Electricity Crisis and the Significance of Indigenous Coal for Electric Power Generation

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ABSTRACT: *A few Asian countries such as Indonesia, China and Pakistan are coal-rich. It is estimated that the total coal reserves of these countries are over several billion tons, which makes them the richest nations of the world in respect of coal reserves. Coal reserves are present in all four provinces of these countries. The largest reservoir accounting to 175.5 billion tons of coal is in Thar area of Sindh province of Pakistan. Some regions despite having the enormous coal reserves, are facing acute shortage of Electricity. The Pakistan's electricity demand is rising at the rate of 11% annually, while incremental rate of production is fairly flat. Country heavily depends upon the import of oil for thermal power generation. Total Power Generation Capacity of Pakistan is approximately 19,855 MW among which 67.2% is generated from thermal sources (oil and gas), 29.4% from hydel and 3.3% from nuclear while coal accounts only for 0.1% which is far less as compared to the world's average of 40%. Due to increased cost of petroleum products, slow development of hydel and nuclear power generation and negligible development of Indigenous-Coal reservoir, country is facing severe energy crisis. The Coal reserves can become a main source for production of cheap electricity for the country and are the only reliable source to minimize the gap between consumption and generation of electricity. It is anticipated that, if properly utilized, these countries' Coal energy resources may generate at least 100,000 MW of electricity for the next few years. This paper provides the overview of electricity shortage, problems associated with energy-mix used for power generation and root causes of electricity shortage. It also highlights the importance, characteristics, and power generation capability of the Coal reservoir of these countries.*

Keywords: Electric Power, Energy Mix, Electricity shortage, Coal, Power generation

Received: 18 August 2014, Revised 25 September 2014, Accepted 2 October 2014

1. Introduction:

Indonesia, China and Pakistan are blessed with tremendous energy resources, these energy resources are distributed evenly from northern areas where there are a lot of geothermal energy resources [1] and snow covered mountains which are the cause of large rivers that flow down towards Arabian Sea in the South. In the southern region, energy resources like crude oil, coal, natural gas, geothermal, renewable energy resources including solar and wind energy are present in abundance. If we talk specifically about coal, Pakistan is the 6th coal enriched country in the whole world [2]. It is anticipated that if properly utilized, Pakistan's Coal resources may generate at least 100,000 MW of electricity, for the next 30 years [2]. Although, Pakistan is a coal-rich country but unfortunately, coal reservoir has not been developed for proper utilization. To boast the proper utilization of

Indigenous-Coal for power generation as well as for other industrial purposes, proper infrastructure, financing and modern coal mining technical expertise is required. There are huge resources of coal in all four provinces of Pakistan and in Azad Jammu & Kashmir. It is estimated that the total coal resources of Pakistan are more than 180 billion tones [3]. "*Table* 1", Shows the quantity and heating Value of coal reserves present in different provinces of Pakistan.

Province	Reserves in Million Tons	Heating Value (Btu/lb)
Sindh	184623	5219-13555
Balochistan	217	9637-15499
Punjab	235	9472-15801
KPK	91	9386-14217
AJK	9	7336-12338
Total	**185175**	

Source: Pakistan Energy Year Book 2003

Table 1. Quantity and Heating value of Indigenous-Coal

The largest coal reservoir in Pakistan is situated in Thar area of Sind province. The desert of Tharparker (Thar Desert) has about 175 billion tons of good quality coal [4]. China and Korea have shown great interest to build power plants based on these coal reserves. However, factors like road infrastructure, non-availability of fresh water and electricity infrastructure has hindered the development of the Thar Coal reserves [3]. The Thar Coal-field is located in the south-eastern part of Sindh. The first indication of the presence of coal beneath the sand of the Thar Desert was reported while drilling water wells by the British Overseas Development Agency (ODA) in coordination with the Sindh Arid Zone Development Authority (SAZDA), in year 1991 [2]. The Thar Coal-field covers an area of 9000 sq.km in the Thar Desert. Thar Coal quality and quantity is shown in "*Table* 2".

Specifications	Percent
Moisture	29.60-55.50
Ash content	02.90-11.50
Volatile Matter	23.10-36.60
Sulphur	00.40-02.90
Fixed Carbon	14.20-34.00
Heating value	
As received	6244-11045 **Btu/lb.**
Dry Basis	10723-11353 **Btu/lb.**
Coal reserves	**Million Tonnes**
Measured	2700
Indicated	9395
Inferred	50706
Hypothetical	112705
Total	**175506**

Source: Pakistan energy year Book 2010. The quality of coal is Lignite-B to Lignite-A

Table 2. Thar Coal specifications and quantity

Unfortunately, despite of this potential, Pakistan still imports coal to satisfy its demand. In 2004, Pakistan imported 1.7 million short tons and indigenously produced 3.5 million short tons of coal to satisfy its demand [3]. Recently, coal production in Pakistan has decreased by 7% in year 2009-2010, resulting overall decrease in coal supplies by 3% [5]. However, it is to be noted that power generation from coal has increased by 12% as compared to previous years.

