TAPPING AFFORDABLE ENERGY RESOURCES

By
RIAZ AHSAN BAIG

1. ECONOMIC DEVELOPMENT

1.1 Economic development is very closely and directly linked with energy development of which power generation is a major part, and result in proportionate change in GDP per capita and in altering structure of an economy. Effective development of affordable cost energy system can be quiet comprehensively used in fast industrial growth and development of socio-economic structure of a society.

1.2 Demand of energy is increasing dramatically. According to an estimate worldwide energy demand will be doubled by 2020. The surge for demand is coming primarily from fastest growing countries like China, India and followed by other developing countries. As people fall more into middle class, they want to buy cars, T.V, Air Conditioners and other products that use oil and electricity. If mankind continued to increase energy consumption at present rate, the useful life of existing fossil reserves will not last more that two decades. Pakistan is amongst low per capita energy consuming country as shown in Figure 1 below:

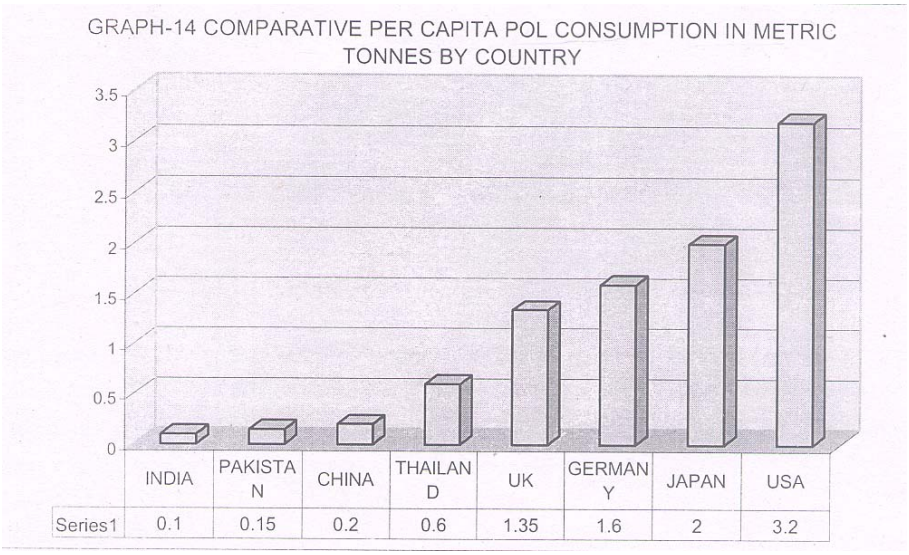


Figure 1

1.3 Before I recommend what are affordable energy resources, it is essential to review existing potential of energy resources in Pakistan and their probable demand in the near future.

2. POSITION OF OIL SUPPLY

2.1 Oil is a resource in finite supply, no major oil fields have been found since 1976. According to oil experts, world oil production is already at its peak, and may continue like this for another decade. The problem however is not “running out of oil” as much as it is “running out of cheap oil”. Today Oil plays such a

fundamental role in economy of the world, that its shortage and high prices may run into crisis of untold proportions. We have very tight energy supply-and-demand balance these days and the small shift is leading large swings in oil prices. The upward trend in oil prices is evitable, as oil will start depleting during the next one or two decades. Supply and demand will be forced to balance but at a price. Developing countries like Pakistan will be badly hit and will pay its price at cost of its development and terms of poverty increase.

2.2 The position of Oil in Pakistan is as under:

Proved Recoverable Reserves (MT)	33
Production (MT)	2.8
Present Consumption (MT)	17.0

If we look at the graph below, crude oil production in Pakistan is on decrease for the last 15 years while oil demand is on increase. Historically, we are dependent on oil imports. In the year 2003-04 about 7.8 million tons of oil was imported costing US$ 3.5 billions. During the current year total import bill may exceed 5 billion US$.

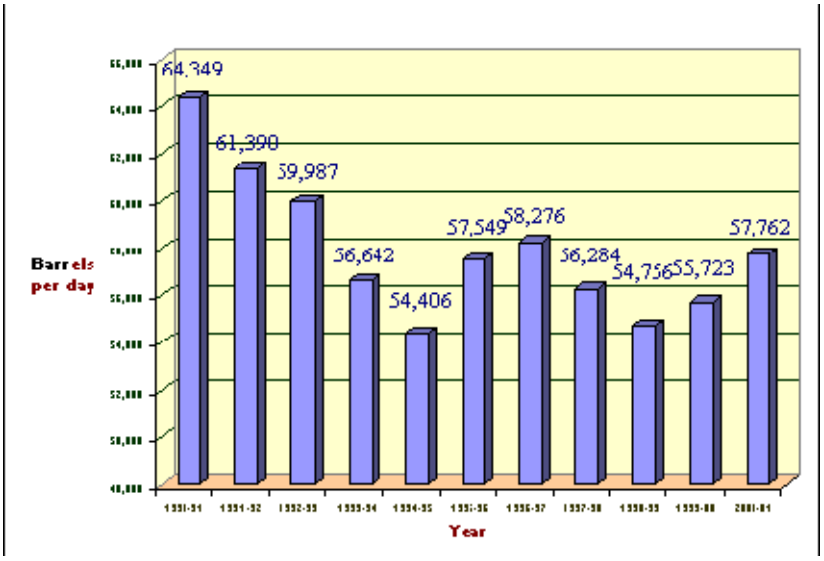


Figure 2: Crude Oil Production in Pakistan

Pakistan will face a major shortage of oil by 2010 unless it steps up exploration activity. At a projected annual economic growth rate of 7%, Pakistan would face a shortage of about 30 million tons of oil equivalent by year 2010 rising to more than 100 million tons by year 2050, there is a need to meet this gap.

