Provision of electricity to remote, off-grid villages through Renewable Energy Sources, e.g. solar, wind, biomass etc. 7,874 such villages in Balochistan and Sindh have been identified initially.
- Replacement of 5% of total annual diesel consumption with Biodiesel by the year 2015, and 10% by the year 2025.

Current installed capacity of ARE in the country (excluding large hydro projects above 50 MW capacity) is roughly around 25 MW only.

Potential for various ARE technologies in the country vary from significant to phenomenal, which is as follows:

- Wind: 346,000 MW
- Solar: 2.9 Million MW
- Small Hydel: 2,000 MW
- Bagasse Cogeneration: 1,800 MW
- Waste to Power: 500 MW

*Director, Alternative Energy Development Board Government of Pakistan

In addition, potential for other ARE technologies such as Geothermal, Wave Energy, Tidal Energy, Biomass etc. also exists but is yet to be determined. In this regard the following activities have been completed:

- National Renewable Energy Laboratories (USA) under the USAID assistance program in 2007 has carried out the wind resource study of Pakistan and developed a meso scale map showing the wind speed potential available at 50m altitude. NREL study has also indicated the wind corridor in the south of Pakistan as already been discovered by PMD. The NREL wind resource map of Pakistan has given a great boost to the wind power development activities in the wind corridor regions. Now this potential area has become the focal point for the development of wind energy in the near future.

- Wind mapping of Gharo-Kaiti Bandar wind corridor has been conducted. Solar Map of Pakistan has also been completed by NERL/USAID.

- A Feasibility Study conducted by SNV of Netherlands indicates the potential of 5 Million Biogas units for domestic use; one of the largest in the region.

- Estimated potential for electricity generation through Biomass / Waste to Power (including Bagasse cogeneration) also exceeds 2000 MW.

Table 1: Renewable Energy Generation in Pakistan

Sr. No.	Technology	Province	Village Name	District	Number of Houses	Year of Commissioning	Generation (MWh/Year)	Capacity (kW)
1	Solar Energy	Punjab	Narian	Rawalpindi	53	2005/2006	80.59	27.60
			Khorian	Rawalpindi	57			
			Basti Bugha	D.G Khan	100			
			Lakhi Bair	D.G Khan	135			
		Sindh	Pinpario	Chachro	100	2005/2006	50.22	17.20
			Bharomal	Chachro	115			
		N.W.F.P	Shnow Garri	Kohat	100	2005/2006	51.39	17.60
			Janak	Kohat	120			
		Balochistan	Takht	Kalat	100	2005/2006	51.63	17.68
			Killa Mama Macherzai	Killa Saifullah				
			Allah Baksh Bazar Dandar	Turbat	121			

Sr. No.	Technology	Province	Village Name	District	Number of Houses	Year of Commissioning	Generation (MWh/year)	Capacity (kW)
2	Micro Wind Turbines	Sindh	Goth Gul Muhammad Khaskheli	Mirpur Sakro	12	2006	91.10	52
			Goth Jumo Khan Khaskheli	Mirpur Sakro	60			
			Goth Ismail Khaskheli 1	Mirpur Sakro	5			
			Goth Ismail Mahpar	Mirpur Sakro	8			

			Goth Mohd Hasan Khaskheli	Mirpur Sakro	14			
			Goth Allah Dino Mahpar	Mirpur Sakro	14			
			Hot Khan	Gharo	10			
			Goth Sher Muhammad Hamaiti	Gujjo	48			
			Goth Daandaari	Ghorabari	250			
			Goth Lukman	Ghorabari	20			
			Goth Sammo	Ghorabari	19			
			Goth Ali Hasan Paareri	Ghorabari	120			
		Balochistan	Goth Meer Isa	Lasbela	3	2006	13.14	7.50
			Goth Ramzan	Lasbela	15			
			Goth Haji Sher Muhammad	Lasbela	35			
			Goth Yaaqoob	Lasbela	18			
			Goth Mir Abdullah	Lasbela	8			
				Lasbela	32			
	Micro Wind Turbine Installed by K.H.FARMA Ltd	Sindh (Karachi)					262.80	150
3	Rural Electrification Programme	Sindh		Tharparker	3,000	2008/09	244.46	167.44
4	Micro/Mini Hydel	Punjab	-		-		-	80
5	Biomass (Bagasse to Energy)	N.W.F.P	-	D.I.Khan	-	2008	94,608	27,000
6	Biomass (Anaerobic Digestion)	Punjab	-	Multan	-	2007	56,064	8,000
	Total						**151,517.33**	**35,537.02**

Source: AEDB / Pakistan Energy Year Book 2008

1. Global Renewable Energy Status

Table 2: Global Renewable Energy Status

Selected Indicators	2005	2006	2007
Investment in new renewable capacity (annual)	$40 billion	$55 billion	$71 billion
Renewables power capacity (existing, excl. large hydro)	182	207	240 GW
Renewables power capacity (existing, incl. large hydro)	930	970	1,010 GW
Wind power capacity (existing)	59	74	95 GW
Grid-connected solar PV capacity (existing)	3.5	5.1	7.8 GW
Solar PV production (annual)	1.8	2.5	3.8 GW
Solar hot water capacity (existing)	88	105	128 GWth
Ethanol production (annual)	33	39	46 billion liters

Biodiesel production (annual)	3.9	6	8 billion liters

Source: Renewables 2007 Global Status Report, REN 21

1.1 Global Market Trends

- Renewable power capacity of about 240 GW in 2007 (ex. large hydro) represents almost 6% of total global power capacity (~4,300 GW) and the share is increasing.
- Over 70 countries now have wind power, and many developing countries have joined the trend recently, including Brazil, Egypt, Iran, Mexico, Morocco, and South Africa, all with added capacity in 2006.
- Offshore wind power grew significantly in 2006-2007, with several projects in the 100-300 MW range underway in Europe and the United States.
- Solar PV market growth is centered in Germany, Japan, Spain, Italy, South Korea, California, and New Jersey, but with the market now broadening to more countries and states (such as France).
- Rooftop solar collectors provide hot water to over 50 million households worldwide, most in China. China now represents 75% of global annual additions of solar hot water.
- Geothermal heat pumps are a rapidly growing market, with over 2 million heat pumps used in over 30 countries, mostly in Europe and the U.S.
- Biomass-fueled heating still provides five times as much heat worldwide than solar and geothermal combined, and continues to grow in northern Europe.
- The U.S. has become the dominant ethanol producer (corn-based), although Brazil has started an ambitious program to increase production by 50% by 2009 (sugar-based).
- Ethanol provided > 40 percent of all (non-diesel) motor vehicle fuel in Brazil in 2005.
- Biodiesel production has increased at 20-100% annual rates in recent years, particularly in Germany, France, Italy, Poland, and the United States.
- Almost half of world biodiesel production continued to be in Germany.
- The first group of commercial-scale solar thermal power plants since the 1980s started operation in 2006-2007, including in Nevada (USA) and Spain. Many more plants are now planned.