2. Overview of Power Shortage

Presently in Pakistan, only about 55% population has access to electricity [13]. However, increasing urbanization and industrialization in the country has provided a great opportunity for expansion of the power sector [2]. Country is presently facing a serious energy crisis. There is acute shortage of electric power in a country. The nation is currently facing 5000 MW of electric power shortage [6]. This power shortage will become more severe in year 2012 and can reach up to 10785 MW. As shown in "*Table* 3" [7]. The occurrence of the prolonged and frequent electricity load-shedding has very bad impact on industry operation, especially on small industries which cannot afford excess investment on power generators, for backup power supply. The economy of a country and the living standard aof citizens are in very critical stage. This load-shedding is the major cause of unemployment, especially in cities like Fasalabad where labor works on daily wages in small industries. This shortage of electric power becomes more severe in summers and as a result of which load-shedding occurs usually 8 to 10 hours in urban areas while 16 to 18 hours in rural areas [3]. Power shortages are due to many reasons, for example, most of the installed power plants are either completely out of order or not capable to generate rated output power, due to inadequate maintain. Due to this problem, despite of the fact that total installed generation is 20922MW (2010 estimate) the firm power supply is only 15055MW, thus there is difference of about 5000MW.

Another major problem with the power sector of Pakistan is that it depends heavily on fuel-oil imports for power generation. Share of oil in power-generation mix is approximately 37.8%. Fuel-oil is the most expensive mean of generating electric power [8]. Due to the high fuel price and large power losses (approximately 35 %) as shown in "*Table* 4", generation cost becomes extremely high as compared to electricity tariffs, the utility companies then adds surplus charges on end user, which is a significant burden on the people of Pakistan. "*Table* 4" projects the power losses reported by Karachi Electric Supply Corporation. The nontechnical losses accounts for the electricity theft, especially in overpopulated areas of large cities like Karachi. **Item 2003, 2004, 2005, 2006** Transmission 6.0%, 5.8% ,5.2%, 5.2%

Year	Firm Supply MW	Peak Demand MW	Surplus Power MW
2007	15091	16548	1457
2008	15055	17689	2634
2009	15055	19080	4028
2010	15055	20584	5529
2011	15055	22205	7150
2012	15055	23953	8899
2013	15055	25840	10785

Source: Private Power and infrastructure board.
Table 3: Firm Supply verse Peak Demand (MW), in Pakistan

Item	2003	2004	2005	2006
Transmission	6.0%	5.8%	5.2%	5.2%
Distribution (Technical)	17.5%	17.2%	15.0%	14.8%
Distribution (Non-technical)	17.3%	14.8%	14%	15%
Total Losses	**40.8%**	**37.8%**	**34.2%**	**35%**

Source: Karachi Electric Supply Corporation Limited.
Table 4. Percentage of Network power losses

3. Energy-mix used for Power Generation

Although, Pakistan has numerous energy resources but energy-mix used by power generation sector in Pakistan depends heavily on fuel-oil imports. About a decade ago Pakistan was self-sufficient in natural gas but presently due to economic growth, urbanization, and conversion of thousands of transportation vehicles from fuel-oil to Compressed Natural Gas (CNG) has compelled the nation towards the import of natural gas as well. Detail of energy-mix used for power generation in Pakistan is provided as follow.