3. GAS SUPPLY POSITION

3.1 With increase of oil prices, there will be more pressure on gas supply consumption which relatively is a cheaper source of energy. Proved recoverable gas reserves in Pakistan are 695 billion cubic meters and present rate of production is about 30 billion cubic meters per year with annual growth rate of 6.5%. The production will reach its peak by the year 2010 when it will start

declining. It is estimated that all indigenous oil reserves will finish in first decade and that of gas in second decade.

Long terms investment for power generation based on indigenous gas supply is not feasible unless some other source is tapped. Let us have a look at natural gas reserves available in neighboring countries of Pakistan.

1.	Iran	24.8 trillion cum
2.	Qatar	17.9 trillion cum
3.	Turkmenistan	Proven data not available
4.	Pakistan	695 billion cum
5.	India	542 billion cum

Gas importation projects envisage about 1500 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 gas per day. With further extension, the imported gas can also reach the Indian market.

Proposed Regional Gas Pipeline Routes are indicated in layout plan below:

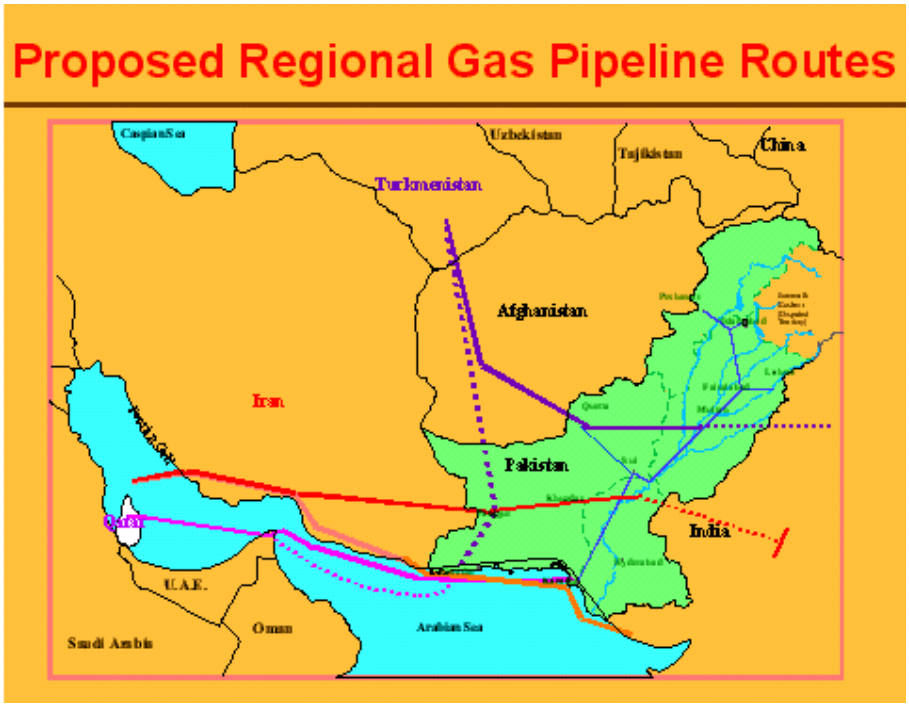


Figure 3

3.2 Present production of gas is hardly sufficient to meet 50% of country energy. Requirement. India has very small reserves even compared to Pakistan and is in dire need to import gas from abroad. One of the proposal is to import gas through pipeline from Iran which is a US$ 4 billion Project. The gas Project was very much on cards when US intervened to stop this Project. The American assistant secretary of state recently said that US intended passing further laws against any investment in Iran and asked Islamabad and New Delhi to explore alternative sources for meeting their energy demands. India also seems to have

changed its stance after Manmohan Singh's visit to US in lieu of a deal on nuclear power plants. I fear under pressure of USA, the Project may be abandoned and Pakistan will be deprived of sustainable and affordable source of gas supply. Importing of gas from Turkmenistan (Central Asian Countries) is not safe and reliable while from Qatar it will be more expensive.

4. COAL RESERVES

4.1 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.