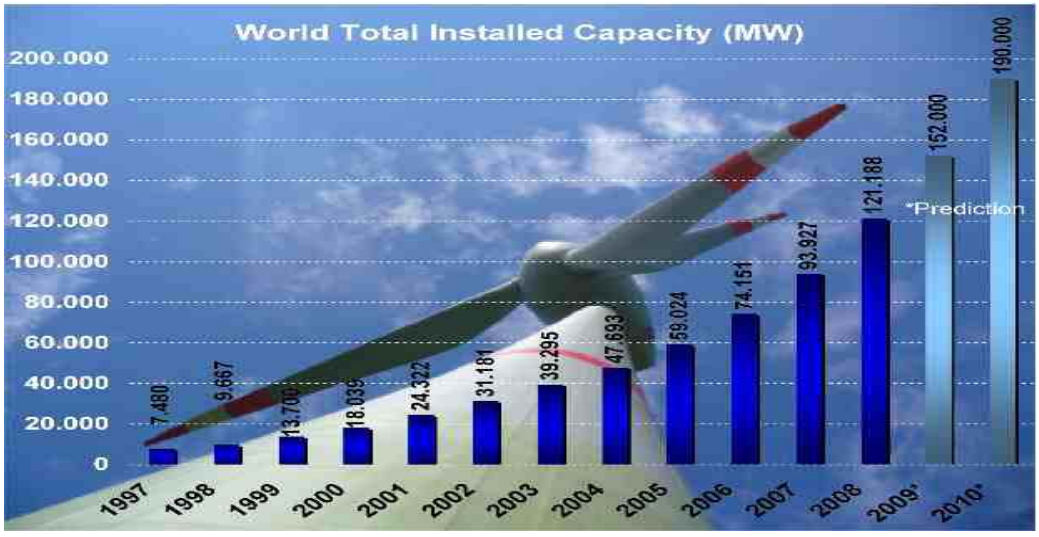


Table 3: Global Wind Installed Capacity, 2008

Position 2008	Country	Total Capacity installed end	Added Capacity 2008	Growth Rate 2008

		2008		
		(MW)	(MW)	(%)
1	USA	**25,170**	8,351.2	49.7
2	Germany	**23,902.8**	1,655.4	7.4
3	Spain	**16,740.3**	1,595.2	10.5
4	China	**12,210**	6,298	106.5
5	India	**9,587**	1,737	22.1
6	Italy	**3,736**	1,009.9	37
7	France	**3,404**	949	38.7
8	United Kingdom	**3,287.9**	898.9	37.6
9	Denmark	**3,160**	35	1.1
10	Portugal	**2,862**	732	34.4
11	Canada	**2,369**	523	28.3
12	Netherlands	**2,225**	478	27.4
13	Japan	**1,880**	352	23
14	Australia	**1,494**	676.7	82.8
15	Ireland	**1,244.7**	439.7	54.6
16	Sweden	**1,066.9**	235.9	28.4
17	Austria	**994.9**	13.4	1.4
18	Greece	**989.7**	116.5	13.3
19	Poland	**472**	196	71
20	Norway	**428**	95.1	28.5
21	Eygpt	**390**	80	25.8
22	Belgium	**383.6**	96.7	33.7
23	Chinese Taipeh	**358.2**	78.3	28
24	Brazil	**338.5**	91.5	37
25	Turkey	**333.4**	126.6	61.2
26	New Zealand	**325.3**	3.5	1.1
27	Korea (South)	**278**	85.9	44.7
28	Bulgaria	**157.5**	100.6	176.7
29	Czech Republic	**150**	34	29.3
30	Finland	**140**	30	27.3
31	Hungary	**127**	62	95.4
32	Morrocco	**125.2**	0.0	0.0
33	Ukraine	**90**	1	1.1
34	Mexico	**85**	0	0
35	Iran	**82**	15.5	23.3
36	Estonia	**78.3**	19.7	33.6
37	Costa Rica	**74**	0	0
38	Lithuania	**54.4**	2.1	4
39	Luxembourg	**35.3**	0	0
40	Latvia	**30**	2.6	9.5
41	Argentina	**29.8**	0	0
42	Philippines	**25.2**	0	0
43	South Africa	**21.8**	5.2	31.4
44	Jamaica	**20.7**	0	0
45	Guadeloupe	**20.5**	0	0
46	Uruguay	**20.5**	19.9	3,308.3
47	Chile	**20.1**	0	0
48	Tunisia	**20**	0	0

49	Colombia	**19.5**	0	0
50	Croatia	**18.2**	1	5.8
51	Russia	**16.5**	0	0
52	Switzerland	**13.8**	2.2	19.2
53	Guyana	**13.5**	0	0
54	Curacao	**12**	0	0
55	Romania	**7.8**	0	0
56	Israel	**6**	0	0
57	**Pakistan**	**6**	**6**	**New**
58	Slovakia	**5.1**	0.1	2.8
59	Faroe Islands	**4.1**	0	0
60	Ecuador	**4**	0.9	30.7
61	Cuba	**7.2**	5.1	242.9
62	Cape Verde	**2.8**	0	0
63	Mongolia	**2.4**	2.4	New
64	Nigeria	**2.2**	0	0
65	Jordan	**2**	0	0
66	Indonesia	**1.2**	0.2	20
67	Martinique	**1.1**	0	0
68	Belarus	**1.1**	0	0
69	Eritrea	**0.8**	0	0
70	Peru	**0.7**	0	0
71	Kazakhstan	**0.5**	0	0
72	Namibia	**0.5**	0	0
73	Netherlands Antilles	**0.3**	0	0
74	Syria	**0.3**	0	0
75	North Korea	**0.2**	0.2	2010
76	Bolivia	**0.01**	0	0
	Total	**121,187.9**	27,261.1	