3.1. Fuel Oil

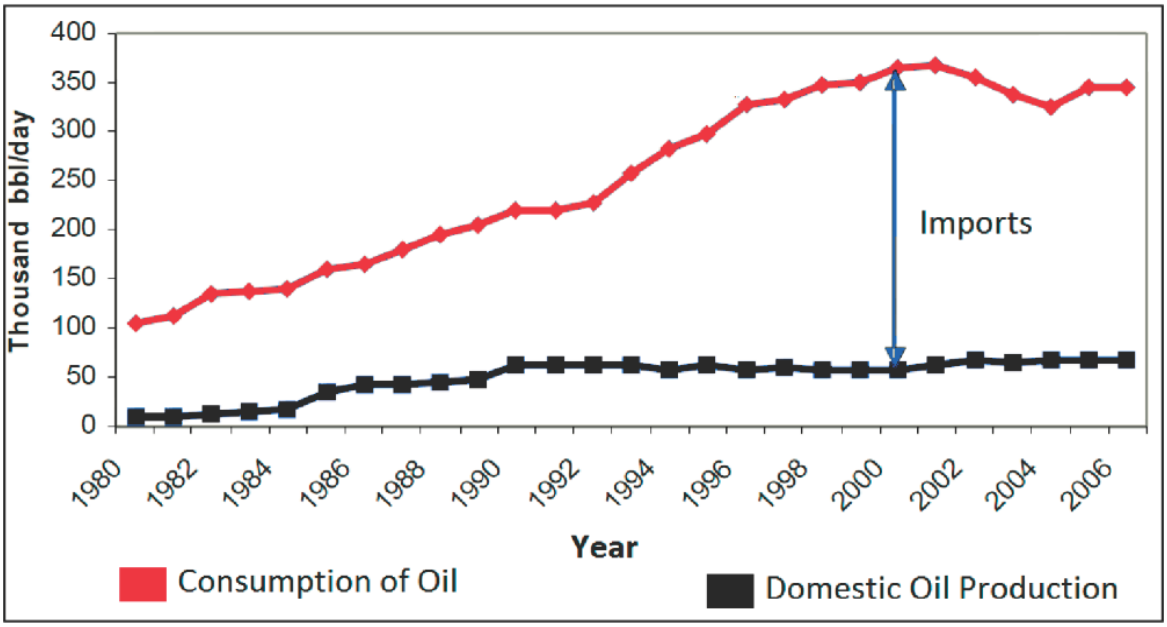
With rising fuel oil prices in the global market, contribution of oil in power generation has reduced substantially over past three decades, worldwide. In 1970's, the contribution of oil in world's total power generation was almost 25% which has been reduced only to 6.6% in year 2005 [8]. If we consider Pakistan, share of oil in power generation has increased from 32.2% in year 2008 to 37.8% in year 2010, as shown in "*Chart* 1".

Pakistan has not explored its new oil fields since late 1980s, as a result of which increment in oil production has remained fairly flat at approximately 60,000 barrels per day [4]. Due to Pakistan's modest oil production, the country is dependent on oil imports to satisfy domestic oil demand. In year 2006, Pakistan had consumed approximately 350 thousand barrels of oil and various other petroleum products, of which more than 80 percent were imported [4]. The majority of oil imports come from the Middle East, with Saudi Arabia as the lead exporter [9]. Pakistan state bank paid $6.7 billion for oil imports during the year 2005-2006 [4]. "Figure 1" shows the difference between oil production and oil consumption, in Pakistan.

3.2. Natural Gas sector

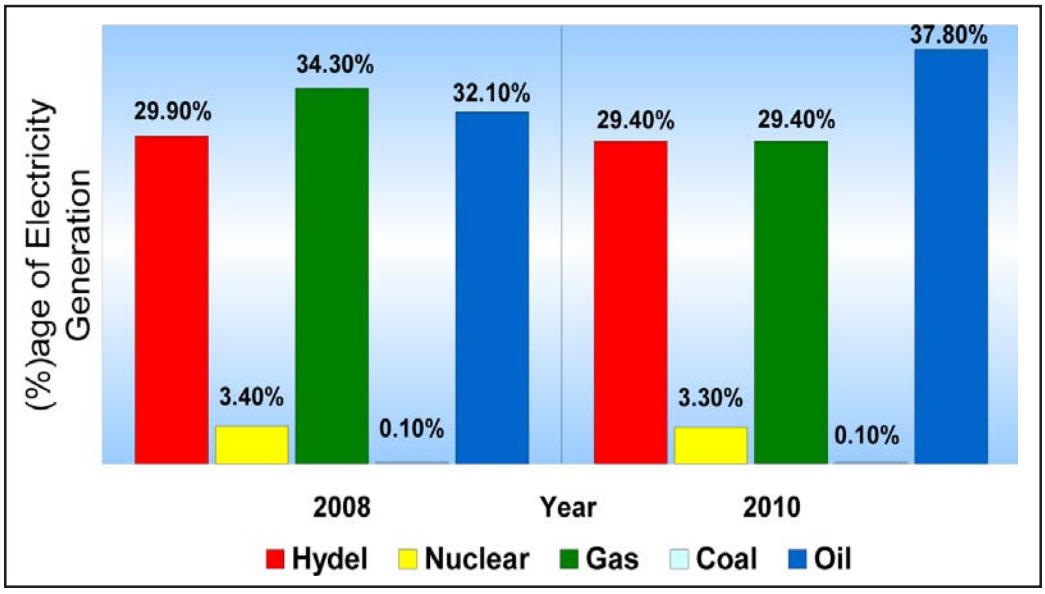
Just like fuel-oil Pakistan is also heavily dependent on natural gas for its energy needs, as shown in "*figure* 2". However, domestic production of natural is very high as compared to fuel-oil. Gas contributes 29% of the total electric power generation in the country, as shown in "*Chart* 1" and 31.9 % of total energy consumption, as shown in "*Chart* 2". Presently, Pakistan consumes all of its domestic natural gas production. In near future, Pakistan will become a natural gas importer, due to rapidly increasing gap in production and consumption. As a result, now government is exploring several pipeline and LNG import options to meet the expected growth in natural gas demand.