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

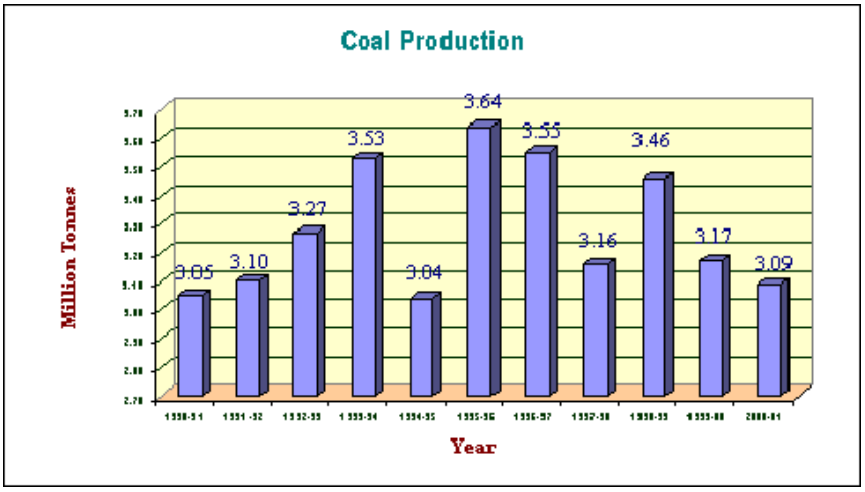


Figure 4: Cola Production in Pakistan

4.3 The vast reserves of coal has failed to benefit Pakistan in any meaningful way particularly 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 but 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 a step forward in the right direction.

5. HYDROPOWER DEVELOPMENT

5.1 Hydropower Development is one of the most affordable sectors of energy, which Pakistan need to harness at a faster rate. It's a non-polluting renewable source of water for agriculture and energy. It is pity that over the last fifty-eight years GOP has not paid due attention to harness this available potential. Over the last 58 years we have just added 6,463 MW of Hydle Generation as given here under:

Table – 1 Energy Data of Hydel Power Station

Power Stations	Installed Generation Capacity MW
Tarbela	3,478.00
Mangla	1,000.00
Warsak	240
Chashma	187
Malakand	19.6
Dargai	20
Rasul	22
Shadiwal	13.5
Chichoki Malian	13.2
Nandipur	13.8
Kurram Garri	4
Renala	1.1
Chitral	1
Ghazi Barotha	1,450
Total	**6,463**

Government should realize that without affordable energy sector there can be no progress in the country. According to an estimate more then 41,000 MW of hydle generation remains untapped while under vision 2025, only 769 MW of power houses are planned to be added by the year 2010, which Projects are also not running according to schedule. The detail of these Projects is as under:

Most of the following Projects, although awarded but their implementation is being delayed due to one or the other reasons.

TABLE-2: PRIORITY HYDROPOWER PROJECTS

Sr. No.	Project	Power (MW)	Project Cost (US$ Mill.)	Implemen. Period (Years)	Status
1	Jinnah	96	162	4	Awarded to Chinese. Delayed due to high rate of interest of 5%.
2	Malakand-III	81	80	3	
3	Allai Khwar	121	110	4	Delayed due to lack of infrastructure to be provided by WAPDA.
4	Golen Gol	106	104	3	Delayed by 4 years.
5	New Bong/UJC	97	110	3	Delayed by 4 years.
6	Khan Khwar	72	86	4	Delayed by 1 year due to lack of infrastructure.
7	Duber Khwar	130	109	4	Delayed by 2 years due to lack of infrastructure.
8	Pehur High Level	12	8	3	Delayed by 2 years due to lack of infrastructure.
TOTAL		**715**	**769**		

5.2 Following is the list of identified Hydropower Projects under vision 2025 which GOP need to concentrate to develop these available sources at a much faster rate then planned.

TABLE 3 IDENTIFIED HYDROPOWER PROJECTS

Sr. No.	Project	Capacity (MW)	Location
1	Basha	3360	Located on Indus River about 40 km downstream of Chilas Town (Northern Area)
2	Dasu	2712	Dam site located on Indus River about 2 km upstream of village Dasu on KKH in NWFP
3	Pattan	1172	Located on Indus River about 4 km upstream of village pattan on KKH
4	Thakot	1043	Dam site is located on site river about 3 km downstream of Besham Kila on KKH
5	Bunji	1500	Located on Indus River, 67 km away from Gilgit in Northern Area
6	Thal reservoir	52	Located on CJ Link Canal near Adhikot/Sher Garh
7	Abbasian	245	Located about 6 km downstream of Kohala bridge on Jehlum river.

8	Kohala	740	Dam site located near village Dhal Chattian about 28 km upstream of Domel on Jhelum river and power house is located near Barsala.
9	Neelam Jehlum	969	Located on Neelam river at Nauseri, AJK.
10	Raised Mangla	180	Raising of existing Mangla Dam height located on Jehlum River
11	Doyian	425	Located on Astore River in Astore Valley N.A.
12	Raj Dhani	86	Located on Punjab River about 10 km upstream of end of Mangla Dam Reservior.
13	Gulpur	116	Located on Punch River about 20 km downstream of Kotli City, AJK
14	Matiltan	84	Located on Ushu River, a tributary of Swat river near Kalam.
15	Munda Dam	740	Located on Swat river about 5 km upstream of existing Munda Headworks in tribal area of Mehmand Agency
16	Chakothi Hattian	139	Dam is located on Jehlum river about 51 km upstream of Muzaffarabad near Chinari and Power House is located near Hattian about 35 km upstream of Muzaffarabad.
17	Suki Kinari	652	Dam site is located on Kunhar River about 2 km upstream of Kaghan. Power house is located near village of paras.
18	Patrind	133	Dam is located on Kunhar river near village of Patrind about 9 km downstream of Garhi Habib Ullah.
19	Naran	219	Dam site is located on Kunhar river about 3 km upstream of village Naran.
20	Azad Patan	222	Dam site is located upstream of Patan Gridstation about 1 km downstream of Patan bridge on Jhelum river in AJK.
21	Karot	240	Dam site is located just downstream of Karot suspension bridge about 29 from the village of Kahota on Jhelum river in AJK.
22	Mahl	245	Dam site is located downstream of confluence of Mahl and Jehlum river about 22 km downstream of village Kahota -in AJK.
TOTAL		15274	

5.3 In addition to above more than 2000 MW of small hydropower potential has already been identified. These schemes are listed below province wise.