Source: World Wind Energy Report 2008, WWEA

2. Policy Highlights (A brief description of successive policies relevant to the industry)

The ARE sector had been largely ignored prior to the establishment of AEDB. Upon its inception, one of the tasks undertaken by AEDB was the formulation of country's first ever Renewable Energy Policy. As a result, the Policy for Development of Renewable Energy for Power Generation was approved by the Federal Government and issued in December 2006. Salient features of the Renewable Energy Policy 2006 are as follows:

- It invites investment from the private sector for following categories of proposals:
  a. Independent power projects, or IPPs (for sale of power to the grid only)
  b. Captive cum grid spillover power projects. (i.e., for self-use and sale to utility)
  c. Captive power projects (i.e., for self or dedicated use)
  d. Isolated grid power projects (i.e., small, stand-alone)
- Except for Category (a) above, these projects will not require any LOI, LOS, or IA from the Government.
- Electricity purchase by NTDC / CPPA from qualifying renewable energy-based generation projects has been made mandatory.

- It permits an investor to generate electricity based on renewable resources at one location and receive an equivalent amount for own use elsewhere on the grid at the investor's own cost of generation plus transmission charges (wheeling).
- It allows net metering and billing so that a producer can sell surplus electricity at one time and receive electricity from the grid at another time and settle accounts on net basis. This will directly benefit the economics of small scale, dispersed generation and optimize capacity utilization of installed systems.
- It de-licences and deregulates small scale power production through renewable resources (up to 5 MW for hydro and 1 MW for net metered sales) to reduce the transaction costs for such investments. This will be particularly beneficial for micro, mini and small hydro as well as solar-based electricity production.
- It lays down simplified and transparent principles of tariff determination.
- It insulates the investor from resource variability risk, which is allocated to the power purchaser.
- It facilitates projects to obtain carbon credits for avoided greenhouse gas emissions, helping improve financial returns and reducing per unit costs for the purchaser.

3. Demand/ Supply Scenario (Current vs Projected, graphs and tables can be included)

Current installed capacity of the country stands at 19,522 MW. There exists a shortfall of 6,000 MW today. The energy demand over the next five years is expected to grow at a rate of 7.4 percent per annum. In order to meet additional power generation requirement of 143,310 MW during 2005-2030, an investment of $ 150 billion would be required.

Renewable Energy, however, can effectively complement the conventional energy resources for meeting the demand / supply gap. Given the right kind of support, over 10,000 MW can be added to the national installed capacity through Renewable Energy resources by the year 2030.

4. Projects in pipeline at this time (Magnitude of projects and required investment, brief description, expected period of commissioning)

Several projects in different RE technologies, which include wind power projects, micro / mini hydel, bio mass / bio gas, waste-to-energy and solar, are currently in the pipeline. A detail of these projects is presented in Table-1 below:

Table 4: Renewable Energy Projects in Pipeline, Pakistan

Renewable Energy Projects In Pipeline						
	Name of Project	**Technology**	**Capacity (MW)**	**Expected Commissioning Year**	**Estimated Cost (Million $)**	**Implementation by**
	Zorlu Enerji Pakistan Ltd.	Wind	50	2009	121	Private sector
	Green Power Pvt. Ltd.	Wind	50	2010	135	Private sector
	Arabian Sea Pvt. Ltd.	Wind	50	2011	161.3	Private sector
	Dawood Power Ltd.	Wind	50	2011	133	Private sector
	Beacon Energy Ltd.	Wind	50	2011	135	Private sector
	Clean Energy Development	Bio Mass	25	2010	-	Private sector

Wind Power Projects

The wind power projects mentioned in the Table-1 are being developed in the Gharo and Jhimpir areas of Thatta District. Construction work is already in progress on one of these projects being pursued by M/s Zorlu Enerji Pakistan Ltd. and the first phase of the project of 06 MW will be completed by March 2009.

Solar Photovoltaic Projects

Under Rural Electrification Program (REP) AEDB is providing solar photovoltaic systems to households in 300 un-electrified villages of Baluchistan and 100 un-electrified villages of Sindh with an envisaged expenditure of Rs. 1167.73 millions. More than 3000 households in Sindh have already been provided with the solar photovoltaic systems.

Bio Mass / Bio Gas Projects

M/s Clean Energy Development Ltd of New Zealand is actively working on the development of a 25 MW biomass project at Landhi, Karachi. The pilot phase of the project (250 kW) has been initiated and the full scale plant of 25 MW will be completed by 2010.

5. Challenges facing the sector (policy issues, technical challenges)

POLICY ISSUES

- The efforts of the government have not met with success mainly due to a lack of integrated planning and implementation mechanism. Unfocussed efforts with duplication of activities by various agencies which is uncoordinated combined with limited resources and constraints leads to confusion and attainment of targets is not possible. There is a proliferation of Government agencies often duplicating functions. These agencies under various Ministries are not empowered sufficiently to develop ARE resources, and are working with limited resources and constraints. Lack of coordination and cohesion among the agencies responsible for developing the ARE sector is preventing from achieving a critical mass concentration of these technologies. Scant, peripheral and parallel activities by various agencies also cause confusion among the Donor Agencies. The provincial governments do not have a proper 'buy-in' and do not support the process.

- Another key issue responsible for hindering the growth of ARE sector in the country is the general lack of capacity in the public sector, which coupled with the already burdensome approval process for RE IPPs, is slowing down tangible progress for setting up RE projects in the country. It is important to understand that building capacity is as important as adding Mega Watts to the grid. The challenge faced today is to make the different Government of Pakistan players coalesce around the development and implementation of a national RE strategy in a complimentary way.

