J. Basic. Appl. Sci. Res., 4(4)147-154, 2014

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

Effect of Coal Fired Gadani Power Project on Energy Crisis in Pakistan

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Received: February 12 2014
Accepted: March 23 2014

ABSTRACT

This paper finds the effect of six thousand six hundred megawatt Gadani Power Project on the energy crisis in Pakistan. First of all the reasons of the energy crisis in Pakistan are identified to evaluate the effect of this project. The biggest reasons of the energy crisis in Pakistan is circular debt that is generated mainly due to (1) The Effect of 1994 Energy Policy (2) Increasing Fuel Prices (3) Electricity Theft (Transmission & Distribution Losses) (4) Change is Generation Mix (shifting to expensive fuel). The paper also discusses the effect of the Gadani Power Project on energy mix, electricity price and situation of the energy crisis after the completion of this Project.

KEYWORDS: Energy Crisis, Circular Debt, Fuel Price, Gadani Power Project, energy mix

INTRODUCTION

At the time of independence, Pakistan has a population of 31.5 million and gets only 60 MW [22] of generation capacity. In 1959, Water and Power Development Authority (WAPDA) was created after twelve years of independence. The authority was created with the mission to coordinate the development of water and power projects; that were previously managed by the provinces through their Electricity and irrigation department.

WAPDA had taken the challenge to develop the water and power system of the country and executed many thermal and hydel projects to cope the rising energy needs. With the commitment and dedication of WAPDA, in just five years, generation capacity rose almost six times to 636 MW [22]. The success story continues and generation capacity was increased to 1331 MW [22] till 1970. In 1980, system capacity touched 3,000 MW that rapidly rose to 7,000 MW [22] in 1990-91.

In 1993-94, the government has decided to stop to installation of new public sector power plants and called the Independent Power Producers (IPPs). In this regard, first power policy was introduced in 1994. After the launch of this 1994 power policy, many IPPs installed the power plants in the country. By year 2000-01, 3113 MW [24] generation was added by the IPPs installed under this policy. Although it has invited Foreign Direct Investment (FDI) in the country; but badly damaged the energy mix of the country. Second Power policy was introduced in 2002, known as Power Policy 2002. This policy is currently implemented and new power plants are being installed under this policy. At present, Pakistan's total installed capacity is 22,797 MW. During last year the capacity factor [6] of WAPDA operated power stations were only 32.9%, IPPs 50.8%, KESC plants 45.9%, nuclear Plants 49.6% and that of hydel plants were 56%. The thermal IPPs can operate at 60% capacity factor as per their agreement with WAPDA [11].

In China 65 % [28] of total electricity is produced on coal while world's 40% [28] power generation is coal fueled; whereas in Pakistan, electricity generation on coal is almost zero [6]. The electricity on solar and wind is also not much in china due to its low capacity factor. In Pakistan, we have potential of both solar and wind but it is needed to analyze these with respect to their capacity factor.

We will further discuss the reasons of the energy crisis in Pakistan and its possible solutions in below sections. We will also discuss that how to make the tariff of new power plants under the 2002 power policy.

Research Purpose

Identify the reasons of the energy crisis in Pakistan and find out the effect of Gadani Power Project on prevailing energy crisis in Pakistan.

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LITERATURE REVIEW

There are two reasons of circular debt; first is insufficient tariff and second is problem during recovery from customers [1]. Author supports the second point with the data of Energy year book that WAPDA has suffered a transmission and distribution loss of 330 billion rupees during FY 2011-12.

The reserves of fossils fuels are diminishing and putting stress on present reserves. He also suggests that there is a need to shift from fossil fuel to renewable fuel. He also discussed the switch over from fossil fuel to renewable resources in Pakistan [22]. The energy resources will be the biggest challenge for the next century. It will be required to shift to alternate and renewable energy resources [4]. The share of conventional energy is much higher in Pakistan as compared to the renewable energy. The share of renewable energy is fractional in the country [3]. We all support the first point that fossil fuel reserves are depleting and data also shows that furnace oil price has increased from 9,700 rupees/ton to 72,000 rupees per ton in last 12 years. We also agrees that share of electricity generation is higher is Pakistan as compared to renewable resources. Author argues that presently, the conversion from fossil fuel to renewable is not feasible for Pakistan because the capacity factor of wind and solar are lower that increases its capacity purchase price. The estimated capacity factor for wind and solar power plants in Pakistan are 28% [27] and 25.8% [8] respectively whereas that of thermal plants is higher. But on small scale, it's very useful to install solar cells or wind mills. It can also be added in long term plan.