Sr.	Province	No. of sites	MW Capacity
1	Punjab	314	381
2	Sindh	5	98
3	NWFP	85	570
4	Nortehrn Area	139	885
5	AJK	27	230
	TOTAL	**570**	**2164**

6. NUCLEAR ENERGY

6.1 Nuclear is another alternate source of energy although highly polluting, capital intensive initially but is an affordable in the long run if developed through indigenous sources. The plants are being commissioned under supervision of Atomic Energy Commission.

6.2 A small 125 MW was commissioned in 1971 known as Knapp at Karachi, which at present has almost exhausted its useful life. A second plant of 300 MW has been constructed at Chasma and connected with the national grid in the year 2000. This plant PAEC has completed with the help of Govt. of China while another unit of 300MW has started in May 2005 at Chashma will be completed in 2011 at a cost of US$ 850 million. Govt. has instructed Atomic Energy Commission to setup new nuclear power plants to generate 8800 MW of power with local and Chinese Technical support in the next 25 years. Each plant may have a capacity of 300 to 600 MW each.

6.3 Due to high initial cost, global restrictions and concerns by IAEA, non-availability of indigenous materials and technology, we cannot depend on this source of energy. However, if PAEC succeeds to develop from indigenous sources it will be a great help to meet the short fall.

7. NON-CONVENTIONAL RENEWABLE NEW ENERGY SOURCES

7.1 New renewable energy is any sustainable energy source that comes from natural environment. The most common form of non-conventional Renewable Energy Sources are:

i) Solar
ii) Wind
iii) Biomass
iv) Geothermal
v) Hydrogen

7.2 Renewal energy sources are essential for sustainable development as they have fewer effects on the environment compared to conventional fossil fuels. Although renewable energies cannot substitute the existing fossil fuels energies due their higher cost but advances are being made during the last two decades including higher efficiencies, improved quality and increased reliability. The cost of renewable energies will drop while fossil fuel cost is on increase. It is expected that during the next two decades renewable energies will substitute the fossil fuels to great extent. In my opinion most affordable renewable energy resources in Pakistan are Solar, Biomass and Hydrogen, which will be discussed hereunder while Geothermal, wind and Tidal waves in my opinion, has its limited applications in Pakistan.

8. SOLAR

8.1 Electricity is produced from the heat energy of sunrays falling on earth, which is available in plenty in Pakistan throughout the year. When fossil fuel will become expansive Energy from solar is likely to replace it.

8.2 Photo voltaic cell

Photovoltaic cells are used to produce electricity. Recently P.V technology based on Silicon wafers is being substituted by depositing a thin film of patented materials on glass to produce the photovoltaic effect which is capable of producing double the power for the same surface area, which has reduced the cost from US 4000/KW to US $ 2000/KW.

8.3 With research and development of new materials, it is expected that solar cell cost will further be reduced by the year 2010 when it may take up boom for mass utilization. Just have a look at the graph placed at Fig 6, which is showing how the cost of PV cell has reduced over the past three decades.