- One of the most critical factors responsible for preventing the realization of RE projects, especially Wind Power Projects is that of **tariff.** More often than not, wind IPPs has found the tariff determined by NEPRA to be unworkable and unacceptable. The leading wind IPPs of the country, i.e., Zorlu Enerji, Green Power Pvt. Ltd. and Dawood Power Pvt. Ltd., all have gone through the cumbersome process of filing multiple tariff petitions with NEPRA due to the fact that the offered tariff was always considerably less than the one petitioned for. Green Power has so far gone through this process three times and still hasn't been awarded a tariff of its liking. This leads to inevitable delays in the project as the IPPs are unable to firm up their turbine supply and EPC agreements and the window of opportunity is lost; not to mention the direct and indirect additions to the project cost as filing of each tariff petition costs in excess of Rs. 2.5 Million and the turbine prices in the international market have been experiencing a continuous upward trend for the past three years. The biggest reason that not a single wind power project has come on-ground to date is that of tariff disputes with NEPRA; thus compounding the current prevailing energy crisis.

TECHNICAL CHALLENGES

- Renewable Energy projects are going to be a first in the history of country's power sector. Due to their unique nature and intermittent resource variability, they also pose technical challenges. The Government entities in the power sector are only experienced in dealing with thermal and large hydro projects, and are therefore not technically equipped to handle RE projects. One of the main reasons for delays in developing a standard Energy Purchase Agreement for wind projects was lack of experience and capacity for understanding and handling the technical aspects of wind energy generation and dispatch issues.

- The currently enforced Grid Codes do not cater for Renewable Energy projects. Modification of these Grid Codes to successfully incorporate wind energy projects is proving to be a major technical issue and challenge. The issue needs to be addressed at the earliest possible to inject wind energy to the national grid without any further delays.

- The NPCC which is the agency responsible for managing and controlling the national grid, also lacks the experience to manage dispatch of wind energy to the grid.

6. 'Immediate Problems Immediate Solutions'

- Focused and integrated approach by the Government to develop the RE Sector is required without any further delays. This can be achieved by strengthening the AEDB as an institution, both in terms of its legal mandate and financial resources. Another practical and extremely useful approach can be to establish a separate ministry for Alternative Renewable Energy, along the similar lines as adopted by India and various other countries around the world which have served them really well. In this way, integrated efforts can be undertaken by the Government by displaying the necessary resolve and political will for development and promotion of RE.

- Renewable Energy around the world has flourished mainly due to the reason that it got unflinching support of the Governments in the form of binding targets, legislations and attractive incentives for private sector investment. Among them, the concept adopted universally with great success is that of Feed-in Tariffs and this mechanism should be adopted in Pakistan without any further delay. Feed-in Tariff not only takes into account the private cost of the project, but also accounts for the externalities arising due to social costs had it been a business-as-usual scenario using conventional energy resources. The approach adopted in Pakistan so far for such RE projects is on "cost-plus" basis. The cost-plus computation requires a case-by-case determination of the applicable tariff for every single producer. This approach is typically favoured by NEPRA in order to help reduce the risk faced by the developers who want to undertake such projects, since it guarantees a return-on-equity (ROE) of at least 15 %.

While this method reduces some of the risks to the developer, it also eliminates any additional incentive to develop these types of projects. For instance, the ROE assured is the same regardless the type of power generation project under consideration (i.e., renewable or conventional). This can lead to quite curious situations, such as that the upfront tariff allowed by NEPRA for conventional generation using reciprocating engines burning diesel oil is 25% higher than the upfront tariff for generation using wind, regardless of the benefits that the latter brings to the environment or in terms of fuel independence.

Additionally, available international evidence shows that feed-in tariffs are the best incentive mechanism for developing RE capacity, as can be observed in the cases of Europe and some BRIC (Brazil, Russia, India and China) countries.

- The few initial wind power projects may be exempted from the Grid Codes currently in vogue in the country so as to ensure their immediate despatch of energy. In addition, the Grid Codes should be revised to cater for off-take of wind energy based on the best international practices instead of re-inventing the wheel all over again.

- The Gharo – Keti Bandar Wind Corridor may be declared a perennial wind corridor by the Government, dedicated to the development of wind energy projects. This will help in making these projects bankable as it would be easier for financial institutions to finance these projects without any fear of land lease for the project being revoked by the Government of Sindh at any stage during the project life.

Mid term and Long Term Problems and Mid Term and Long Term Solutions

The issues addressed above are also generally applicable for the mid term as well as the long term. However the biggest challenge will be for the Government to continue its resolve to support the initiatives undertaken already and during the short term to make this sector a viable and sustainable option for Pakistan. This may include the following:

- Capacity and capability building of the public sector institutions involved with the development of RE sector, i.e., AEDB, NTDC, NEPRA, CPPA, NPCC etc.

- Development of an enabling environment for Renewable Energy technologies by introducing and implementing plans and policies that offer enough incentives to sustain the sector in the medium term and enable the RE technologies to become competitive with the conventional technologies on a level-playing field in the long term.

- Introduction and implementation of the feed-in tariff mechanism at least for the medium term.

- Introduction of binding targets and legislations for use of RE technologies, both for utilities and consumers.

- Incentives to manufacturers for indigenization of RE technologies, as it will help in not only considerably reduce the projects' cost in future but will also have a very positive impact on the overall economy of the country.

- Strengthening of the Alternative Energy Fund (AEF), which has been recently established with an objective to develop the RE sector and to promote PPPs as well as to assist the private sector for developing RE projects that have certain risk perceptions associated with them due to not having any past precedence in the country.

7. Investment requirement for the next 15 years to carry out major projects. How will the capital requirement be met?

On –grid RE projects in the country are mainly being established on the IPP model. However pilot projects are planned to be undertaken by the public sector to provide a certain level of comfort to the private sector for investing in such projects of mega scale. In addition, RE projects are also being undertaken by the Government to improve the livelihood of the impoverished inhabitants of remote, off-grid areas with a view of social development and meeting the Millennium Development Goals.

To meet the projected targets in the next 15 years, an investment of USD 500 Billion will be required for wind energy projects alone. USD 250 Million may be required for Rural Electrification Programme.

