Energy Crisis in Pakistan: Causes and Consequences

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It is without exaggeration and beyond the doubt that energy has become one of the most significant needs of the human being. The utility of energy has greatly evolved over the last century. The whole range of human activities including dwelling, trade and commerce, industry, transportation and agriculture has mostly become depended on energy. Globally, energy prosperity has become very crucial to overcome fundamental social problems such as poverty, hunger, disease and illiteracy. The growing human reliance on energy has been paralleled by a string of challenges that are both local and global in nature. It is increasingly understood that ensuring availability of sufficient, affordable, and environmentally friendly energy' is one of the major challenges faced by the world in the twenty first century.

Energy is considered to be the backbone of human activities. The accomplishment of human civilization has been achieved through the increasingly efficient and extensive production of various forms of energy to extend human capabilities and ingenuity. Providing adequate and affordable energy is therefore, essential for the eradication of

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poverty, improvement of human welfare and raising of living standard of human being throughout the world (Asif, 2011), the per capita energy consumption is an index used to measure the socio-economic prosperity in any society. The human development index of a country has a strong relationship with its energy prosperity.

With the evolution of civilizations, the human demand for energy has continuously increased. At present , the key factor which drives the growth in energy demand include increasing human population, modernization and urbanization .According to the united nations , the world population 6.5 billion in 2005 is to grow to 9.1 billion by 2050 and most of the population growth is expected to place in the developing world Asia and Africa.(Dinner, 1999). Poverty, hunger, disease, illiteracy and environmental degradation are the most important challenges faced by the world. Poor and inadequate access to secure an affordable means of energy in one of the crucial factors behind these issues. Electricity for example is vital for providing basic social services such as education and health, water supply and purification, sanitation, and refrigeration of essential medicines. Electricity is of course, very helpful in supporting a wide range of income generation opportunities.

Although during the last twenty five years over 1.3 billion people living in developing countries have been provided access to electricity, but more than 1.4 billion people over 21 percent of the world's population do not have access to it .(Human Development reportundp,2007-2008). Although about 2-4 billion people depend upon traditional biomass, including wood, agriculture residues and dung for cooking and heating purposes. Statistics suggested the more than 99 present of people without electricity live in the developing regions and

four out five live in the rural areas of south Asia and Africa. (Poverty, Energy, society, energy forum the backer institute, Rice University)

The leading countries in the world in terms of population without access to electricity include India, Bangladesh, Indonesia, Nigeria, Pakistan, Congo, Ethiopia, Myanmar, Tanzania, Kenya (asif, 2011). With the growing world population and people's aspiration for improved life a central and collective global issue in the new century is to sustain socio-economic growth within the constraints of the earth's limited natural resource along with preserving the environment.

Resources of energy: The energy resources being consumed in the world at present can be broadly classified into three groups: (1) Fossil fuels (2) Nuclear power and (3) Renewable energy .In near future Hydrogen is also expected to be another resource for the generation of energy.

Fossil fuels: Fossil fuels are deposits of the organisms once living in the world ,basically consist of carbon and hydrogen bonds. With the advent of industrial revolution, fossil fuels have been the main source of energy supply. These are further classified into three types: .Coal, oil and natural gas. Coal has equipped the industrial revolution which transformed the human civilization .Coal is usually extracted from mines in three main forms i.e. anthracite, bituminous and lignite.

Oil: Oil is another source which is more efficient than coal .Crude oil consists of many different organic compounds which are transformed into a wide range of products through a refining process. Oil is extracted from the earth through a drilling process.

Natural gas: Natural gas has been the most recent gaseous form of fossil fuels. It is mainly composed of methane .Natural gas is generally found in the earth’s crust at varying depths and may or may not be in

association with oil. It is also extracted through drilling process .Natural gas is more attractive than coal and oil because of its highly colorific value and lower carbon dioxide emissions as shown in the table.