Demand for natural gas in Pakistan has increased by almost 10% annually from 2001 to 2008, reaching around 3,200 Millions of



Source: Pakistan energy year book 2006-2007

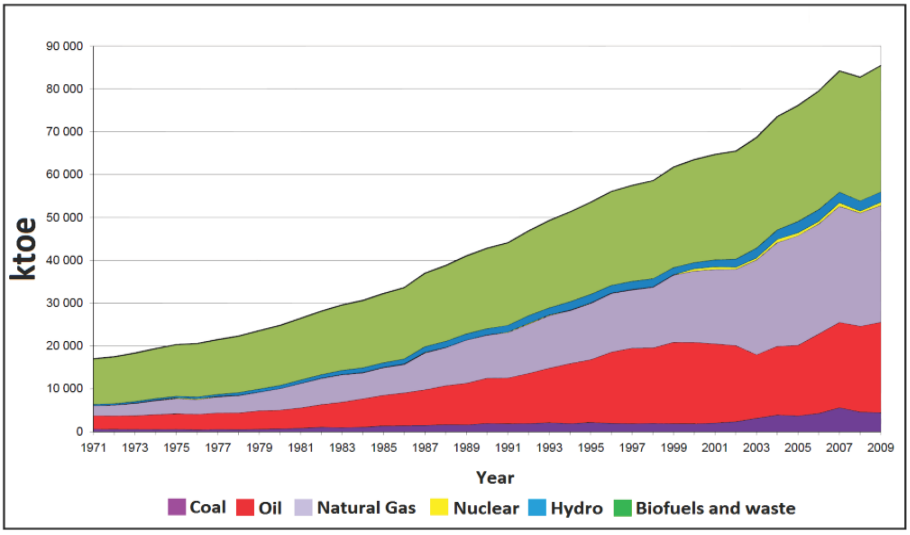
Figure 1. Domestic production, total consumption and imports of fuel-oil in Pakistan



Source: Pakistan energy year book 2008 and 2010

Chart 1. Comparison of energy-mix used for power generation in Pakistan during the year 2008 and 2010

cubic feet per day (MMCFD), against the total production of 3,774 MMCFD. But, during 2008-2009, the demand for natural gas exceeded the available supply, with production of 4,528 MMCFD gas against demand for 4,731 MMCFD, indicating a shortfall of 203 MMCFD. The gas supply-demand imbalance is expected to grow every year to cripple the economy by 2025, when shortage will be 11,092, against total 13,259 MMCFD productions [5].