This capital requirement may be met from various sources, including Government funding, e.g. PSDP, international donor agencies (who are already supporting such initiatives in Pakistan, e.g. ADB, UNDP/GEF, USAID, EC, World Bank etc.), and the private sector which may be the biggest driver for investment in the RE sector. However it is estimated that a support of USD 1-2 Billion dollars during the mid term will enable the sector to become self-sustainable in the long term.

8. Opportunities for improving efficiency (production, transmission)

Renewable Energy technologies, by default, are the most energy efficient options available. Implementation of RE technologies will result in considerably improving the efficiency of the country's power sector.

In addition, one of the biggest advantages of utilizing RE technologies is the reduction of T&D losses in the grid. This is achieved either by having the electricity generating source right next to the point of consumption or relieving the grid of the amount of power that is otherwise generated by an RE application.

Hence using RE options provides excellent opportunities for considerably improving both the production and transmission efficiencies of the overall grid system.

9. Opportunities for technological enhancement

Promotion of RE technologies in the country can also open the floodgates to technological advancement of Pakistan in this area. Indigenization and transfer of such technologies can bring about a revolution in the engineering and industrial sector of the country. Another advantage that can be gained out of this technological advancement is the strategic location of the country. Pakistan has the potential of becoming a hub for exporting the RE technologies and equipment to the countries in the region.

10. Biodiesel

Oil imports of Pakistan continue to rise, presenting a serious cause of concern for the Government due to rising and unstable crude oil prices. Pakistan consumes 8 Million tons of Diesel annually out of which 4 Million tons is imported. Diesel is consumed by the industrial, transportation and agriculture sectors, which make up for 75% of the country's annual energy use at 26.280 MTOE. 10% of country's annual Diesel consumption replaced with Biodiesel will result in estimated savings in excess of US $ 1 Billion per annum.

The ECC of the Federal Cabinet approved the Policy Recommendations for Use of Biodiesel as an Alternative Fuel in February 2008, which has set the indicative target of Gradual introduction of Biodiesel fuel blends with petroleum diesel so as to achieve a minimum share of 5% by volume of the total Diesel consumption in the country by the year 2015 and 10% by 2025.

Pace of development of Biodiesel sector in Pakistan is such that events may overtake policy leading to Government losing control over the production of Biodiesel which can either destabilize this sector or stint its growth before the sector gets the opportunity to mature and become viable. Integrated and focused efforts are required on government's part as multiple stakeholders are involved from the public sector including AEDB, Ministry of Food, Agriculture & Livestock, Ministry of Petroleum & Natural Resources, PSO, OGRA as well as the provincial governments. These stakeholders need to realize the gravity of the situation and address all the critical issues associated with the sustainability of the National Biodiesel Programme spearheaded by AEDB. Immediate decisions are required in order to effectively address these issues and formulate a National Biofuels Policy in the soonest possible time span.

10.1 Issues & Recommendations

- Any act or policy formulated in haste without first catering to all the relevant issues and plugging the techno-economic gaps in this largely untested sector, will only lead to disastrous results. This is one area where the government needs to tread very carefully as a false start can derail this fledgling sector, adverse effects of which will be felt on the economy for a very long time; a situation Pakistan cannot afford given the current energy crisis.

- Only non-edible oil feedstock may be allowed for Biodiesel production as a policy decision. However another important issue that can't be ignored is the quality of the Biodiesel thus produced and its conformance to international standards. Inferior quality Biodiesel produced from a certain feedstock will only serve to damage the National Biodiesel Programme. Hence it is imperative to carefully evaluate the pros and cons associated with a certain type of feedstock before it is given priority or preference over other available feedstock for production of Biodiesel.

- Aggressive R&D is being conducted globally to identify next-generation Biodiesel feedstock options to diversify Biodiesel production resources, otherwise known as lignocelluloses. The technology will allow Biodiesel to be produced from any plant material, there would be no conflict between the need for food and the need for fuel. It will also significantly lower the Biodiesel production cost. R&D efforts in this regard need strong and continuous support & commitment from the Government to ensure the viability and sustainability of the National Biodiesel Programme.

- As already mandated by the ECC, AEDB is to spearhead the National Biodiesel Programme and ensure that the targets determined by ECC are met with successfully. However there already is a duplication of efforts as evidenced by the Committees formed under the President ZTBL and Adviser to the PM on Finance for Biofuels, which also include Biodiesel in their TORs. The government needs to empower and strengthen the agency mandated with this responsibility accordingly so as to enable it to formulate and come up with the necessary Policy and Regulatory framework by involving all the stakeholders

11. Recommendations and Conclusions:

Today's global quest for energy is impacted by the following realities:

- Depleting Fossil Fuel Reserves
- Geo-political Issues
- Volatile Oil Prices
- Environment Concerns

Collectively, these issues have dictated a global shift in strategy which has led to a growing trend for utilization of clean Alternative Renewable Energy (ARE) technologies world-wide. In addition, issue of Social Responsibility in the form of binding agreements for CO_2 emission reductions has put an obligation on countries around the world for adoption of ARE technologies. This had forced both the developed and developing nations of the world to show resolve for promoting ARE technologies by setting firm mid and long term targets for replacement of conventional energy based generation systems to RE based generation systems. Pakistan is also obligated to show its resolve to the world in this regard by establishing itself as a responsible and serious nation committed to the cause of protecting the environment degradation. Hence it is imperative for Government of Pakistan to support and develop the ARE sector.

This can be achieved by adopting the following recommendations:

- Fixed 'Feed-In Tariffs' for a five year period be introduced that are competitive with the world and not based on a "cost-plus basis." This would give the RE sector a 'jump-start' and enable investors to 'fast-track' the project. It would have a multiplier effect for job generation and boost the engineering industry in the country.
  - Setting of firm targets for RE deployment over the short, mid and long terms taking into account that there are no recurring fuel costs and after the first ten years of a project life the tariff will drop significantly as the capital cost is paid off..
  - Wind mapping to cover the whole of Pakistan to be comprehensively carried out.
  - Enactment of legislations for mandatory use of RE technologies. For promotion of RE technologies, high profile targets in government buildings should be initiated to develop success stories.
  - Provincial, city and local governments should be given monetary incentives to introduce RE technologies in various projects.
  - Removal of policy and regulatory barriers.
  - Formulation of favorable policy and regulatory framework for deployment of RE technologies including feed-in tariffs and obligating the utilities to meet a certain percentage of their electricity demand with RE technologies. Similarly, power distribution set-ups (DISCO's) should be 'incentivised' to utilize RE sources.
  - Smart Grids be developed with reversible meters to allow utility companies to purchase surplus power generated by consumers.
  - Institutional strengthening of AEDB. A review should be carried out to create an independent Ministry of Renewable Energy for focused efforts for growth of all RE activities.
  - Financial support of the RE sector by strengthening the Alternative Energy Fund (AEF) and provision of an estimated USD 1-2 Billion till the year 2016, beyond which AEDB and the RE sector should be able to sustain itself.
  - City governments should be encouraged to produce bio-energy through anaerobic digesters to produce power.