Fuel	Specific energy Content	Specific Co2 emission
Coal	6.7	.37
Crude oil	12.7	.26
Natural gas	15.3	.19

(Asif,2011)

Nuclear power: Nuclear energy is derived from controlled nuclear reactions and is classified into two types; nuclear fission and nuclear fusion. Nuclear fission is the splitting of a heavy atom into two or more parts due to which a huge amount of energy is released. In nuclear fusion process energy is released when several small nuclei are combined to make a larger one whose mass is slightly smaller than the sum of the small one. Nuclear fusion power is a future technology and all of the nuclear power comes from the fusion process with respect to energy yield, fusion is considered richer than fission process.

Nuclear power has played a vital role in reducing the world's use of oil for electricity generation in recent years. Nuclear power makes a contribution of nearly 7 percent in the global primary energy supply. In terms of electricity, it contributes to over 15 percent of the global generation (facts sheet and FAQS, IAEA)

In 2007 ,for example form its 59 nuclear plants, France, produced about 78% of the country's total electricity(Schneider 2008), similarly ,the united states from its 104 nuclear power plant supplies, about 20% of the overall electricity in the country.(Asif, 2007).

Renewable Energy: Renewable energy is obtained from natural sources such as wind power, solar energy, hydropower, biomass energy, and geothermal energy. This type of energy is considered to be one of the most prominent solutions to future energy challenges .Renewable energy sources have been very important for human civilization .Biomass, for example, has been used for heating, cooking and steam production .Wind has been used for moving ships .Both hydropower and wind have been used for producing energy for mills to grind grains. Renewable energy resources are abundant in nature. At present they meet almost 13.5% of the global primary energy demands. (Asif, 2011)

Hydrogen: The vision of building an energy infrastructure that uses hydrogen as an energy carrier, a concept, called the hydrogen economy, consist of an economic system in which energy is supplied by renewable resources and hydrogen is used as the energy vector, medium of energy storage and transportation.

Hydrogen is one of the plentiful elements in the Universe. Chemically bound hydrogen is found abundantly on earth in water, fossil fuels and living things. Generally, it is extracted from water or from hydrocarbons. Hydrogen can also be produced through reformation of natural gas, electrolysis of water or partial oxidation of heavy fossil fuels such as diesel. The potential use of hydrogen in fuel and energy applications includes powering vehicles, running turbines or fuel cells to produce electricity and generating heat and electricity for buildings.

Development of the National Energy Base of Pakistan:

Pakistan is one of the most populous, geographically and strategically important countries situated in south Asia. The energy supply base of Pakistan consist of two major segments i.e. commercial and non commercial. At the time of independence in 1947, the proportion of energy received through Commercial channels is reported to be equivalent to about 1.2 million tone oil equivalent .For the total population of about 33 million, the installed electricity generating capacity was 50 MW. (WAPDA, 1995.) The major energy consuming sectors such as, industrial, transport domestic agriculture and commercial had very little reliance on commodity. Particularly, the industrial sector was almost nonexistent and motorized traveling was not very common. (Ebinger 1981) In the absence of a national grid, out of over 200000 towns and villages only 640 making up 7% of the population were connected to local grid. Similarly, the agriculture sector was not introduced to machinery .Thus it took almost a decade to grow the commercial energy base to take off.(Asif,2011)

Currently, hardly 60% and 20% of the total number of households are connected respectively to the national electric grid and gas pipelines implies that the non-commercial base still makes up a considerably large proportion of the total supplies in the country. Firewood is vastly used for cooking and heating purposes. Similarly, the agriculture and livestock sectors, by producing abundant amounts of biomass in the form of crops residues and dung is collected and used as unprocessed fuel for cooking and house hold heating. According to an estimate ,the biomass based non-commercial form of energy makes up almost 35% of the total consumption in the country, (Asif,2009)