ENERGY MIX & 1994 POWER POLICY

The following graph is self-explanatory that in 1994-95, from total installed capacity of 12,100 MW, 5,000 MW were of Hydel. After the installation of IPPs (based on 1994 Power Policy), total generation rose to 17,799 MW in 2000-01 but Hydel stayed at same 5,000 MW. The mismanagement continues and in 2011-12, out of total installed capacity of 22,797 MW hydel is around 6,500 MW. This shows that how the energy mix was damaged and the overall unit price increased (Figure-1 Source: Energy Year Book 2012, Page # 82).

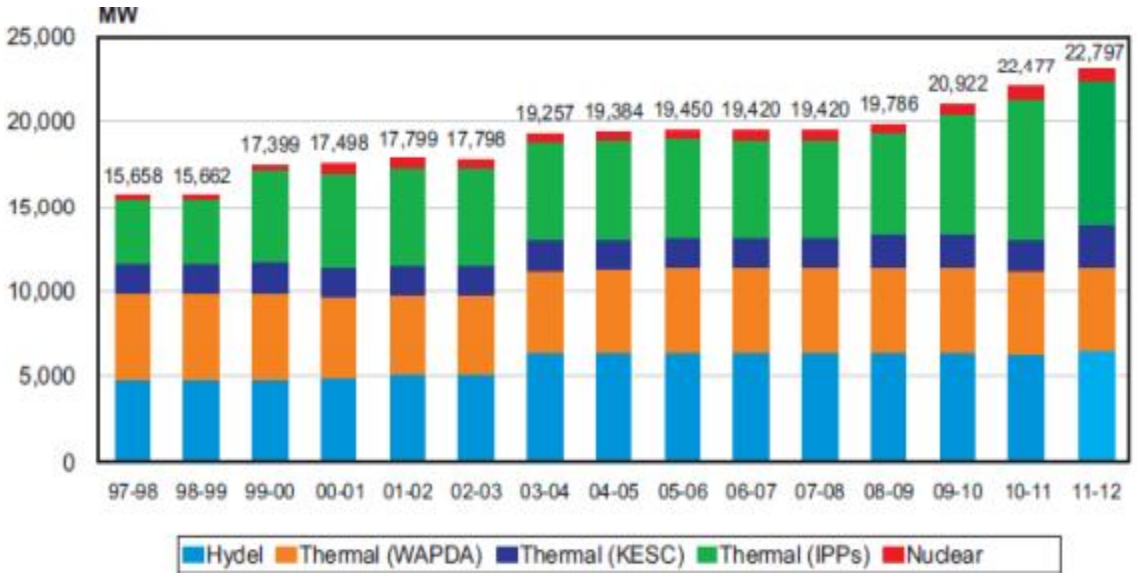

Figure 1 Electricity Installed Capacity by Type [6]

INCREASE IN FUEL PRICES & CONSUMPTION

As the energy mix shifted from Hydel to oil fired thermal plant. Global oil prices increased rapidly that also put a significant impact on fuel prices in the country. The following is the trend of price of Furnace Oil that is mostly used for electricity generation on liquid fuel. (Prices are without GST)

Consumption of Fuel oil has also increased during last decade. In 2002-03, 24, 353 GWH electricity (32.17% of total generation) was produced by oil that was increased to 33,562 GWH (35.3% of total generation) in 2011-12.