The investment potential for the RE sector of the country from short to medium term is over USD 16 Billion Dollars, which if supported through Government resolve and initiative can help in turning around the energy sector of the country; not to mention an overall strengthening of the country's economy and its projection around the world as a responsible, modern and committed nation. RE deployment has to be supported by the Government as a strategic option.

Paper No. 268

RENEWABLE ENERGIES-AN ULTIMATE SOLUTION TO OVERCOME POWER CRISES OF PAKISTAN

By

Muhammad Ammad Riaz, Sana Amin

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I. Energy Rational

Demand for electricity grows with the growth of economy and if the growth on the supply side is not maintained at the same pace, a crisis is always in the making which has already emerged in Pakistan during the last two years. Non-availability of natural resources for expansion of power sector has widened the gap between demand and supply. At the growth rate prevailing in Pakistan, power shortage was likely to appear in 2006, which practically happened and forced utilities load shedding. The typical shortfall is 4000-5000 MW, which could be the major cause of stagnant growth in all sectors. If any of the pipeline projects is not implemented in near future, there will be enormous pressure on the electrical infrastructure of the country.

The thermal sources induce exorbitant import bills and deployment of FOREX reserves in case of oil whereas gas reserves are diminishing. The hydal and coal projects have political concerns and long gestation periods before they can start generating.

In order to rescue the situation, Renewable Energies deserve a strong pursuance for both on grid and off grid applications. The on grid applications will take the pressure off from national grid and the off grid applications will add productivity in the areas which are deprived of electricity access even in current era.

II. Solutions for Pakistan:

- Off Grid / Micro Generation
- On Grid Power Generation

Within the broad scope of above, following concrete opportunities can be exploited:

1. Solar Water Pumps
2. Solar Home Solutions (Rural)
3. Outdoor Lights (Solar / LEDs)
4. Solar PV
5. Solar Water Heating Solutions
6. Wind Power Projects
7. Solar Thermal Power Projects
8. Bio Diesel Projects
9. Micro / Mini Hydal

1. Solar Water Pumps:

Pakistan has remained an agricultural based economy for ages. The sector still has a lot to add in the economy mix. The diversified climate, fertile lands and good canal systems make all contribute to keep on improving this sector.

Water pumping is conventionally done through large tube wells, which are operated on WAPDA Electricity or Diesel Generating Sets.

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The concept of Solar Water Pumping will support *drip irrigation*, a much appreciated practice almost globally. This is because it is not only an efficient irrigation system consuming optimum water quantities, it also requires relatively less delivery and distribution infrastructure. Rather, its basic principle is to have more scattered pumping units at designated places from where, the further distribution is easier. *Solar water pumps having the limitation of flow rate fits well in this concept*. It is partly offset by the fact that sun is available throughout the year and it even keeps pumping during off season. *The water pumped during off seasons can be stored to meet the demands of peak season*.

Keeping all the above in view, the solar water pumps can be installed and used effectively. The capacity calculation needs to be determined on the basis of annual delivery capacity as sun is available throughout the year to operate the pump. An appropriate storage is to be prepared/utilized, which will keep storing the water during off seasons. This approach will enable to select low delivery pumps, which will deliver less on a daily basis but meet the overall requirement on an annual basis.

It is also necessary to analyze the distribution requirement. There should be scattered pumping units with a relatively small network of distribution streams with each unit. This will also regenerate the un-utilized or virgin lands, which are waiting for supply of irrigation water from canals or tube wells.

In order to implement the program at the country or province wide scale, a real-time feasibility can be undertaken to study the land utilization and water table in different areas followed by a pilot project. The exercise will ultimately determine the exact locations and size of solar water pumps along with the distribution network, which will be sufficient to meet the requirement of those particular areas.

2. Solar Home Solutions (Rural):

According to a survey, far flung areas which are located more than 20 Km away from existing national grid are financially not viable for provision of electricity through conventional means. There are as much as 4,000 such villages, where people are still deprived of electricity.

In such areas, micro level energy solution can be provided to the households and the standard of living can be improved.

A detailed feasibility study needs to be carried out in parallel for pilot projects of rural Electrification. Solar Electrification in rural areas will not only provide electricity to the communities but also help to improve their standards of living. Proper implementation plan and awareness campaigns for rural communities also need to be planned along with the installation of solar home systems

3. Outdoor Lights (Solar / LEDs):

In the present circumstances, the cost of electricity will be a mere consideration in near future and the focus will be to have whatever can be made available. Considering street lights in particular; they cause certain hurdles during installation, operation and maintenance. These include grid connectivity, transmission line, internal cabling and transformers etc. Setting up the infrastructure causes wastage of time and money and introduces a lot of administrative constraints.

As mega watt scale power generation is required to feed the national grid, Government is rightly taking steps to achieve that. Wind power projects will contribute in the coming years. As a short / medium term plan, solar photovoltaic lighting solutions can straight away take over some grid load in urban areas and cities, where outdoor public and community lights such as on streets, roads, parks, billboards, public places etc have a handsome share. Similarly, the far off and scattered applications are also a win – win situation for solar solutions.

This is economically and even financially viable when the overall cost of developing the project including allied accessories at the back end to energize the systems and the O & M are considered all together. The financial implications of capital cost of conventional lights, grid connectivity including transmission line, inter connect cabling, transformers, distribution boxes, fuse circuits, the civil works and labor, the daily tariff, the operation and maintenance, the cost and over heads of repairs and replacements including manpower and equipment are all together analyzed. The use of solar technology to contribute in power sector, being an environment friendly and non depleting energy resource remains above everything.