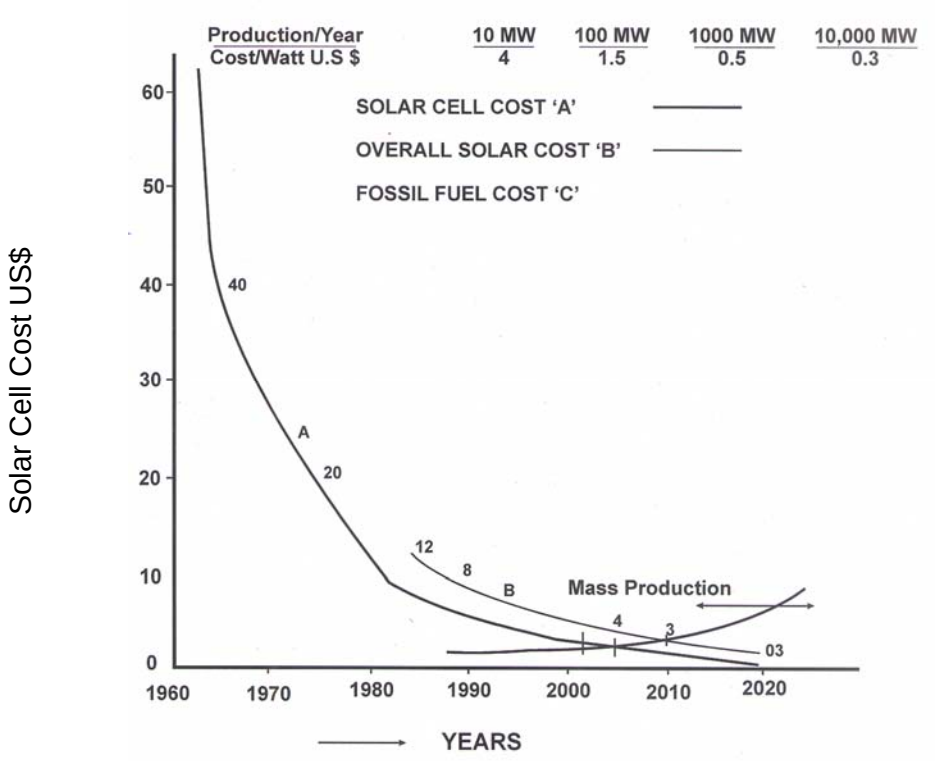


Figure 5

8.4 Solar Thermal Systems

There are several Solar Thermal Systems used but the most popular is Parabolic Trough Solar System which is getting its popularity day by day and is likely to be the most economical system for power generation. I am not going into technical details of this system. In simple words, the solar energy is concentrated on to the receiver from where heated fluid is transported to the point of use in this system. Sun heat is directly transferred to heat water for pools, homes and industry, to provide space heating, operate steam turbines or steam engines to produce electricity. In California, USA, a USA Company is producing several hundred MW of solar energy. In Pakistan we can even today make use of direct solar energy in remote areas of Sindh and Balochistan where electricity transportation is expensive.

In addition currently some 800,000 solar energy water heaters are sold in the world. In Europe and America passive solar houses in stand alone capacity are now being marketed by an increasing number of builders. Water pumps for agriculture and swimming pool heaters are also getting popular day by day to save electricity bills which over a period of its life is more economical.

8.5 Biomass

One of the most affordable energy sources for the poor in rural area is biomass which is used for cooking and heating because electricity even if available is a costlier option. Pakistan forest area is spread over 3.2% of the total which needs to be increased. An Agro Forestry Campaign already in vague for improving supply of wood needs to be accelerated. Presently fuel wood and biogas share in primary energy consumption is 13.4% and 9.5% respectively.

8.6 Hydrogen

Hydrogen is the future transportation fuel for our vehicles. This fuel is available in abundance in form of water. It will be cheapest source of fuel, which is combustion at low temperatures. We need to carryout extensive research for its development for commercial use in our Engineering Universities as in case of Solar Energy for which necessary facilities for research and development are to be provide.

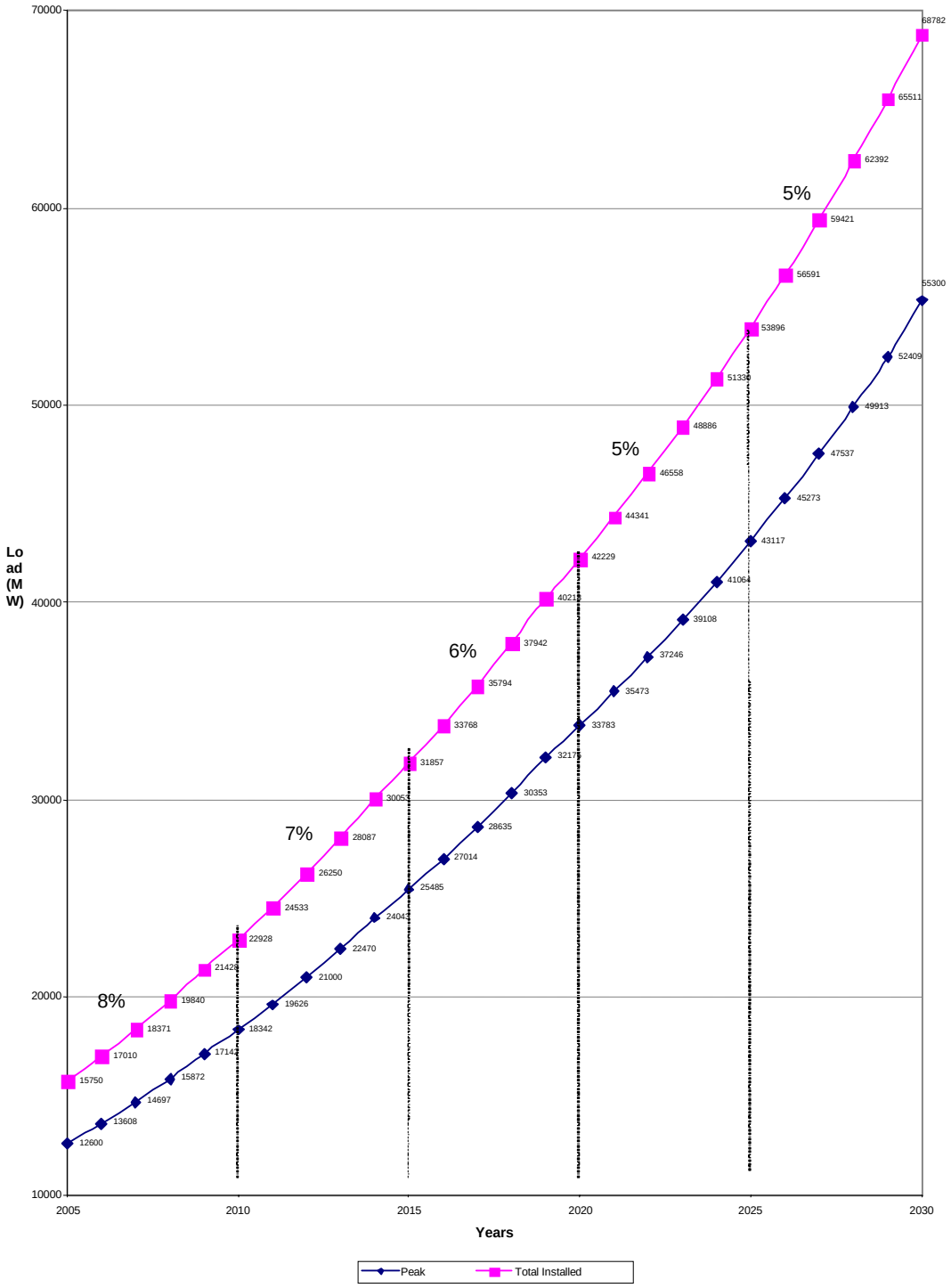
9. Electricity Demand and Installed Capacity