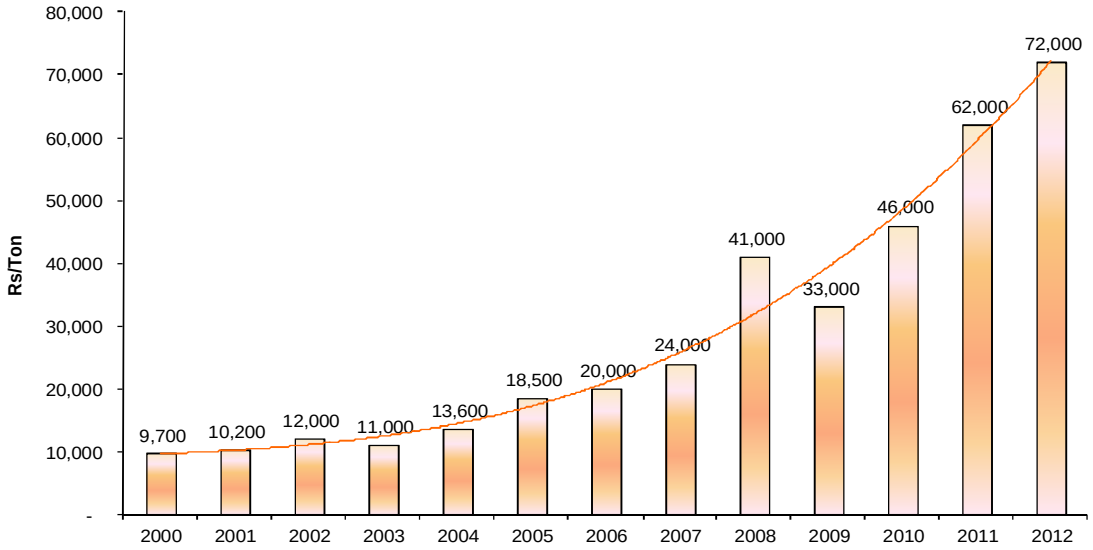

Figure 2 History of Fuel Prices [10]

The following table clarifies the effect of fuel price rise on the cost of electricity generation:

Table 1 Calculation of Electricity Cost on Oil [6]

Year	2002-03	2011-12
Total Electricity Produced (GWH)	75,682	95,091
Electricity Produced by Oil (GWH)	24,353	30,818
Oil Consumed (Ton)	6,019,958	7,594,663
Oil Consumed (gm/unit)	247.20	246.44
Fuel Price (Rs/Ton) [10]	13,920	83,520
Electricity Price (Rs/unit)	3.44	20.58

TRANSMISSION & DISTRIBUTION LOSSES

Another reason of the energy crisis is Transmission and Distribution losses that are majorly electricity theft. The Transmission & Distribution (T&D) losses were 20,043 GWH in 2002-03 and that were 16,054 GWH in 2011-12. Although T&D losses are less as compared to 2002-03 but it's still 16.90% of total generation. Second reason of its significant effect is increase in electricity generation cost. "Note: One GWH is equal to one million units."

Following table describes how the T&D losses are impacting the overall system:

Table 2 Transmission & Distribution Losses [6]

T&D Losses	2002-03	2011-12
Cost of electricity (Rs/GWH)	3,440,965	20,582,330
T&D Losses (GWH)	20,043	16,054
T&D Losses (Billion Rs)	68.97	330.43

The above calculation shows that approximately Electricity of 1 Billion rupees is being theft is Pakistan on daily basis.

THE GENERATION MIX

The generation mix has also changed during last few years. In 2005, 52% of total electricity was produced by gas. Now in 2012, that has reduced to 26% and load has been shifted to expensive oil.

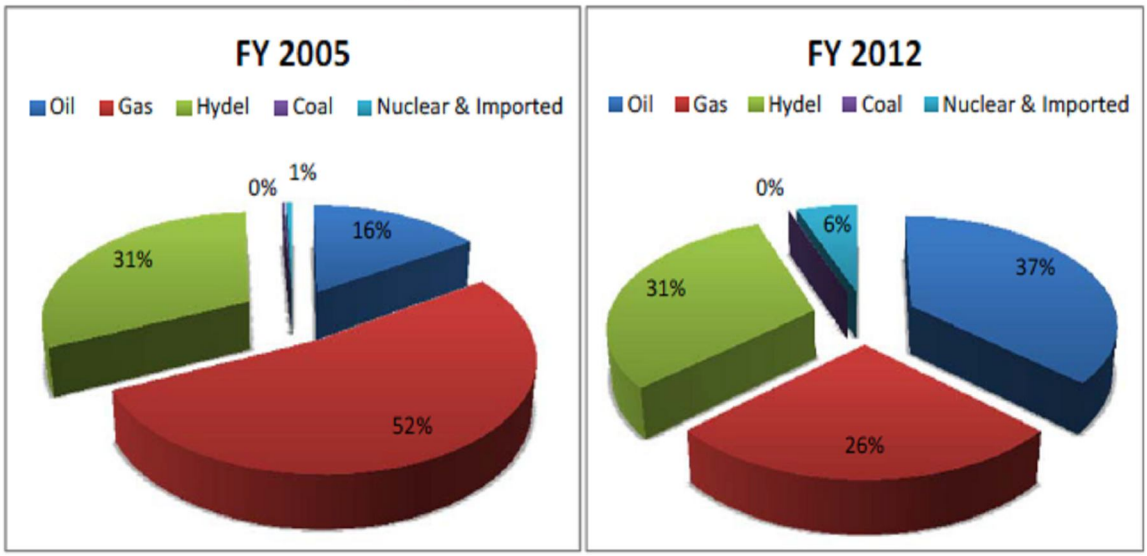

Figure-3 Generation Mix [7]

Following Tables shows the difference of gas price and oil price:

Table 3 [10]

Calculation of Oil Price (Rs/Million Btu)	
Furnace Oil Price (Rs/Ton)	83,520
Furnace Oil CV (Btu/Kg)	38,000
Furnace Oil Price (Rs/MM Btu)	2,198

Table 4 [26]

Type of Fuel	Price (Rs/Million Btu)
Furnace Oil	2,198
Gas for IPPs	488.23
Gas for CNG	656.52

THE CIRCULAR DEBT

As the Fuel prices increases from 2005, circular debt situation worsened in the country. Following table shows how the circular debt increased from 2005 to 2013.

