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REVISITING THE KALABAGH DAM IN LIGHT OF THE CURRENT GAS CRISIS

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Abstract

Pakistan is facing an energy crisis since 2007, which is mainly due to the undiversified energy mix. There is a heavy reliance on conventional sources of energy and hydropower energy; which is the cheapest and reliable source accounts for only 33.2% of the generation mix. The development of Tarbela and Mangla Dams in the 60s and 70s promoted tremendous economic growth within the country. Unfortunately, this pace of hydropower development could not be maintained and, in the 90s, electricity generation, using hydropower, was replaced with thermal energy supported by government policies. During this time, the only notable hydropower project, that could have been developed, was the Kalabagh Dam. Despite, the completion of feasibility studies and initial assessments of the project, it was never completed. The energy crisis would not have transformed into such hopeless picture, if the dam had been built timely. This study reveals that the Kalabagh Dam, if it had become operational by 1993, then by 2010, it had been producing 11,400 GWh (million units) of energy, would have preserved 13.87% of 25 trillion extracted reserves and could have saved Rs. 79 billion from gas consumption and Rs. 128 billion against oil consumption. Thus, hydropower is the most cost effective way of catering the increasing energy demands and every effort should be made to repeat the mistakes of Kalabagh dam project.

Keywords: Hydropower, Electricity generation, Kalabagh dam, Gas, Cost effectiveness

1. Introduction

Pakistan has been undergoing an acute energy crisis since 2007, thus dragging the nation's economy on the verge of destruction (Malik, 2012). This prevalent energy crisis is primarily due to undiversified energy mix and increased reliance on conventional sources (oil and gas) of energy. The electricity demand has been outstripping the supply for more than three to four years. According to State of Industry Report, the total installed generation capacity of Pakistan is 23,500 MW, while the available electricity is only 14,000 MW against the demand of 19,500 MW. Hence creating a persistent shortfall of 5,500 MW (NEPRA, 2012), it is significant to mention that the power system is unable to operate at its full capacity due to the lack of fuel availability, which is attributed to excessive reliance on expensive oil.

Initially, hydropower was looked as the preferred means of catering the energy demands of the country and exhaustive efforts were being directed to develop this indigenous source of energy (Asif, 2011). The development of Mangla and Tarbela Dams in the 60s and 70s prompted a simultaneous growth in the economy of the country with energy being more readily available at a lowered cost (WAPDA, 1969). The Tarbela dam alone, which was completed in 1997, had, by December 2007, reaped benefits totalling Rs. 221,902 million for the national economy which is more than 13.5 times the original cost of the project (WAPDA, 2008). Yet, by the 90s, prompt growth in thermal energy began to displace hydropower as the preferred means of energy generation in the country. This period was marked by increased investment in thermal energy which was facilitated by government policies (WAPDA, 1990). The generation mix thus started shifting towards the thermal resources after this paramount investment in thermal energy (see Table 1).

Table 1 identifies, that after 1995, the share of thermal resources started increasing as compared to hydel resources and, at present, more than 60% of the generation is dependent on thermal resources (NEPRA, 2012). The current generation mix is given in Fig. 1.

During this time, the only notable hydropower project being developed was the

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Kalabagh Dam. Despite the completion of feasibility studies and initial assessments of the project, the Kalabagh Dam never entered the construction phase. It is estimated that if the dam had been completed, the energy crisis would not have transformed into such grave situation. This paper assesses the loss in terms of gas crisis due to delay in Kalabagh dam and its pivotal role in curbing this situation.

Table 1. Historic generation mix of Pakistan (Petroleum Institute of Pakistan, 2012)

Year	Hydel	Thermal
1995	50%	50%
2000	34%	66%
2005	35%	65%
2010	32%	67%
2011	32%	68%

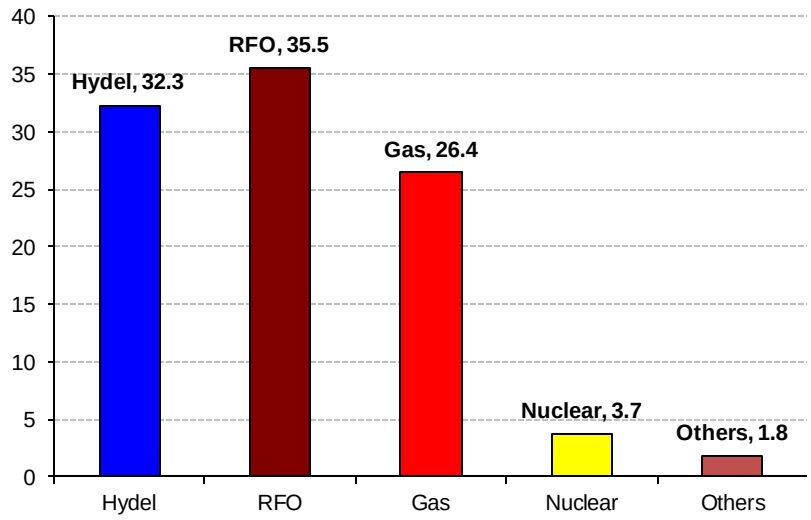

Fig. 1. Generation mix of Pakistan (NEPRA, 2012)