9.1 Economic development and increase in GDP per capita of a country is directly proportional to increase in power consumption, as such there should be no compromise to curb the power demand which will directly effect the economic growth of the country. Like other sectors, power sector is also suffering from lack of long term planning. All decision of Government are based on Adhocism and short term plans. Consequently WAPDA cannot frame its long term plans due to lack of GOP vision to support it and coordination between various agencies. Even under short term plans, implementation of the Projects is abnormally delayed compared to its targets due to inconsistency in GOP policies, lack of trained man-power in the country, and good governess.

9.2 The peak demand and required installed capacity over the next 25 years has been worked out based on average growth rate of power consumption as shown in Figure 6 for WAPDA System. By the year 2030 a peak demand of 55000 MW is estimated requiring an installed capacity of 69000 MW by adding 25% over and above the peak demand accounting for derated values of thermal generation, spinning reserve, units outage of maintenance and reduced generation due to low water levels in winter season. Similarly KESC demand and generation requirements have been worked out separately as shown in Figure 7. An additional generation including the replacement of existing power plants of 8,000 MW will be needed by the year 2030 to cater for KESC requirement. Finding affordable energy sources of generations, requires indepth study by the planning departments of GOP & WAPDA. This is a big challenge and can only be achieved if our policy makers follow a consistency in their vision for the future plans. I have made a rough attempt to achieve the targets based

on available energy sources with the following assumptions as shown in Figure 8:

FIGURE 6: LOAD DEMAND GROWTH FOR WAPDA



i) Indigenous Gas production will reach its peak by 2010 and will be depleted by the year 2020.

ii) 20,000 MW of Hydel generations shall be harnessed by the year 2025/2030.

iii) Bulk Gas shall be imported from Iran by the year 2010 and additional 20,000 MW capacity gas plants shall be installed by the year 2025/30.

iv) Additional Nuclear Power Plants of about 2000 MW capacity shall be installed by the year 2020 to fill the gap.

v) Coal in Sindh shall be mined and 20,000 MW capacity of Thermal Power Plants shall be installed by the year 2025/30.

vi) New Renewable energies shall become viable by the year 2010 and will fill the shortfall of about 12000 MW by the year 2025/30.

FIGURE 7: LOAD DEMAND GROWTH FOR KARACHI ELECTRIC SUPPLY COMPANY (KESC)