Table 5 Circular Debt in Pakistan [7]

Year	Rs (in Billions)
2006	84.07
2007	111.26
2008	144.99
2009	161.21
2010	235.65
2011	365.66
2012	537.53
2013	872.41

CONCLUSION FOR REASONS OF ENERGY CRISIS

From above data, following reasons has been identified for the energy crisis in Pakistan:

- After the implementation of 1994 energy policy, attention was not given to indigenous resources like hydel. IPPs were called for installation of thermal power plants that have increased the overall electricity cost.
- Fuel prices have increased globally from 2005 onwards that has increased the fuel cost of an electricity unit by 7 to 8 time as compared to 2002-03.

- Transmission and distribution losses were also a major reason of the energy crisis. T&D losses have increased to 330 Billion that is approximately 900 Million rupees a day.
- Generation mix has also been affected by the CNG sector. The gas used by power sector has been moved to CNG while electricity generation has been shifted to oil. The price of oil is 4.5 times more than that of gas.
- All of the above points have created the circular debt. This circular debt has messed up the situation. WAPDA does not have the money to pay to power producers, similarly power producers failed to pay to oil companies and oil companies failed to pay to refineries. The series of non payments have forced the plants to shut down that creates an energy shortfall across the country even that we have the installed capacity more than our demand.

CALCULATION OF POWER PLANT TARIFF

Before start working of Gadani Power Project Tariff ; first we will discuss the calculation of power plant tariff based on the basis of 2002 Power Policy [16], PPA and FSA of different plants[11, 12, 13, 14, 17, 18, 19] and new coal Power plant policy 2013 [9]:

Power Plant Tariff

The power plants tariff is based on 2 parts i.e.

- Variable Cost / Fuel Cost / Energy Cost
- Capacity Charges / Fixed Charges

Variable cost is mainly the cost of fuel and depends on efficiency of units. Efficiencies of different types of plants are following:

- Combined Cycle Power Plants (CCP): 48~51 % (based on fuel type and weather condition)
- Diesel Engines combined with steam turbine: 45~48 %
- Thermal Power Plant (Conventional Steam Turbine): 40~42.5% (Based Super Critical Boilers on HFO/Coal)
- Captive / Small Plants (Biomass based): 20~22 %

Heat Rate of the plant can be calculated by the efficiency. As per standard conversion, one kWh (unit of electricity) is equal to 3,412.5 Btu. If this standard figure is being divided by the efficiency, the result would be the heat rate. For example heat rate of 40% efficient plant would be 8,532 Btu per kWh. The prices of different fuels are following in Rs/mmBtu (Million Btu):

- Diesel: 2,900
- HFO: 2,198
- Coal: 600
- Gas: 488
- LNG (Imported): 1,700

The other variable factor is the VOM (variable operation and maintenance costs) that include the cost of chemicals and different types of lube oils.

Next part of the tariff is capacity or fixed charges. Calculation of this part is slightly lengthy as it includes different factors that are following:

- Fixed O&M (Operations & Maintenance Costs)
- Return on equity (ROE)
- Return on Equity during Construction (ROEDC)
- Insurance
- Cost of working Capital
- With Holding Tax
- Debt Repayment (Principal & Interest Payment)

Following are some important definitions that need to be known before calculating the capacity charges:

- Installed Capacity: Total generation capacity of Power Plant
- Auxiliary Load: Electricity used by plant to run its own auxiliaries (It is normally 6~10 % of generation/installed capacity)
- Net Capacity: Installed Capacity – Auxiliary Load
- Unit Exported in year: The units a plant can export to the WAPDA in a full year
- Capacity Factor: Units Exported in a year / (Net Capacity X 8760 hrs)

- Agreement Year: Total time of the agreement between the WAPDA and IPPs (Normally 25~30 years)
- Loan Re-Payment Schedule: It depends upon the banks and normally 10-15 years of time is available to re-pay the loan

Indexation Factors: Few indexation factors are used to nullify the effect of inflation and exchange rate fluctuations. These are normally the following:

- Exchange Rate (US$ / Euro / JP Yen)
- US CPI
- Pakistan Inflation

By applying all the indexation factors, electricity cost is being calculated. The variable cost of the wind, hydal and solar plants is lower but their capacity cost is more because of less capacity factor.