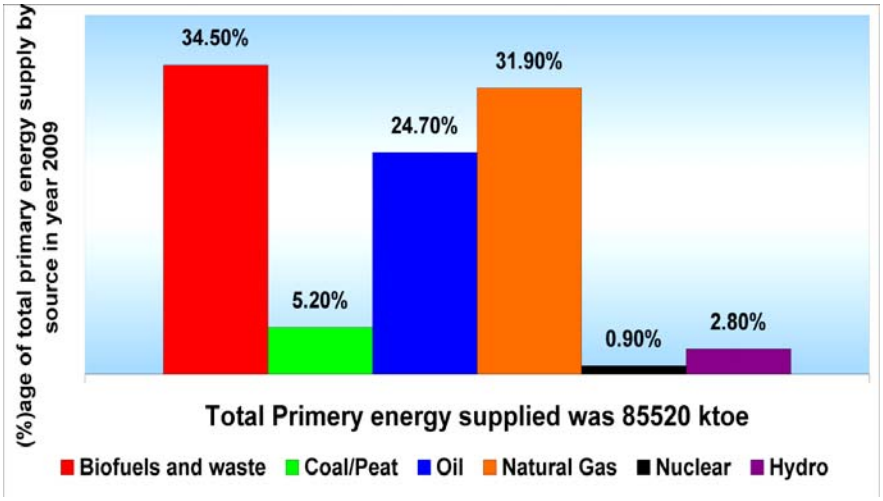


Source: International Energy agency 2011, Ktoe stands for Tons of Oil Equivalent

Figure 2. Total primary energy supply in Pakistan in year 2011

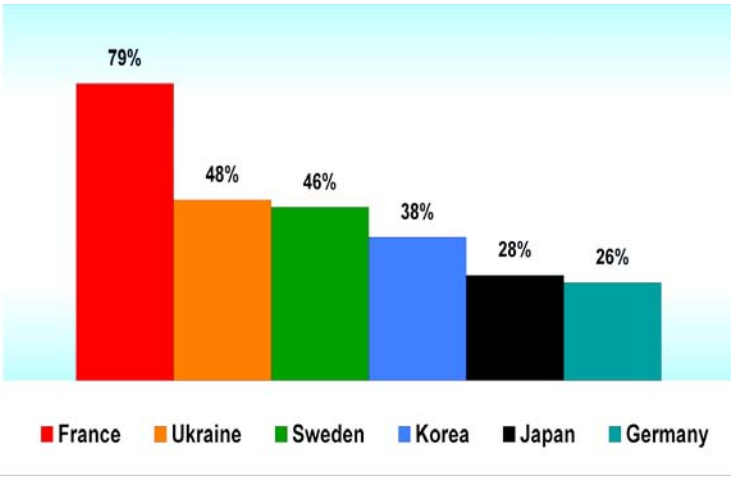
3.3. Nuclear Power Generation

Pakistan is one of the 30 nations in the world, which have reposed confidence in Nuclear Power Plants. Worldwide, total installed power generation capacity of Nuclear Power Plants stood at 375,000 MW at the end of 2010, having 442 operational Nuclear Power Plants [3]. Nuclear power generation has gained significant popularity in recent years. In 1970s only 3.3% of total electric power production was based on Nuclear power, worldwide. However, presently it has reached to 15%. In recent years China and India have made huge investments in Nuclear Power Plants. China has 11 Nuclear Power Plants with capacity of 9000 MW while India has 20 Nuclear Power Plants having power output of about 4780 MW. Nuclear electricity is the most dominant part of electric energy in France where 79% of the total electricity is generated from Nuclear Power Plants, as shown in "*Chart* 3".



Source: IEA 2011, Note share of under 0.1% are not included.
Chart 2. Total primary energy supply by source in Pakistan, during 2009

Pakistan is a country having more than 110 nuclear war heads but unfortunately, only about 3% of the total electricity in Pakistan is generated from nuclear fuel. There are three operational Nuclear Power Reactors in Pakistan namely KANUPP, CHASNUPP-1 and CHASNUPP-2, as shown in "Table 5". Country has also drawn up plans to import more Nuclear Power Plants from China. Currently, country heavily depends upon China for Nuclear Power Generation. In order to make the Nation self-sufficient in nuclear fuel, a facility is being developed, which will use locally available Uranium-ore to produce 350 tons of nuclear fuel annually, starting from year 2015 [3].



Source: International Energy Agency
Chart 3. Percentage of Nuclear electricity in power generation-mix, in some developed countries

3.4. Hydel Generation

Pakistan's water resources have rich potential for hydropower generation, it is estimated that 60000 MW of electric power can be generated economically from these resources. But so far only 11% of this cheap resource has been developed [10]. The country is situated between the Arabian Sea and the snow covered mountains like Himalayas, Hindu Kush and Karakoram Mountain Ranges. The hydropower resources in Pakistan are mainly located in the mountainous areas in northern region of the country. The Water and Power Development Authority (WAPDA) controls the major hydroelectric plants.

Hydropower development in the area now in Pakistan started in 1925 with the construction of 1 MW Renala Khurd hydropower station. At the time of independence, Pakistan inherited a very small power base of around 60 MW capacities for its 31.5 million people. At the time of creation of WAPDA in 1958, the country's total hydropower capacity was enhanced to 119 MW. With the signing of Indus Basin Water Treaty in 1960, Pakistan was entitled to use Indus, Jhelum and Chenab River. Pakistan is an

Name	Type	Rating MW	Operational Since	Planned Close
Kanupp	PHWR	125	1972	2019
Chasnupp 1	PWR	300	2000	2040
Chasnupp 2	PWR	300	2011	2051
Total		**725**		

Source: Pakistan Atomic Energy Commission
Table 5. Operational Nuclear Power Reactors in Pakistan

agriculture based economy, therefore, hydropower is one of the best available option for Pakistan because apart from electricity, there is acute shortage of water for irrigation and drinking purposes as well. The total installed capacity of hydropower projects in the country up till 2010 was 6720 MW out of which 3849 MW is in Khyber Pakhtunkhwa province, 1699 MW in Punjab, 1039 MW in AJ&K and 133 MW in the Gilgit-Baltistan. The largest hydropower plant is Tarbela hydroelectric plant with installed capacity of 3046MW. Other large hydroelectric plants include Mangla having 1000MW installed capacity, Warsak 240MW and Chasma 184 MW. The WAPDA is vigorously carrying out feasibility studies and engineering designs for various hydropower projects, in different part of country, with accumulative generation capacity of more than 25000 MW [10]. Most of these studies are at an advance stage of completion. After the completion of these projects the installed capacity would rise to around 42000 MW by the end of the year 2020 [10].