Hydropower: Hydropower is one of the most important and reliable energy resources for Pakistan. This has played a vital role in meeting national electricity requirements in a secure and cost effective manner. In 1947, only two hydropower projects of collectively 10.7 MW(9.6MW Malakand power station and 1.1 Mw Renala power station)existed in Pakistan. After independence hydropower development remained sluggish due to two major factors (a) the water dispute between Pakistan and India and (b)lack of financial resources required to construct large scale dams based on hydropower projects. But only small and medium scale projects could be commissioned at certain sites. Consequently, when in 1958 the water and power development authority (WAPDA) was established, the installed hydropower capacity stood at only 52 MW .By 1960, the installed capacity grew to as much as 253 MW (NTDC,2008). The Indus water treaty between Pakistan and India with the support of World Bank to resolve the water issue proved to be the turning point in the development of hydropower in Pakistan.

It also provided construction of replacement work called Indus basin projects (IBP) to compensate for the perpetual loss of eastern rivers water. The works proposed under the treaty included two multipurpose dams i-e Magla dam on the Jhelum river and Tarbela dam on the river Indus with the provision for power generation which were commissioned in 1967 and 1977respectively. Over the last three decades, only the 450 mw run-off river Ghazi Barotha project was commissioned in 2003. At present the total installed hydropower capacity stands around 6550 MW. Details of WAPDA's hydropower projects have been provided in the table.(WAPDA December ,2009) Hydropower currently makes around 32.7% the total installed power generation capacity in the country.

Development of thermal power: In addition to exploitation hydropower resources, in 1960, Pakistan also slowly developed its thermal power base .Thermal power plants were initially established as a back up to hydropower. Transmission losses have become an important issue over long distances. Thus, thermal power was intended to facilitate the areas difficult to be served by hydropower .The rational thermal power base been developed and is controlled by three major players i-e WAPDA , independent power producers (IPP'S) and the Karachi electric supply company (KESC). (Asif, 2011)

Nuclear power: Nuclear power accounts for around 2.3% of the total installed capacity in Pakistan , it is controlled by the state owned department Pakistan Atomic Energy Commission(PAEC) Pakistan started it limited program for research and development in atomic energy in 1954 . In May 1972, Pakistan's first nuclear power plant KANUPP was commissioned. The plant operated safely for 30 years and generated 1.7 billion KWH before retiring in December 2002. It was reconditioned in 2004 to extend its life by fifteen years with a reduced capacity. A second nuclear power plant CHASNNUPP located at Chasma with gross capacity of 325 MW was established in September 2000. Efforts are being made to construct a third nuclear power plant of 325 MW at Chasma and is expected to be completed by 2011. (Pakistan atomic energy commission website Islamabad Pakistan)

Renewable energy: Several initiatives were taken in Pakistan almost three decades ago in respect of renewable energy productions. Over the years, a number of development such as Appropriate Technology Development Corporation (ATDC), National Institute of Silicon Technology(NIST), Pakistan council of Renewable energy

technologies(PCRET) and Pakistan Council for Appropriate Technologies were setup to promote the cause of renewable energy. However, these departments could not deliver because they remained constrained to demonstration projects. In 2002 the Alternate Energy Development Board (AEDB)was setup to pursue vigorous targets particularly with regard to wind power. The long term task ahead of AEDB was to contribute 5% of the total national power generation capacity i-e about 9700 MW through renewable technologies by 2030.Under the village electrification program in Sindh and Balochistan the AEDB has achieved up to mid 2009. The following are:

(1) 6MW wind farm installed in Jhimpir

(2) Two Wind turbines each of 10kw capacity installed at Kallar Kahar.

(3) 100 Micro wind turbines each of 500W capacity installed in Sindh and Balochistan as part of the village electrification program.

(4) Solar home system each of 80W capacity installed in 1000 homes. (AEDB officials May 20,2009) However, AEDB is still far from being able to play a noteworthy role in the energy scenario of the country.