The real benefits of Solar Lights are realized when LEDs (Light Emitting Diodes) are used. LED's are very low in charge consumption, thus requiring low powered solar panels and low capacity battery banks. A low power LED light powered by a low power panel charging a low capacity battery can produce much more light than equivalent conventional light.

Even in cases where grid infrastructure is available, LEDs contain a lot of potential to be used as Energy Efficient Lights saving 75% electricity as compared to conventional lights.

A system on solar lights has a typical payback period of 5-6 years, whereas a system on LED lights powered by WAPDA electricity has a typical payback period of 2-3 years.

4. Solar Water Heating Solutions:

This is a need of the hour solution in the market in view of depleting gas reserves in Pakistan, low pressures of gas & load shedding during winters and increasing gas tariffs. The solution is based on a collector, which can operate in cold climates to heat the water in a thermally insulated tank. The solar system is modular in terms of interface and it can be used as an independent unit or a pre-heater or a hybrid with gas geyser.

In any of the configuration, it contributes in saving the gas consumption resulting in cost savings for the consumer (reduced gas bill) and also safeguards this rapidly depleting resource at national level. Burning of natural gas also results in GHG emissions, which another advantage to the solar system use.

Like all Renewable Energy Technologies, the solar water heaters have high CAPEX and low/negligible OPEX with a very attractive payback period of *2-3 years*.

The solar collector is based on evacuated glass tubes. The size and number of tubes depend on the heating requirement. The tubes are directly attached with the storage tank. The principal of operation is same as of gas heater. The piping is also on the similar techniques. In order to utilize max solar potential, special measures are required to keep the piping network insulated. Moreover, the system needs resident time for water to stay in the tank during sunshine in order to achieve the desired temperature.

The system has an inbuilt optional feature of electric hybrid.

The system can be installed in three (03) configurations according to the user's suitability:

- **Independent Unit:** It operates in the same configuration and principle as of conventional gas geyser except that heat source is sun.

- **Pre-Heating / Dual Source Heating:** The inlet water of a conventional gas geyser is pre-heated through a solar system to reduce the operation of its burner and thus reduce gas consumption.

- **Hybrid Unit:** The system can be made hybrid in two ways. Either to use electric heating coil in the tank of solar water heater. The coil will operate under certain temperature conditions when performance of solar collector is down. The other way is to use a conventional gas geyser and a solar water heater, both connected with the main piping network. Any one of the two can operate through flow control valves.

5. Wind Power Projects:

Wind Power projects are already underway in coastal areas of Pakistan. However, there is very little practical implementation.

Pakistan has a considerable potential of wind energy in the coastal belt of Sindh, Balochistan and as well as in central Punjab and northern areas. The Wind Data of selected areas has been collected by Pakistan Metrological Department and analyzed by AEDB. As per the collected data, the coastal belt of Pakistan is blessed with a God gifted wind corridor that is 60 km wide (Gharo ~ Keti Bandar) and 180 km long (up to Hyderabad). This corridor has the exploitable potential of 50,000 MW of electricity generation through wind energy. AEDB has made a wind resource study to setup the benchmark wind speed values at different levels from Gharo and Jhimpir regions at present.

Most of the remote villages in the south can be electrified through micro wind turbines. It is estimated that more than 5000 villages can be electrified through wind energy in Sindh, Balochistan and Northern areas.

With the efforts of AEDB, aggressive lobbying for investment has been done with national and international investors to make them realize the potentials of renewable particularly the wind energy. Till date, 93 LOIs have been issued for 4650 MW wind power generation. Land has been allocated to 20-25 investors, who are now working on the feasibility of their proposed projects. There have been delays due to slow implementation of policy but a few projects are now really on the way to enter in implementation stage.

6. Solar Thermal Power Projects:

Solar thermal energy has been in use for several decades. Solar thermal technology is basically concentrating the sun light to a single point to generate a lot of heat which is utilized to generate electricity. The power generation by solar thermal technology was introduced several years ago and it has proven itself most viable future technology for large scale power generation through alternate means.

Pakistan being in the Sun Belt is ideally located to take advantage of solar energy technologies. This energy source is widely distributed and abundantly available in the country. The mean global radiation falling on horizontal surface is about **200-250 watt per sq.m** in a day. This amounts to about **2500-3000 sun shine hours** and **1.9 - 2.3 MWh per sq.met** in a year. It has an average daily global irradiance of 19 to 20 MJ/sq.met per day with annual mean sunshine duration of 8 to 8.5 hours (6-7hrs in cold and 10-12 hrs in hot season) and these values are among the highest in the world. For daily global radiation up to 23MJ/m2, 24 (80%) consecutive

days are available in this area for solar energy. Such conditions are ideal for solar thermal applications.

To summarize, the sun shines for 250-300 days per years in Pakistan with an average sun shine hours of 8-10 per day. This gives huge amount of energy to be used for electricity generation by solar thermal power plants.

A quick idea for the potential of solar energy in Pakistan can be obtained from the satellite map of solar radiation released by National Renewable Energy Lab (NREL) of USA

Solar Energy can be used for heating, cooling and cooking purposes with very simple-to-use technologies. In Pakistan, except some isolated examples, there is no mass scale implementation of these simple technologies. Solar cookers in northern areas can greatly help in saving forests. Solar water heaters in cities can save valuable natural gas. There are many individuals making effort in this field but we have to integrate them for focused efforts and better results.

7. Solar PV Power Projects:

Solar PV can be used on mass scale is the lighting, indoor and outdoor. Indoor lighting meant for offices and homes for which solar PV modules can be coupled with LED lights which require very little electrical energy for the same luminosity and at the same time have very long life.

Alternatively, we can use energy saver bulbs. Outdoor lights mainly comprise street lights as discussed earlier. It is the time when private business groups should plan and implement a phased change-over of conventional lights with solar PV and LED lights for streets and parks; we can start with alternate light poles, if not all. Housing societies like DHA, Bahria Town, and the townships of industrial units must also come forward to launch such projects. These projects will trigger and encourage/promote local mass production of solar PV modules and LED lights, which will result in low cost of such systems.