Sr.No	River/Tributary	Power(MW)
A	**Hydropower Projects above 50 MW**	
1	Indus River and its Tributary	44334
2	Jhelum River	4341
3	Kunhar River	1455
4	Neelum River and its Tributary	1769
5	Poonch River	462
6	Swat River and its Tributary	2297
7	Chitral River and its Tributary	2285
B	**Projects below 50 MW**	
8	On Tributary	1591
9	On Canals	674
Total		**59208**

Source: Hydroelectric potential of Pakistan [10]
Table 6. Summary of Hydropower Potential in Pakistan (River wise)

Hydel electricity is considered cheaper source as compared to thermal sources. Pakistan is blessed with ample water resources. Unfortunately, it could store only 13% of the annual flow of its rivers. The storage is fast depleting due to sedimentation. In contrast, US has developed 497% storage capacity of annual flow of River Colorado, Egypt possesses 281% of River Nile and India 35% on Sutlej-Bias Basin. There is intense need to construction number of dams to enhance availability of water in Pakistan.

The hydropower potential in Pakistan is over 100,000 MW with identified sites of 59000 MW as shown in "*Table* 6". However, political instability in a country is one of the major causes of slow development of hydroelectric power generation. If we talk specifically about the propose project of Kalabagh Hydroelectric Project (3,600 MW capacity). This Project was designed in 1984, with the assistance of the United Nations Development Program, supervised by the World Bank, for the client WAPDA. Following the submission of its Project Planning Report it was put up to the Federal and Provincial Governments for approval of the launching of this gigantic project. It was estimated to be completed in 6 years, with first generating unit to be commissioned in April 1993. But unfortunately, this program could not be materialized due to opposition from some provincial parties, mainly on political grounds. On May 26, 2008, Federal Minister for Water and Power of Pakistan, Raja Pervez Ashraf said that the "*Kalabagh Dam would not be constructed*" and the project have been cancelled.

Coal-fields	Power Generation Potential (MW)	Consumption Million Tonnes/ Year
Sindh Province		
1. Thar	100000	53600
2. Lakhra	1000	460
3. Sonda	500	230
Balochistan Province		
4. Sor-Range-Degari	50	0.13
5. Sharigh-Khost	50	0.13
6. Mach	25	0.06
7. Duki	25	0.06
Punjab Province		
8. Salt-Range	80	0.35
9. Makarwal	50	0.13
KPK Province		
10. Hangu/Cherat	10	1.03
Total	101790	54292

Source: Pakistan energy year Book 2010

Table 7. Power Generation Potential of Indigenous-Coal of Pakistan

However, the large ongoing project of Diamer-Bhasha Dam in northern part of Pakistan and some other medium and small scale hydroelectric projects in other parts of Pakistan are worthy step of the Government of Pakistan to overcome shortage of electric power in country. Foundation stone of Diamer-Bhasha Dam was laid by Prime Minister, Yousaf Raza Gilani on 18 October 2011. Upon completion, Diamer-Bhasha Dam would be the highest RCC dam in the world. The dam site is situated near a place called "*Bhasha" in Gilgit-Baltistan's District*". Upon completion, Diamer-Bhasha Dam will produce 4,500 megawatts of electric power as well as 8,500,000 acre feet of water that would be used for irrigation and drinking purposes. [11].