Oil and gas: Pakistan does not have rich oil and gas reserves. The oil reserves in particular are very limited. After the independence, the first major exploratory success was the discovery of the Sui Gas field in 1952. In 1961, the government of Pakistan established the Oil and Gas Development Corporation (OGDC). From 1947 till 1977 the foreign countries drilled only 160 exploration wells followed by OGDC with 30 extra wells (Ebinger, 1981)

From 1982 to 1992 , new discoveries and development of new oil fields triggered a sharp increment in production of oil from almost 4.3 million barrels annually in the early 1990s.(Blood , 1994) Although in

2007 the annual production reached to 2.4 million barrels , however , this growth in the production of domestic oil is about 16% of the total national requirement .According to EIA Pakistan, total recoverable oil reserves at the end of 2007, stand at about 300 million barrels.(Energy Information administration statistics 2007) According to the ministry of petroleum and national resources , however, the country has over 326 million barrels of oil (Pakistan energy year book 2008)

Pakistan is amongst the most gas dependent economics of the world. Natural gas was first discovered in 1952 at Sui in **B**aloachistan by the Pakistan petroleum Ltd. It was brought into service in 1955. Shortly afterward, another gas field, Mari was discovered in 1957 by ESSO Eastern and with passage of time a number of the gas fields have been discovered in various parts of Pakistan. Gradually, the share of natural gas in the energy supply rose to such an extent that at present it has became the backbone of the national energy base as gas contributes to about 48%of the total primary energy supplies. During 2007-2008 the country production of natural gas stood 1418billion cubic feet (Energy Year Book 2008)

Energy Crises Origin Diamantine and Implications:-

Pakistan has struggled to have a stable energy situation. Especially, whenever there is talk of electricity in terms of demand and supply, there have been regular spells of intense shortfall. The most recant trough ever the national electricity system experienced, was triggered in 2006-07 with gradual buildup of a gap between demand and supply. Very soon it turned into a worst energy crises in Pakistan's history. In the Proceeding three years instead of relief, helpless Pakistanis found themselves in intense situation. In March 2010, they were enduring up to Eighteen hours of load Shedding.

The Present crises are also a self-inflicted problem resulting for years of poor policies and reckless attitude on the part of concerned authorities. The scale of the Problems has now almost grown beyond any instant solution. This has happened at a time when energy is considered to be the backbone of human activities and a vital commodity for the survival of modern economies. Like a global trend, energy has become very important in the life of an average Pakistani. In 2007, for a population of about 160 million, the installed capacity had grown to 19,500MW, on the contrary to 50MW for the population of 33.7 million in 1947. It simply means that within the span of six decades, the per capita electricity Consumption has increased by 82-fold. This implies that electricity has become an integral part of present day life in Pakistan. However, the bankrupt national electricity portfolio suggest that the trend of electricity proliferation is likely to be hampered for at least the next few Years.(Asif,2011)

Energy Crises is not new to Pakistan. Load Shedding, has frequently plagued the Country, particularly over the last three decades. The recurrent crises from the very beginning has inflicted enormous economic, Socio-political and strategic damage.

Energy Shortfall; Gap between Supply and Demand.

In recent decades, Pakistan has experienced a very rapid growth in primary energy demand. Figures indicate that there is an about 150% increment in primary energy Consumption over the last twenty Years (Pakistan country statistics, 2008). The primary energy is a much broader commodity and it takes into account all forms of energy such as electricity, gas and fuel for transportation and other industrial and commercial applications. The gap between demand and supply is gradually increasing. Statistics show that over the last thirty-six years,

the gap between commercial energy demand and supply has grown to six times from 1971-72 to 2007-08 i-e from 3milion tons MTOE to 18milon MTOE.(Asif, 2011)

Electricity Shortfall: The most obvious indicator of the scarcity of energy is the shortfall of electricity in Pakistan. The number of electricity consumers has increased from the 7.9 million in 1992 to 19.9 million in 2008 (i-e about 150% growth).Despite such a sharp rise in consumers number, still only 60% of the total population is connected to the national grid. Although while a major proportion of population still remains deprived of the national grid, those who are connected to it have hardly enjoyed a secure supply of electricity. For the last ten years, the generation capacity has not been enhanced in response to swallowing electricity requirements. WAPDA's daily report on 3 January, 2008 recorded a supply of 7,237 MW against the demand of 11,509MW, recording a shortfall of about 37?%. Similarly, WAPDA sources suggest that on 22 March,2010 as weather was in transition from winter to summer, the country faced a deficit of about 5,300MW (Asif,2011).