8. Bio Diesel Projects:

Bio Diesel has a lot of potential through various means. It is a renewable fuel, produced from local resources, which will never deplete and avoids dependence on conventional oil thus reducing import bill in foreign exchange.

The project of bio diesel needs studies on land / soil conditions, the production options and the supply chain network. The most difficult part is considered to be the supply chain mechanism. However, it is a known technology across the world and its introduction in Pakistan can be made practical.

Biodiesel policy has been approved by Government of Pakistan but practical implementation is still lacking, Feasibility on bio diesel resources, its mass production, and supply chain mechanism can be carried out to implement the program in Pakistan.

In parallel, pilot phase projects can be initiated to create social adaption of technology. In this regard oil marketing companies can take the initiative by making biodiesel blends (B5, B10, B20) with conventional oil in order to develop supply chain mechanism and identify the barriers.

9. Micro / Mini Hydal:

Mountain Regions of Pakistan receive high rainfalls and are rich in water resources. Most of the large rivers originate in these mountain ranges. There is abundance of perennial streams,

waterfalls and canals, which can be successfully exploited to generate electricity and mechanical power by using mini and micro hydro power plants.

The need is to explore potential of hydroelectric power in Pakistan that has been estimated to be nearly 40,000 MW, whereas only 16% of the total potential has so far been exploited.

Micro hydropower technology has various positive attributes not usually associated with large hydropower plants. One is that due to their size, Micro hydropower technology scheme permits local involvement in the full range of activities from initiation and implementation to operation, maintenance and management. It is predicted to improve the quality of life of the people of far-flung rural areas by providing them with clean, renewable and carbon free source of energy. Moreover establishment of small-scale industrial units on Micro hydropower technology plants may help in the uplift of socio-economic conditions of the remote areas.

III ISSUES AND CHALLENGES

1. Human Acceptance and Mindset

Lack of awareness toward renewable energy technologies is one cause leading to social rigidity toward adapting these technologies. There is a need to understand that to promote renewable energy is not the problem or responsibility of an individual suffering from routine power outages cuts but a shared responsibility to lower the dependence of country on non renewable resources which are continuously depleting and also to adapt healthier environment friendly renewable technologies.

With this mindset, strife and struggle expanding the RE sector is a priority of all policy makers across the world; and Pakistan is surely in the same queue. A lot has been envisaged on the potential and viability of RE technologies and the decision makers have now managed to decide towards adaptation. As the RE Program enters into the planning and pre-implementation phase in Pakistan, the stage has reached where the implementation is stuck; rather slowed down because of many factors.

It is also time to understand the challenges that why investors from private sector have not been able to implement RE technologies. One reason is that our policy makers did not foresee the changing technology needs and are still skeptical about it. Second, for every new technology there is an incubation period. One has to follow a learning curve to gain confidence about a new technology, whether it is the investor or the regulator.

2. Financial Viability

Whenever one speaks about these renewable energy sources in Pakistan, they are often taken as very expensive, un-reliable technologies. The need is to change the approach and realize as to why the world markets of these technologies are exploding? Although it is a fact that conventional resources are ideal but depletion of these resources lead us to serious power crises we are facing today. In this scenario, philosophies of renewable energy need to be understood.

For example a thermal power plant starting the tariff with 16 cents will reach to 25 cents in in 20th year. On the contrary a wind power plant, if started with 12 cents per kWh will drastically decrease to around 3-4 cents per kWh in the later part of its service.

The same is true for other technologies with different starting points on the tariff ladder.

As renewable energy technologies are getting better transaction in the world (many US states now mandate nearly 10-20% of all energy to be derived from renewable sources), prices per

KWH are coming down. Wind energy is now almost competitive with natural gas derived electricity, and solar is not that far away as well.

The futuristic approach reveals that RE options will sustain forever and these must be inducted in our system.

3. RE Philosophy

The RE technologies have their own psychology and suitable scenario. These have their own usage phenomenon and the benefits can be realized by developing a complete understanding and capability. The technical viability of RE technologies is often challenged due to lack of awareness and misconception circulating about RE. As said earlier that conventional resources are ideal but non reliable, non environment friendly and are depleting continuously. On the other hand Renewable technologies are life long, reliable and environmental friendly solution. Therefore it is pointless to compare renewable resources with conventional resources and consider them impracticable.

For example if a solar system fails due to non availability of sun, it doesn't mean that the technology is not technically viable. The solar power system is designed to provide a fixed daily KWh of energy. Once installed, the system can only provide that amount of energy every day against which it is designed and that too is subject to availability of sun shine. It cannot be unlimited unlike WAPDA; where subscriber can use as much as desired and pay the bill accordingly. Similarly a solar water heating system is designed for a fixed water volume which can be heated to a certain temperature in one sunny day. Same is with wind. The usage scenario needs to tailored with built in / default philosophy of RE instead of going for a total refusal.

IV Recommendations:

- Legislation for Solar Water Heaters on all Government Buildings
- Legislation for 5% of all Public Buildings to become Green Buildings
- Legislation for mandatory Solar Billboards
- Feasibility Study for Bio Diesel, Solar Thermal and Solar PV
- The wind power projects need to be expedited by minimizing the lengthy legal procedures during development.
- Pilot Projects of LED Lights, Solar Pumps, Rural Electrification and Micro / Mini Hydal
- A Vocational Training Institute for RE/EM/HRD is mandatory for successful induction and operation
- Establishment of regulatory and incentive frameworks (feed-in tariff, etc) for all renewable energy sources
- Develop strategy and action plan for local RE manufacturing and for other renewable.

V. Way Forward:

The challenges to understand the dynamics of RE based power planning, system integration designs of an RE power project, technical and financial, due diligence of RE projects, the optimum utilization of renewable energy, long term financial benefits and a lot more issues against while the RE program is battling recently, which is otherwise recognized as *real future of energy*.

However, it is quite an understandable phase which occurs quite often while adapting a new technology/methodology. Most of the challenges have the solutions, which will off course streamline everything – **the picture is turning round and the other Side is very bright**.