2. Objectives

The foremost objective of this paper is to determine the damages incurred as a result of delay in Kalabagh dam. It also aims to analyse the role of Kalabagh dam in endemic gas crisis and to quantify the loss due to delay in the project. Furthermore, to evaluate the role of hydropower projects in providing cheap and reliable electricity in order to assess the savings in terms of generation cost.

3. Consequences of Delay in Kalabagh Dam's Construction

The idea of Kalabagh Dam was perceived in 1953 and it was scheduled to be completed in 1993 (Haq, 1983). The proposed site for the dam is situated in Kalabagh across the Indus River in Mianwali District of Punjab, bordering KPK province (Haq, 1983). The project location map is given in Fig. 2.

This dam, if completed, would have become an effective tool to save the people of Sindh from the menace of flood and its grievances. The dam would have stored this surplus water during the flood season and would have made it available for irrigation purposes. In addition to these benefits, the project would have played a pivotal role in relieving the masses from the current bleak energy situation within the country by supplying cheap and reliable source of electricity. However, the Kalabagh dam, notwithstanding these benefits, has remained a source of dispute in hydro-political history of Pakistan and it is unfortunate that we as a nation failed to build such mega projects beyond the apprehensions of all provinces within Pakistan.

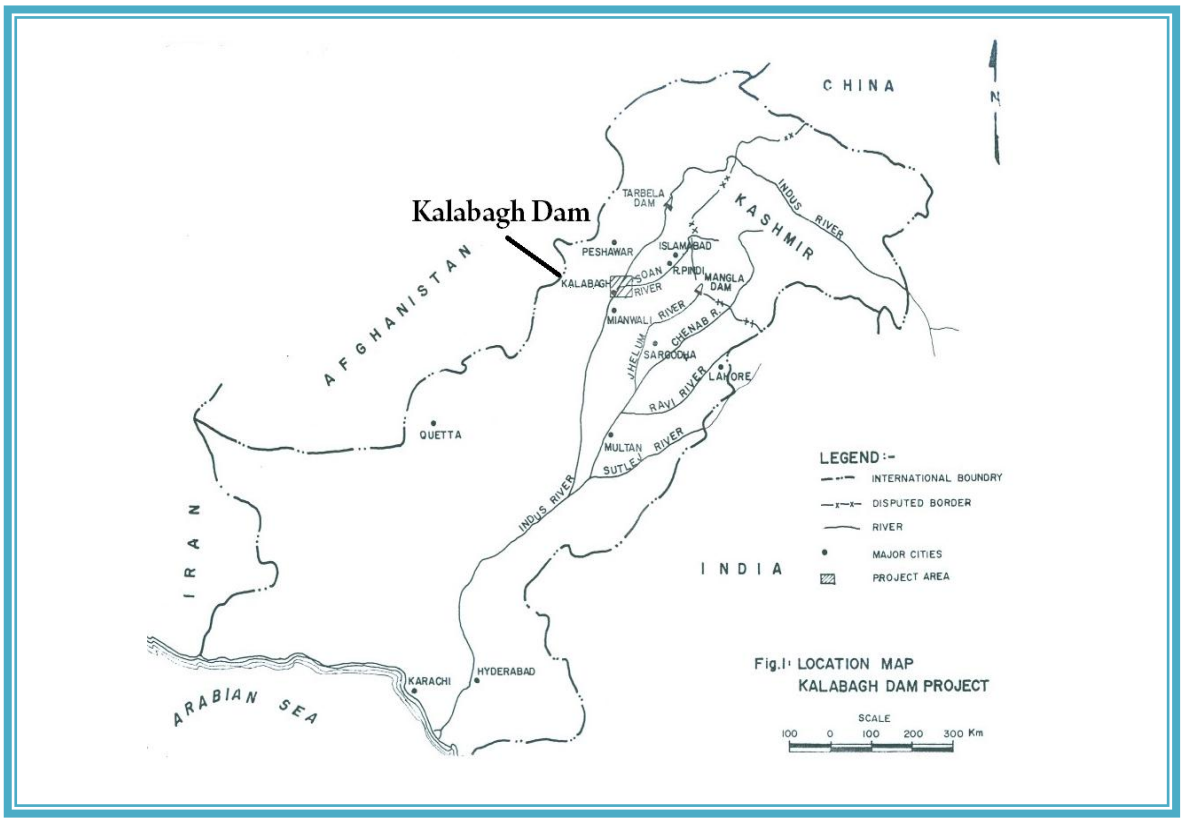

Fig. 2. Location map of Kalabagh dam (Haq, 1983)

The salient features of Kalabagh Dam are documented in Table 2.

