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

By

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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 Hydel:

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 Hydel
- 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**.