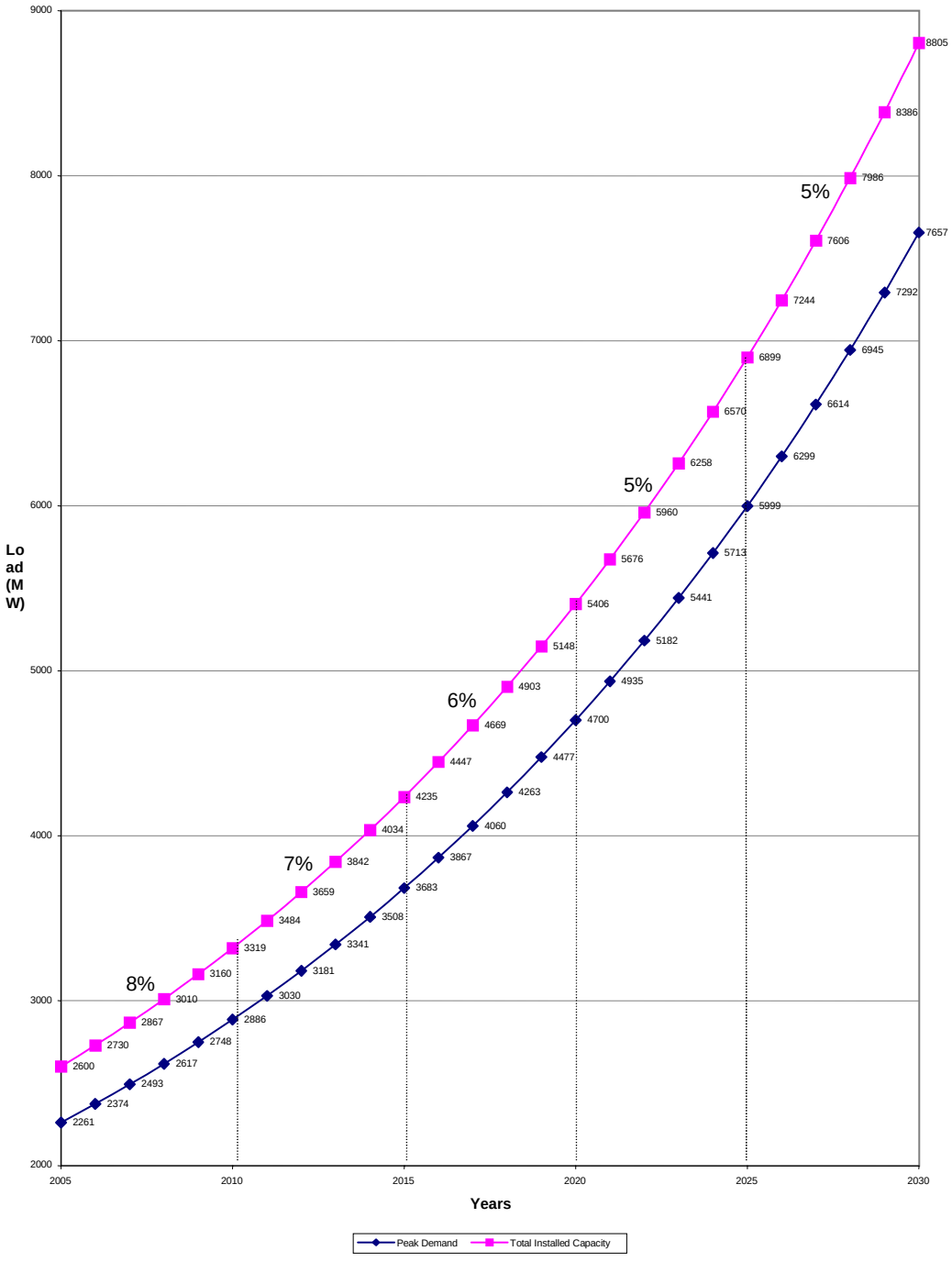
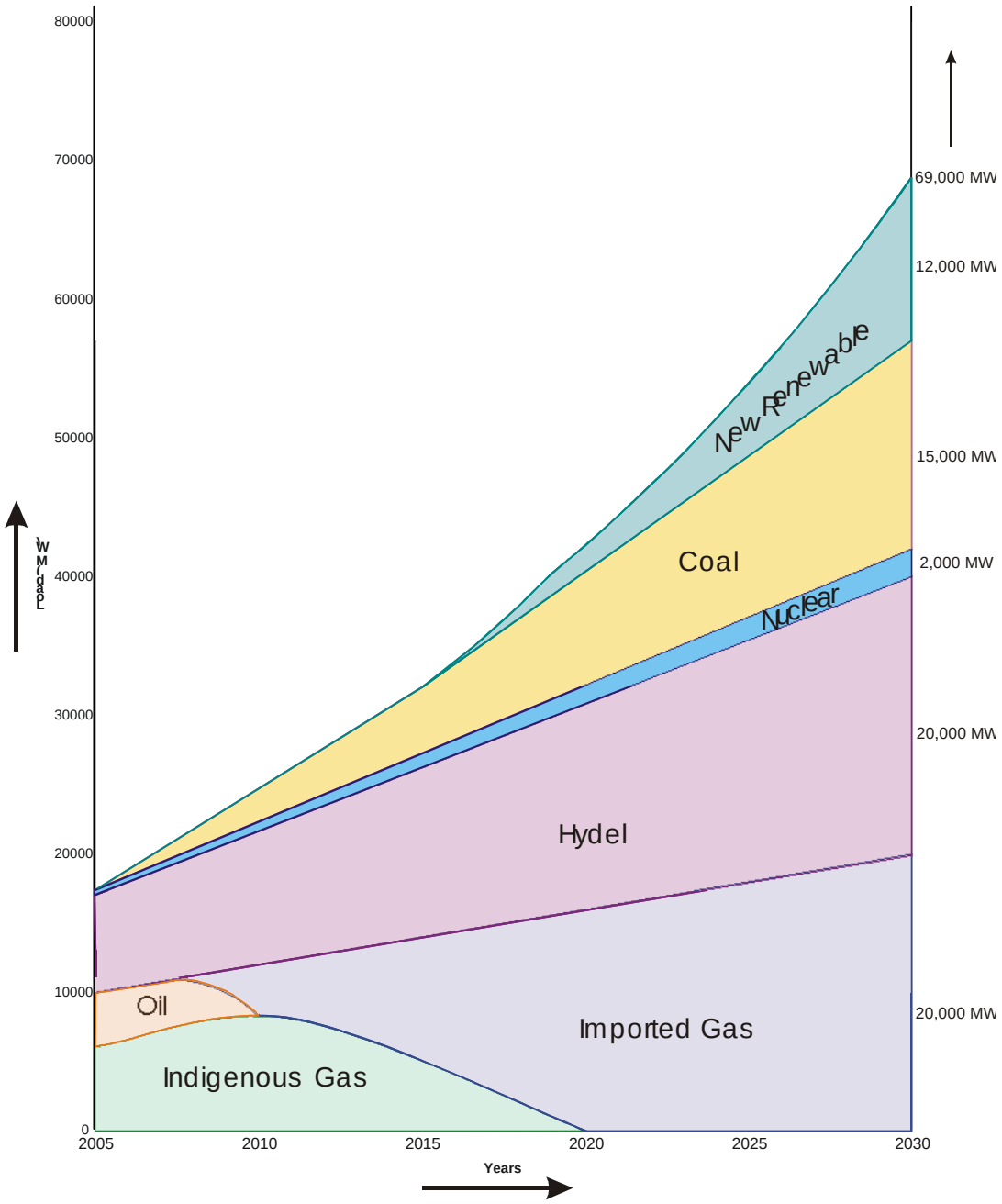