3.5. Coal Power Generation

Coal is the world's most abundant and widely distributed fossil fuel with global proven reserves of nearly 1000 billion tones [9]. Due to cheaper price as compared to oil and gas, and easy availability all over the world, coal has been a key component of the electricity generation mix, worldwide. More than 40% of the world's electricity is fueled by coal. This figure is much higher in many countries, such as South Africa in which almost 93% of the total electricity is generated by coal driven power plants, similarly, 92% in Poland, 79% in China, 69% in India and 49% in US. Moreover, the growing energy needs of the developing world are likely to ensure that coal will remain a key component of the power generation mix in the foreseeable future, regardless of climate change policy [9]. However, coal currently plays a minor role in Pakistan's electricity generation mix. Only 0.1% of the total power generation in Pakistan is based on coal which is negligible as compared to the world average of 40%. Although, the country contains an estimated 185 billion tons of proven recoverable reserves but Pakistan still imports coal for industrial sector as well as for power generation. In 2002, Government of Pakistan issued a new policy to promote power generation from indigenously produced coal for a total capacity of 2600 MW but, despite of large interest from both foreign and local investors, progress seems to be very slow. By 2010, it was targeted to add 900 MW coal-based electric power into National-Grid but not a single megawatt has been added till now. It is imperative therefore, for the government to earnestly review, evaluate and determine the policies. If we talk specifically about Under Ground Coal Gasification (UCG) Pilot Project of 2x50 MW power plants in Thar area, the project is being implemented and managed under the chairmanship of Dr. Samar Mubarakmand (a renowned nuclear scientist of Pakistan). On 24 January, 2012, Dr.Samar Mubarakmand has said that the finance ministry is not issuing the funds despite the directives of the President and the Prime Minister. He further said that Rs.1 billion has been spent on the projected and Rs.2 billion is needed immediately. The finance ministry has not issued a single rupee during the current fiscal year [12].

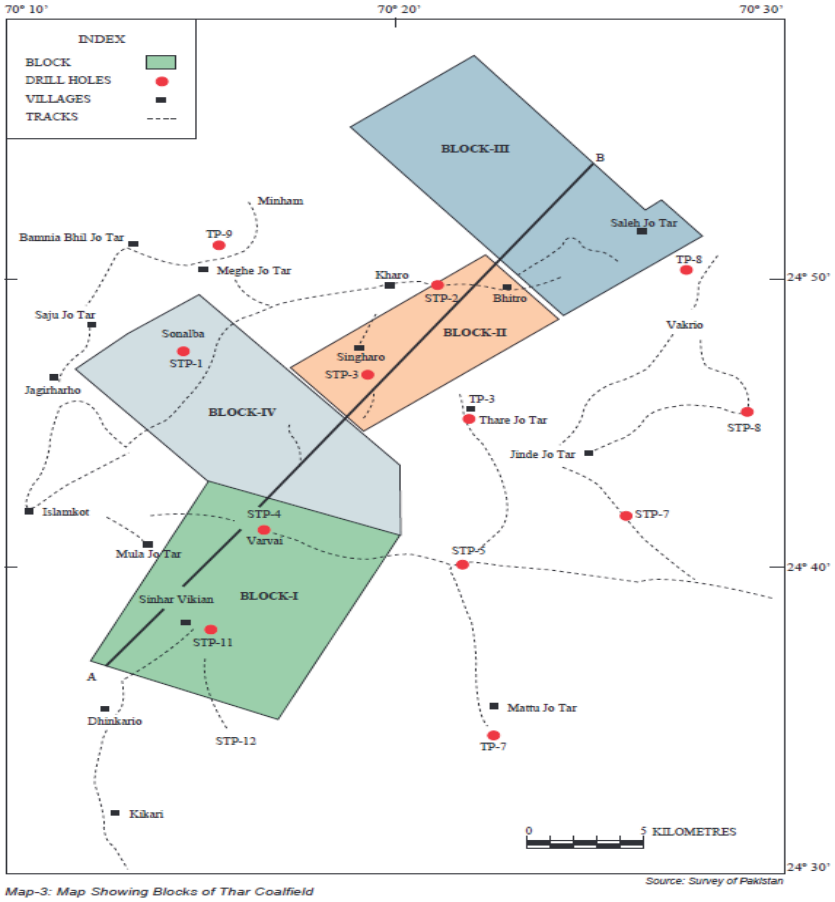
4. Coal power potential

As mentioned earlier that there is a vast coal power potential in Pakistan. The Thar Coal-field is the largest coal-field and is capable to generate enough electricity to completely satisfy the power demand of Pakistan for more than three decades. But unfortunately, this Coal- field is not properly developed yet. The bulk of Pakistan's Indigenous-Coal resources lie in Sindh province due to the presence of Thar Coal-fields. Although, 21 years have passed since after the discovery of Thar Coal

Blocks	Measured	Indicated	Inferred	Total
Block 1	620	1918	1028	3566
Block2	640	944	-	1584
Block3	413	1337	258	2008
Block4	684	1711	76	2471
Total	2357	5910	1362	9629