It is forecasted that the primary energy demand has to be increased from 55 MTOE in 2005 to 301 MTOE in 2030 and the electricity demand will increase to about 8 times more i-e from 19,540 MW in 2005 to 163,000 MW by 2030. (Pluming Commission 2005)

Gas Shortfall: In Pakistan, not only the electricity crisis is becoming a headache but, a severe gas crisis is also fast approaching. For the last fifty Years the country has enjoyed a supply of gas from local resources to meet the demands of the national gas pipelines network that reaches about 20% of households and a considerable degree of

industrial and commercial consumers. This indigenous supply of cheap gas has greatly helped industrial and economic activities to flourish. However, the demand and supply situation has been changed from affluence to deficiency. Reports show that after 2006 the country has entered in to the deficiency phase. (Business Recorder, July 24, 2007).

According to the Ministry of Petroleum and Natural Resources, during 2007-08 the Production of gas increased from 3837 to 3973 million cubic feet per day recording a growth of 2.6% but the at the same, the growth in Consumption increased by 4.4% which out placed the growth in production of the gas. (Pakistan Energy Year Book 2008). As for as the shortfall is concerned, gas Load shedding and supply cuts have been quite common practices. During the winter season, it affected almost all sectors including domestic, industrial and commercial. The severity of the issue can be measured from the government's decision in November 2009 to impose a two-day per weak load shedding on industries and CNG stations from November 2009 to March 2010. (Business recorder 2009). If, this trend continued, and the government failed to check the very crisis immediately, urgently and effectively. Reports suggests that by 2030 , the gap between the demand and supply is likely to increase by eight times , as indicated below

Years	Demand	Supply	Net difference
2004-2005	3173 Mcf/day	4033	860
2009-2010	4565 Mcf/day	4424	-141
2019-2020	9114 Mcf/day	3001	-6113
2029-2030	19035 Mcf/day	2299	-16736

Source: Robert Hathway and Michell Kugelmn (eds) powering Pakistan oxford university Press, 2009 (p.32)

According to the energy information administration Pakistan's natural gas reserves in 2007, were about 28000 billion cubic feet .(Energy Information Administration, 2008) keeping in view the consumption level of the same year, the reservoirs are said to last for twenty one years. (Hathway, 2009) However, if growth in the demand remained continued at this rate, the reserves are expected to be exhausted even more quickly.

Water short fall: Water is considered to be one of the most important resources in the world. It is because of the fact that it is the source of life. With the growth in population, urbanization, industrialization and change in ecosystem, water resources have been under intense pressure through out the world. There is also warning about international confrontations on water resources in near future. The former UN Secretary General warned in 2001, 'fierce competition for fresh water may well become a source of conflicts and wars in the future. (Diner, 2007) Similarly, in 1995, the world bank Vice President Ismail Serageldin has been of the view that, the wars of the next century will about water (BBC, Feb 13, 2009)

Pakistan's own fresh water resources are also under pressure. If government did not act on urgent basis, it shall face a desperate water scarcity in the coming few years. (Pakistan council for research, December 5, 2009). The annual per capita availability of water has dropped from 5260 meter cube.(m3) in 2006 (WAPDA website, December 5, 2009)

Under the prevailing circumstances, when Pakistan needs to save every drop of the available water, it could only be said to be a national misfortune that every year over 30 million acre-feet of water is thrown in to the sea which could otherwise, be carefully capitalized .Thus, it became almost imperative, that this water can be captured for different purposes including electricity generation, irrigation and dinking.