Table 2. Salient features of Kalabagh dam (Haq, 1983)

Hydrology	
Catchment area	110,500 sq mi
Maximum recorded flood (1929)	1,200,000 cusecs
Average annual flow	91.4 MAF
Reservoir Storage Capacity	
Gross	7.9 MAF
Live	6.1 MAF
Dam Details	
Maximum height above river bed	260 feet
Total length above	11,000 feet
Total fill volume	60 million cu yds
Spill-ways	
Overflow spillway capacity	1,070,000 cusecs
Orfice spillway capacity	980,000 cusecs
Power facilities	
Unit size	300 MW
Penstock	12 No
Turbine design head	170 feet
Installed capacity	2400 MW (Initial) 3600 MW (Ultimate)
Average annual energy	11400 GWh
Estimated total investment	Rs. 250 Billion (1997)

3.1 Effect on natural gas

The proposed Kalabagh Dam was to become operational by 1993 (Haq, 1983), and its total annual production would have equalled 11,400 GWh by 2010. The conjunctive operation of Kalabagh and Tarbela Dams would have cumulatively generated 336 million kWh of electricity in addition to the existing power production. However, as the project never entered the construction phase, the energy which Kalabagh Dam would have supplied was met through the exploitation of gas reserves. To produce the same amount of energy that Kalabagh Dam would have produced, 161 billion CFT of gas reserves has been utilised annually (Ministry of Finance, 2009). Sector wise consumption of gas in 2009 is given in Table 3.

Consequently, if Kalabagh Dam had been operational in 1993, as had been proposed, by 2010, 2737 billion CFT of gas would have been preserved. Given that even generous estimates of the gas reserves place its potential at 54 trillion CFT of which 25 trillion CFT has already been utilised by 2009, the Kalabagh Dam would have

Table 3. Sector wise gas consumption in 2009

	House-Hold	Commercial	Cement	Fertiliser	Power	Industrial	Transport
Gas consumption (2009) in billion CFT	**214.1**	**35.5**	**4.8**	**201.1**	**404.1**	**319**	**88.3**

Source: Ministry of Finance, (2009)

preserved close to 13.9% of the 25 trillion extracted reserves and 6.2% of the total reserves of this finite and exceedingly valuable energy source. Of the total gas consumed from 1993 to 2009, the construction of the Kalabagh Dam would have saved maximum of 2.7 trillion CFT from the consumption of 10.9 trillion CFT; this equals 24.8% of the total gas consumed during this period.[1]

The construction of the Kalabagh Dam would have effectively diffused dependence on gas and save this finite reserve for household and transportation consumption. By 2008-09, gas consumed by the household sector stood at 214.1 billion CFT and by transport sector at 88.3 billion CFT (Ministry of Finance, 2009). With the construction of the Kalabagh Dam, energy demands of other sectors could have been met in the most appropriate manner. The closure of CNG stations and load shedding of gas supply, which is leading to greater social unrest today, could have effectively been averted. Based on the consumption figures of 2008-09, exclusive use of natural gas preserved through the construction of Kalabagh in the transport sector would have ensured its constant supply for another 31 years (see Table 4). Similarly, household supply of natural gas could have been maintained for another 12.8 years.

Table 4. Amount of gas preserved, had Kalabagh Dam been built on time

	Household	Transport
No. of years gas reserves would be available after 2009	**12.8 Years**	**31.0 years**

Source: Author's Calculations

[1] The data for gas consumption has been taken from Economic Survey of Pakistan, 2009. The analysis shows that the construction of the Kalabagh Dam would have saved maximum of 3, 329.705 billion CFT from the consumption of 10, 990.41 billion CFT.

This would have bought greater time to initiate programmes to ensure the constant supply of gas whilst also develop other sources that could diffuse the demand for gas. Work on the gas pipeline extending from Iran has only recently been initiated and given that it would not be completed at least till 2014, provided that no further international sanctions are levied on Iran, gas shortages will continue to wreak havoc in the country.

Solar heaters, ethanol fuel production and solar cookers could potentially reduce the demand for gas from the transport and household sector but, for now, the initiation is still in its pilot phases, taking years before the alternatives are mainstreamed into the power sector. Moreover, the current energy crisis that extends to include electricity production is likely to persist as no major alternate to gas has been developed, yet. As a consequence, the pressure on the depleting gas reserves will further be augmented leading not only to their more rapid decline but also limiting its availability to all sectors of the economy.