Source: Pakistan energy year Book 2010

Table 8: Coal reserves in Million Tons in four blocks of Thar Coal-field



Map-3: Map Showing Blocks of Thar Coalfield

Source: Geological survey of Pakistan 2010

Map 1: Four blocks of Thar Coalfields

reservoir, but this reservoir is yet to be investigated and developed for mining and power generation purposes. However, Lakhra, Sonda, Indus East and other coal-fields of Sindh province are comparatively more developed. Lakhra Coal-field is thoroughly investigated and comparatively more developed among all. Several public and private mining companies are already mining coal from Lakhra Coal-field. It has been confirmed that Lakhra Coal is suitable for power generation because already 150 MW of Coal Fired Plant is currently being operated by WAPDA on Lakhra coal [2]. In the provinces of Balochistan and Punjab, coal has been continuously mined since before independence in year 1947. Good quality Sub-bituminous Coal is available in various coal-fields of Balochistan and Punjab. However, due to political uncertainty in Balochistan province and small quantity of coal in Punjab province, these reserves are not suitable for large scale power generation. Some small coal reserves are also located in KPK and AJK, and are being mined on a small scale. On the basis of available mineable coal reserves, a tentative estimate of power generation potential and quantity requirement of an Indigenous Coal is set forth in "*Table* 7".

4.1. Thar Coal

The Thar Coal-field is located in the south-eastern part of Sindh province of Pakistan. The first indication of the presence of coal beneath the sands of the Thar Desert was reported first time in year 1991, while drilling water wells by the British Overseas Development Agency, in coordination with the Sindh Arid Zone Development Authority. The Thar Coal-field, with a resource potential of over 175.5 billion tons of coal, is expanded in an area of almost 9000Km2 in the Tharparker Desert. The mineable coal reserves are estimated to be 1,620 million tons. The coal-bearing area is covered by stable sand dunes. In order to establish the coal resources in the selected four blocks a total of 167 holes were drilled at one kilometer spacing as shown in "*Map* 1". Coal resources of the four blocks are estimated at 9,629 million tons, as shown below in "*Table* 8".

The number of coal-seams varies from hole to hole, and a maximum of 20 Seams have been logged in some of the drill holes. The thickness of coal-seams varies from 0.2 to 22.8 meters, wherein the cumulative coal thickness in one of the drill holes is found to be 36 meters. The thickness of overburden varies from 112 to 203 meters. Thar Coal reserves and chemical analysis of the coal samples are shown in "*Table* 2" on page 2.

4.2. Proposed subjections for Coal Power Generation

Due to the presence of large moisture content in Thar Coal (29.60-55.50 %), it is important to consider following factors:

a) The power station must be located at the mine site, so that low energy and high moisture content of lignite coal could be justified by decreasing the transportation cost.

b) As Tharparker Desert is a remote area, therefore, ultra high voltage Transmission line should be used to limit Transmission line losses.

c) Lignite coal has certain characteristics which require special consideration when selecting the type of equipment for mining and power generation, High moisture content reduces the efficiency of power generation. The elements present like sodium can cause severe slugging and fouling problems in conventional boiler. Therefore, these factors should be taken into consideration while purchasing the power generation equipment epically the boilers used in steam turbines. Despite these problems, lignite coal is used extensively for power generation throughout the world.

5. Conclusion

As, Pakistan is blessed with plenty of natural resources therefore, country instead of relying heavily on fuel-oil imports for Electric Power Generation, should develop its own resources to satisfy power demand. It is observed that percentage of fuel-oil in energy mix has increased significantly in past decade, which is not in the favor of the already depressed economy of Pakistan, to limit dependency of a country on fuel imports, government should have to make a new policy to limit fuel-oil based thermal power plants. Presently, Coal reserves of Pakistan are the only solution to this electricity crisis in the country. The Indigenous-Coal especially Thar Coal has capability to energize Pakistan's National Grid for many decades. Although other resources like hydel power generation has the same potential but the political issues are the main hindrance in a way to success. Nuclear generation is a security risk for a country which is on the hit list of terrorists. Natural gas resources are also under stress due to large consumption of natural gas in residential and transport sector. Renewable energy resources like solar and wind are much expensive choice for a developing country like Pakistan. Therefore, Indigenous-Coal reserves of Pakistan have only left as the most economical and the only self-sufficient source of power generation on large scale to overcome the electricity shortage. As, Thar Coal-field is generally located in remote and semi-desert area where the basic amenities of life such as roads, railways, telephone lines and cooling water required for mining and setting up Coal Power Plants are either minimal or absent. So, massive investments for development of infrastructure are needed. Therefore, the Government of Pakistan must take bold steps towards the development of infrastructure for mining Thar Coal and development of power plants. Financing and technology access must also be addressed. Apart from further power generation, adequate maintenance of previously installed power stations, transmission lines and distribution system is also required to overcome the electricity crises in the country.

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