At present, when a number of dams are being constructed in India and china, Pakistan shows very little concern for such a precious source of energy .If Pakistan does not change its altitude towards meaningful exploitation of its water resources for different application in general and for electricity generation in particular, the coming days are going to be extremely difficult for Pakistan to maintain and strengthen its socio-economic conditions and national sovereignty.

Pakistan's Rising Energy Demands and Alternate Measures:

Pakistan is facing energy crisis in natural Gas, power and Oil. Pakistan's total energy requirements are expected to increase from 48 million tons of Oil equivalent (MTOE) to about 54 million tons of Oil equivalent (MTOE). (Blank, February 28, 2001)

Natural Gas is an important feature of Pakistan's energy mix, currently representing 49% of total consumption, mainly for the power generation, residential and industrial sectors. Oil makes up 31% and most of this is imported. (Blank, February 28, 2001)

Alternate Measures: The local Gas reserves are of strategic importance for Pakistan but these have been used lavishly and relatively irresponsibly for the last few years. In 2008, 34742 GWH of electricity was produced from Gas, accounting for about 35% of

the total electricity generated to the country. (Electricity Marketing Data, 33rd issue NTDC, 2008)

In the back-drop of the imminent Gas crisis, Pakistan has been exploring options for Gas import. In this regard, three different options have been brought under Consideration over the years which are as follows.

- Natural Gas pipeline from Turkmenistan to Pakistan through Afghanistan TAP.
- Natural gas pipeline from Qatar to Pakistan through Oman.
- Natural Gas pipeline from Iran to Pakistan(Ipi)

Qatar Pakistan Gas Pipe Line: On 17 July 2004, the Government of Pakistan signed a memorandum of understanding (MOU) with crescent Petroleum, regarding a plan to build an undersea Pipeline from Qatar, the country with world's third largest proved Gas reserves (behind Russia and Iran).(Qatar Pakistan Gas Pipeline, Economic Review 2004) . There was an option to extend this line to India. This would tie up with the Qatar-UAE-Oman Dolphin project (which aimed to create a Gas pipeline network connecting the three Gulf Countries) and would run 1,225 km under the sea to Pakistan, probably Gawadar , at a cost of 10 billion. However, though Exxon Mobile is said to be interested, the cost look too high now for immediate viability.

Natural Gas pipeline from Turkmenistan to Pakistan through Afghanistan (TAP): There is a potential for reviving the TAP Project which would terminate at Gawader and possibly a complementary road link to Heart in Afghanistan. After the fall of Taliban in 2001 momentum

returned to the trans Afghan project. In 2003, the Asian Development Bank (ADB) initiated a feasibility study, which envisaged the TAP as a natural Gas transmission pipeline of about 1700Km to Gas transport about 30 Billion centimeter of Gas annually from Daulatabad Gas field in South East Turkmenistan to Consumers in Afghanistan, Pakistan and possibly India. The cost of the reborn project was estimated at about 3.3 billion.(N.Jung, December,2003) Plans for the TAP pipeline include various routes. For example, one from Daulatabad to Mazar-e-Sharif, Kabul, Peashawar and Lahore, a total of 1860km. Another from the same point to Heart, Kandhar and Quetta at a length of 1860km.(Oil & Gas Journal 7 Feb,2005)

An MOU was signed in 2006 for Turkmenistan to supply 32.7bcm per year of Gas to Pakistan over 30 years and both India and China have expressed interest in extensions. (Smith, 2007) But there have been no further Developments over these options. The greatest hurdle to the pipeline from Turkmenistan is the volatile geo political situation in Afghanistan. More over there are also issues with regard to the price of Gas. However, the Iran pipeline proposal has matured and is expected to be almost materialized in the recent future.