3.2 Impact of cost of delay on electricity generation

The electricity generated from hydropower is comparatively cheaper than using natural gas as a primary source of energy for electricity generation. By 2007-2008, natural gas contributed to 51.3% of electricity generated while hydropower constituted 33.8% in the electricity generation mix (NEPRA, 2012). When contrasted with the cost per unit of electricity, this scheme of affairs seems to be an undesirable option for a country already embedded in a fiscal crisis. Even if capital costs are included, electricity from hydropower still retains a cost per unit which is much lower than natural gas. The lowered cost of electricity generation through hydropower should have served as the rationale for keeping the contribution of natural gas minimal and thus not only saving costs of electricity generation but also preserving the finite resource.

Kalabagh Dam by 2010 had been producing 11,400 GWh of energy and could have saved Rs. 79 billion if replaced natural gas and Rs.128 billion, if it replaced oil (see Table 5).

Table 5. Savings in cost of generating electricity, had Kalabagh Dam been built.

	Kalabagh Dam	Natural Gas	RFO
Total cost in Rs. of generating 11,736 GWh	4342320000/ 4.34 Billion	83442960000/ 83 billion	132499440000/ 132.49 billion
Savings in the event of Kalabagh Dam's operation		79100640000 **Rs. 79.1 billion**	1281571200/ **Rs. 128.2 billion**

Source: Author's Calculations

Table 5 identifies that, in addition to the savings in event of operation of Kalabagh Dam, the completion of this project could have also led to saving in terms of cost of generation. Rs. 83 billion might have been saved in terms of reduced gas consumption and Rs. 132 billion might have been conserved in case of oil. Instead, the increased reliance on gas and oil led to increased cost of generation, consequently contributing to dilemma of circular debt in the energy sector. The figure of circular debt at present has swelled to Rs. 872 billion, (Planning Commission of Pakistan, 2013) thus draining the national exchequer.

4. Policy Recommendations

1. The introduction of tele-metering system will ensure transparent water management between provinces in Pakistan. One of the chief factors of the closure of the Kalabagh Dam project was the trust deficit between the provinces which led to claims of "water stealing". Further expansion of hydropower, critically depends on fostering an atmosphere of trust between the provinces, so that the mutual benefits of hydropower can be attained.
2. Extensive expansion of the use of hydropower and raising its share in the overall energy mix of the country is recommended. Pakistan is endowed with vast potential of hydropower of which only 13% have been utilised to date. Technical expertise and suitable terrains for hydropower development are available in the country, making hydropower a rational option to cater the energy demand. In addition to this, hydropower plants last longer and ensure reliable, efficient and cheap source of energy. The use of hydropower to cater energy needs is a sustainable option which is not only renewable but that it also environmental friendly.
3. Hydro-thermal generation mix ratio needs to be revised. This could save billions of rupees associated with electricity production of thermal sources and contribute towards preserving of diminishing reserves of natural gas, making gas available to other sectors where the usage of gas cannot be substituted.
4. Timely implementation of hydropower projects that are under construction needs to speed up. Further delays in the completion of hydropower projects would only cause an increase in the intensity of the current energy crisis. The timely implementation of hydropower projects is crucial as the exploitation of coal reserves or the import of natural gas, which could serve as alternates to the depleting gas reserves, would take years before coming into operation. Current delays caused by corruption, negligence and insufficient efforts should be addressed immediately.
5. Renewable energy, apart from hydropower, could play a vital role in reducing the pressure on thermal sources of energy. In addition to the advantages offered by renewable energy, it could provide decentralised energy in some cases while also contribute to the on-grid applications. Yet, the vast potential of renewable energy sources remains untapped and unexplored. The use of solar cookers, solar heaters, solar dryers, biomass and waste to energy, could potentially reduce the dependency on natural gas particularly in the domestic sector. Additionally, the use of wind energy, small hydro and solar PV technology has the potential of contributing to the grid.

5. Conclusion

In the light of the above discussion, it is seen that there has been an acute dependence on finite sources of energy, which was an unsustainable move as it undermined with the development of other renewable sources of energy. The use of indigenous natural gas reserves could not be avoided nor could their depletion be evaded. However, the magnitude of the current gas and energy crisis could have been averted. This could have been achieved if adequate efforts had been directed towards developing other renewable sources of energy while simultaneously exploiting gas reserves. Lack of planning resulted in excessive usage of natural gas which led to rapid depletion of the finite reserve without any contingency plan to cope with the energy demands in near future. The construction of Kalabagh Dam would have saved much of the cost of electricity generation and deterrence of the present natural gas crisis.

Amongst all the renewable sources of energy, hydropower emerges as the most cost-effective option for catering the energy demand and to promote sustainable development within the country. Amidst the clutches of rampant energy insecurity, every effort should be undertaken to prevent mistakes like that of Kalabagh Dam; otherwise the country would be pushed further into under-development.

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