Pakistan's Energy Import Options

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***Abstract*--Energy has been one of the key requirements for mankind since its creation. Increase in population and race of modernization have increased the per capita energy requirement. The most commonly used energy sources are electricity, oil, natural gas and coal. Nature has blessed Pakistan with abundant energy sources, however the country is characterized with very low per capita energy consumption and severe energy crisis. Shortfall of electricity is increasing day by day and recorded up to 4500 MW in 2010. In 2011, this deficit reached to 7000 MW. On the other hand, the shortage of natural gas kept on increasing and reached to 2000 Million Cubic Feet per Day (MMCFD) in 2014. Government of Pakistan is taking serious measures to mitigate the shortage, however, meeting the growing energy demand in near future seems nearly impossible. To overcome the shortfall, Pakistan has to import energy from its neighboring countries. In this work, a comparative review of energy import options for Pakistan in context of recent developments in energy sector has been presented. Energy import options include the projects like IPI, TAPI, CASA-1000, GUSA and LNG from Qatar etc.**

Index Terms—Pakistan, Energy, Import, IPI, TAPI, CASA-1000, GUSA

I. Introduction

Energy has been a key requirement for mankind since the beginning of life. Population increase, modern life style and industrial progress have increased the overall energy requirement. The race of modernization is increasing energy demand exponentially. However, the conventional energy resources are depleting at an alarming rate [1]. The modern machine age requires continuous and reliable energy supply in every field of life. According to the International Energy Agency (IEA) the energy requirement has been increased from 6016 Million Tons of Oil Equivalent (MTOE) in 1971 to 13371 MTOE in 2012. The major contributors to meet this challenge are oil 31.4%, coal 29%, natural gas 21.3%, nuclear 4.8% hydro 2.4% biofuels and waste

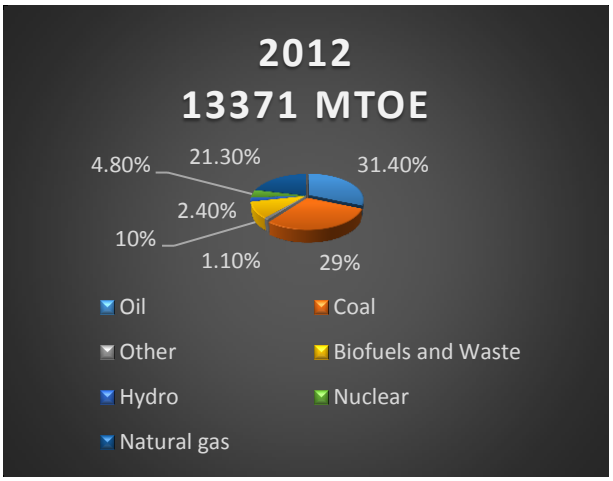

Figure 1. Sources of Energy

10% and other sources 1.1%; these are depicted in Figure 1 [2].

Some of the energy sources, such as oil, gas and coal, have adverse impact on nature due to emission of Greenhouse gases (GHG).

These gases increase the environmental hazards like global warming, greenhouse effect etc. [3]. During 1973-2012, the CO_2 emission has been increased form 15633 million tons (MT) to 31734 MT [2] due to which serious environmental concerns have been raised. In U.S carbon dioxide emission has been increased by 5% in last two decades [4]. For environmental protection, European Commission of Climate Action has set a target of reduction in GHG emission at least 20% below then 1990 [5]. On the other hand, the energy consumption has direct impact on the economical, technological and social growth of a country. Nations like China, France and USA have the highest per capita energy consumption;

which is the major reason for their economic stability [6, 7, 8].

In Pakistan's case, per capita electricity consumption is approximately 456 kilo watt hour (KWh) which is 30% less than Asian average of 646 KWh and one fourth of world average [9]. Electricity shortage is one of the major reasons of low per capita energy consumption. In last two decades due to political instability, limited resource, lack of effective energy policy, poor law and order situation, the energy crisis kept on increasing. Short fall of electricity reached to its peak i.e. 5000 MW while 2000 MMCFD shortage of natural gas has also been recorded. Government of Pakistan is taking serious steps to mitigate short fall. However, ongoing projects are not likely to meet the growing energy demand in near future. Pakistan's energy sector mainly relies on the usage of fossil fuels. The fossils share to meet our energy requirements is about 65% of total energy [10]. On the contrary, fossils in the country are depleting rapidly. To overcome the challenge of increasing energy demand, Pakistan has to seek import options from its neighbors. This work presents a comparative review of energy import options like IPI, TAPI, CASA-1000, GUSA and LNG from Qatar. The work also highlights national and international challenges related to these projects.