SOLUTIONS TO THE ENERGY CRISIS AND GADANI POWER PROJECT

Government is paying an annual subsidy of around 300 Billion rupees to the WAPDA to overcome the circular debt which is due to difference of production cost and recovery. WAPDA is left with two options either to pass over all the production cost to the customer (including the loss due to T&D losses) or to reduce production cost.

Now we will discuss the solutions to reduce the production cost by shifting the generation to cheaper fuel (i.e Coal). Government has already announced to build ten 660 MW power plants at Gadani (Balochistan):

The NEPRA has announced the upfront tariff for the new coal projects on 6th June 2013. Upfront tariff is the guideline for the companies that are interested to install the coal fired plants in Pakistan. It includes the required minimum efficiency of plant, type of fuel, tentative capital cost of plant, expected fuel price and other such kind of important information. The upfront tariff is given for three different categories:

- 200 MW Power Plants
- 600 MW Power Plants
- 1,000 MW Power Plants

These are further divided on the basis on lending into foreign and local financing. In foreign financing loan is given in currency other than Pakistani Rupees while in local financing, loan amount is paid in Pakistani currency. For foreign currency loans, WAPDA also pays an exchange rate adjustment in Capacity Payment.

Based on the detail procedure discussed above we have taken the 600 MW power plant tariff table from upfront tariff of NEPRA (Page#38) and carried out further calculation based on it.

Table 6: Analysis of Electricity Price based on NEPRA upfront coal tariff [9]

Coal Price	11,613	Rs/Ton
LHV (Calorific Value)	25,556	Btu/Kg
Efficiency	42.0	%
Heat Rate	8,125	Btu/KWh
Fuel Rate	317.93	gm/kWh
Fuel Cost Component	3.692	Rs/kWh
Net Capacity	6000	MW
Capacity Factor	60	%
Annual Generation	31,536	GWH
Energy Price	4.1167	Rs/kWh
Capacity Price	4.2235	Rs/kWh
Total Price	8.3402	Rs/kWh

Table 7: Share of Gadani Power Project

Total Electricity Production in 2011-12	95,091	GWH
Addition by Gadani Power Project	31,536	GWH
Total Production after Gadani Power Project	126,627	GWH
% of Gadani Power Project in energy mix	24.90	%

According NEPRA's upfront tariff for 600 MW coal power plant (page # 38), fuel cost on coal would be Rs. 3.692 / kWh **[9]**.

Table 8

Effect of Gadani Power Project on Energy Price of Electricity					
Existing Energy Mix (2012)			Energy Mix after Gadani Power Project		
Hydel	31.0	%	Hydel	23.3	%
Oil	37.0	%	Oil	27.8	%
Gas	26.0	%	Gas	19.5	%
Nuclear	6.0	%	Nuclear	4.5	%
Coal	0.0	%	Coal	24.9	%
Energy Price(Rs/kWh)			Energy Price(Rs/kWh)		
Hydel	2	Rs/kWh	Hydel	2	Rs/kWh
Oil	20.6	Rs/kWh	Oil	20.6	Rs/kWh
Gas	4.5	Rs/kWh	Gas	4.5	Rs/kWh
Nuclear	3	Rs/kWh	Nuclear	3	Rs/kWh
Coal	0	Rs/kWh	Coal	3.692	Rs/kWh
Average	**9.58**	**Rs/kWh**	**Average**	**8.12**	**Rs/kWh**
Reduction in Energy Price after Gadani Power Project				15%	

Conclusion:

EFFECTS OF GADANI POWER PROJECT ON ENERGY CRISIS IN PAKISTAN

- The above calculation shows that the energy prices will reduce by about 15% after the completion of 6,600 the Gadani Power Project.
- As we have concluded above that biggest reason of the energy crisis is the generation of circular debt. By reducing the energy cost, circular debt will also reduce. This will help in reduction in the energy crisis.
- By the addition of this 6,600 MW power project, generation will increase by 33 % from 95,091 GWH to 126,627 GWH. This will definitely reduce the load shedding.
- After installation of this project 24.90% of Pakistan's electricity production would be on coal whereas 40% [29] of electricity generation in the world is coal fueled. This will help the country to improve its energy mix.

The analysis is based on the effect of installation of Gadani Power Project on energy crisis in Pakistan. Other initiatives of Quaid Azam solar park and coal conversion of existing IPPs are not included in this research.

Acknowledgment:

We are thankful to Dr. Muhammad Aslam Asadi for his kind support and guidance.

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