FIGURE 8: LOAD DEMAND AND INSTALLED CAPACITY FORECAST FOR WAPDA POWER (BASED ON LOW GROWTH



Even with modest growth rate as shown above, there may be severe power shortages if Projects to meet the growing load demand are not implemented in time.

9.3 It would not be out of place to clarify here that the estimated electricity load demand and the required installation capacity for power generation as worked out above for WAPDA and KESC system, is not an ambitious plan by any means compared to electricity consumption/capita of developed countries. It is

hardly sufficient to meet our minimum requirement to control increasing poverty, taking into account expected population growth rate.

10. SUMMARY

10.1 Virtually most of the governments of developing countries are not aware of forthcoming energy crises and lack in planning and implementation of projects. Without an efficient energy sector, there can be no development of industries. Government need to concentrate on energy sector to increase power generation from indigenous sources of hydel and coal and lay a pipe line from Iran to import gas to meet the shortfall. Pakistan cannot meet its energy requirements without import of gas from Iran.

10.2 Hydle has a big potential to meet our energy sources. Under vision 2025 GOP proposed to add 715 MW by the year 2010, which is not adequate. There is additional identified 15,000 MW of hydle power, which must be harnessed by the year 2025 for which GOP must streamline the policies.

10.3 Sindh has very large Coal reserves, which are sufficient to produce 20,000 MW of energy for 100 years. Although Thar Coal requires special technology due to high Sulphur and moisture contents but still it will be a viable solution being indigenous source. GOP need to streamline its long term policies to use abundant indigenous coal reserves to reduce dependency on costly imported fuels. In addition there is a rising pressure from the International donor agencies for environmental issues. Due to increased ratio of CO_2 coming from fossil fuel use in atmosphere which is a serious health hazard for human beings, restriction on use of fossil fuels are likely to be imposed in the near future even though they may be available in plenty. It is therefore essential that fossil fuel reserves specially Thar Coal should be exploited well in time otherwise they may remain unexplored due to restrictions likely to be imposed by International Agencies in the near future.

10.4 We cannot conserve Water unless big dams such as Bhasha, Sakardu and Kalabagh dams are built to save 38.5 MAF of surplus waste wasting into sea. All projects irrespective of their nature have positive and negative impacts and a project is declared viable if positive impacts over weigh the negative areas. Requirements for food and energy are increasing day by day. Government of Pakistan has not planned any strategy to meet with growing population and food requirements for the future. Kalabagh dam is held hostage to political issues, construction of which will not only produce electricity but will also meet emerging water shortages boasting agriculture production to save starvation and suffering of poor for the times to come. Time is approaching fast, when our agriculture will be deprived of water. There could not a more disconcerting situation than today when Army Rule has also left construction of Kalabagh Dam to public opinion and open debates in all communication medias creating a Kiosk situation. We have then all sorts of arguments in favour and against. Normally arguments against are more powerful, as they are based on vested interests and backed by Agencies. If we leave the technical evaluation to public for open debate as Government of Pakistan did in case of Kalabagh Dam, I assure you Sir, Pakistan cannot move an inch ahead. Not to talk of big Dams we cannot even construct a single flyover, an inch of motorway, and of

transmission lines etc. We can live without electricity but survival without water is inevitable. Striking in time is essential for survival of nations before calamity from Almighty God takes over.

10.5 Countries which will take initiative for research and development in new renewable energies will become suppliers of equipment and Projects to the developing and under developed world, strengthening economy of their country. Pakistan has taken initiative by establishing Pakistan Council of Renewable Energy Sources at Islamabad, where some research facilities are provided but this action is not enough. We should extend similar facilities of research in all the Engineering Universities of Pakistan, leading to Masters and Ph.D degrees in the field of Development of Non-conventional Renewable Energy Sources. Graduate Engineers shall also play their role in research once the facilities are made available at the university level.

10.6 Pakistan forest area is spread over 3.2% of the total, which needs to be increased in a scientific manner and is one the most affordable energy source for the poor in the rural areas.

10.7 Government of Pakistan should prepare long term energy plan spread over 50 years based on energy/capita requirement taking into account, population growth rate and than abstract short term plans out of it to be in line with the final target. In case of any lapses under the short term plan, the same should be recovered under the next plan period. Government of Pakistan has to streamline and channelize the energy policy for healthy development of economy, longer the Government waits to implement its development plan, the harder the task will be.