The Iran-Pakistan-India Pipeline: The Iran pipeline proposal was matured in 2005. The idea for the Iran-Pakistan pipeline project was originally conceived in 1995 as Iran- Pakistan-India (IPI) pipeline. Its total length was to 2700km with 1100km, 1000km and 600km long sections in Iran, Pakistan and India respectively. However, after thirteen years India finally decided to quit the project in 2008 (Asif ,2011). Talks between Pakistan Prime Minister Shukat Aziz and Murli Deora , the Indian Minister of Oil; and Gas led to a tentative new formula where by

Pakistan would sell gas directly to India at the border, rather than act as the transit Country for Iran- India sales. Thus, in 2009, Pakistan and Iran finally signed the initial agreement to start working on the project by 2010. That would take about five years to complete. (The Dawn, May 24, 2009). Pakistan aims to capitalize the gas imported through these pipelines for the usage of power generation and heavy industries. This is a very beneficial development but the project may not be completed successfully for a number of reason such as volatile geo-political situation in the region, pressure on Pakistan from western countries in general and US in particular not to involve in economic and strategic ties with Iran and doubt on the Consistency of policies on both sides particularly at the Pakistani end. It is however hoped that policy maker will do their best to materialize the Iran- Pakistan pipeline project in the best national interest of Pakistan.

Hydropower Projects: A country is said to be experience water stress when the annual per capita water supplies drop below 1700m^3 and when the annual per capita supplies drop below 10000m^3, the country is considered to have water scarcity for all or part of the year.(People and the Planet 2000-2009). Hydropower is one of the most important sources of energy in Pakistan. It is more economical source of electricity. Hydropower is an indigenous and renewable source of energy and has a strategic significance for the country. The future of Hydropower project depends upon the secure supply of water from the river that flows in Pakistan. Safeguarding the supply of this water has become a matter of life and death for the agricultural base of Pakistan as well as it is equally important for the sustainability of power sector and the national economy. For this

purpose, water storage capacity needs to be improved so that it could be effectively capitalized for generation of electricity and irrigation purpose. Currently, Pakistan can store water for only 30 days. Thus Pakistan needs to develop and build large as well as small dams to enhance its water storage capacity. More over this storage of water can be a provision of a shield against the impact of natural calamities like drought and flooding.

Pakistan's total identified potential for hydropower is about 42 G.W (gigga watts) out of which only 15% amounting to nearly 6.4 GW has been exploited so far. In order to meet the energy challenges faced by the country and to ensure a sustainable energy future, multifold exploitation of hydropower is imperative.

At present, there are at least seven potential hydro projects with capacity in multigiggawatts. These include Bhasha (4500MW), Bunji (7100MW), Dasu (4320MW), Kalabagh (3600MW), Kohala (1,100MW), Patan (2800MW) and Thakot (2800MW). Apart from these , there are a number of other projects with the capacity in hundreds of megawatts. These include Neelam Jehlum (950MW), Munda(750MW) Akori (600MW), Dubar Khwar (130MW), Alai Khwar (121MW) Golan Gol (106MW) and Khan Khwar with capacity of 72 MW(WAPDA, December12,2009). More over their generation capacity can further be enhanced provided arrangement were made for maximum utilization of water.

Notwithstanding initial work in the form of feasibility and pre-feasibility reports have been under taken on almost all of these projects long before but construction of any of these is yet to be initiated. Apart from these major reservoir-based projects, a number of potential small

and medium scale run-of-river sites have also been projected in the Northern Areas. Estimates suggest that upto 350MW of power projects can be materialized in this fashion. (The Nation, Augest11, 2009).

Conclusion

The energy problem faced by the country cannot be addressed with out fully utilizing its hydropower potential. Pakistan needs to learn lessons from the on going situation and hydropower development thought the world and particularly in the neighboring countries. Every potential project needs to be capitalized to ensure the development of hydropower, wind power, nuclear power, and coal reserves and biomass for the national electricity supply mix. More over, geographical location topography and climatic conditions of Pakistan are very ideal for exploiting Solar energy. On the average, almost all parts of the country have more than 300 sunshine days years. This available level of solar radiation makes the climatic conditions of Pakistan highly favorable for the production of solar energy by exploiting different solar energy applications such as solar thermal power, solar water heating, solar photovoltaic, solar desalination, solar cooking and solar crop drying.

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