Rest of the paper is organized as follows. Section 2 covers the current energy scenario of Pakistan. Energy import options are presented in Section 3. The comparison of energy import options is discussed in Section 4 and conclusions are drawn in Section 5.

II. Current Energy Scenario of Pakistan

Pakistan is a developing country with population of 181.3 million people and facing a serious energy crisis since its creation. However, in last few decades the energy shortage has deteriorated exponentially and is damaging the economy badly. From 2002 to 2007 Pakistan had a stable economic growth of 6% per annum which resulted in rapid increase of energy demand. Due to lack of planning and proper infrastructure, energy sector was unable to counter growing demand which resulted in severe energy short fall, loss in 2.5% of GDP per annum, increase in unemployment and loss of exports worth 1.3 billion USD [11, 12]. According to the economic survey of Pakistan the primary energy supplies in Pakistan were 28.5 MTOE during 1991 which increased with the annual growth rate of 3.6% and became 66.8 MTOE by the end of 2014 [10]. The share of natural gas in energy mix is highest with

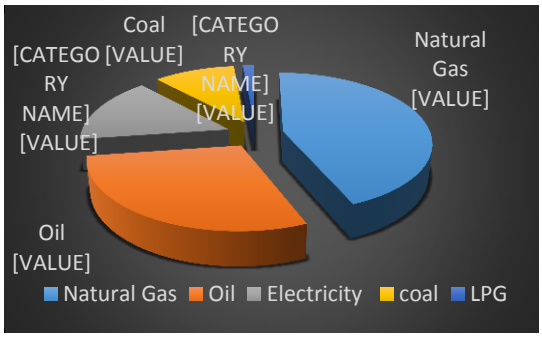

Figure 2. Share of Energy Sources in Pakistan

43.7% followed by oil 29%, electricity 15.3%, coal 10.4% and Liquid Petroleum Gas (LPG) 1.5% of total energy [13].

III. Energy Import Options for Pakistan

Despite of heavy investment, the current situation of energy sector is not very encouraging. The ongoing projects will not be able to meet the growing energy demand. Pakistan's energy sector mainly relies on imported oil which is not an economical option. To reduce dependence on expensive imported oil, Government has to explore alternative energy import options. Various import projects have already been proposed. These include IPI, TAPI, CASA-100 GUSA and LNG from Qatar. This section presents the comparative study of the energy import options in context of cost, feasibility and regional security.

A. The Iran-Pakistan-India (IPI) Pipeline

Due to recent nuclear agreement between Iran and US there is a ray of hope for Pakistan to proceed with Pak-Iran gas pipeline. The discussions between Islamabad and Tehran on Pak-Iran gas pipeline were started in 1994. Later Iran suggested the inclusion of India in this pipeline, hence IP gas pipeline became IPI pipeline. In 2008, India signed a nuclear deal with US; one of the consequences of the deal was India's withdrawal from the IPI project on the pretext of over pricing and security issues with Pakistan [14]. After withdrawal of India from IPI project, Pakistan and Iran signed an agreement on May 24, 2009. According to the agreement both countries decided to lay pipeline to their borders by the end of 2014. Penalty of 3 USD per meter per day in case of failure to complete on time was also decided for compensation purposes [15]. The pipeline on the Iranian side has already been completed; however, Pakistan has not yet completed its own side. The US

opposition is the key barrier in the completion of the IP project. Another hurdle is lack of finance to implement the project. Due to US pressure both domestic and international investors are unwilling to get involved in the project.

As part of agreement, Iran undertook to supply Pakistan with natural gas, starting in 2014 and reaching a level of one billion cubic feet per day (BCFD) by mid-2015. Consequently due to unnecessary delays natural gas supply is not yet started and caused the shortfall of 2000 MMCFD. The total cost of the pipeline is estimated to be about 7.5 billion USD. The 900 km Iranian part of the pipeline is reportedly already built up to the borders of Pakistan. Due to various reasons, Pakistan has not yet completed the 800 km section to bring the gas to their demand centers. IPI is considered as the most viable and economical project for long term energy needs. This project starts from Assaluyeh gas field of Iran and covers 1150 km to reach Iran-Pakistan border. Iran has already completed 900 km pipeline of 56 inches up to Shehr and remaining 250 km is expected to complete soon. On Pakistan's side pipeline will be laid along with Makran costal highway and cover 781 km and reach Nawabshah off-take point. Sui southern gas company (SSGC) pipeline infrastructure will connect this pipeline with different parts of country.

Despite the challenges, the IP gas pipeline will have a significant impact on the energy sector of Pakistan. Some of the major benefits are discussed below:

- It will help to overcome the shortage of natural gas of 1000-1500 MMCFD and electricity shortage of 5000 to 6000 MW
- IP will save approximately 2.5 billion USD spent on imports of oil
- Pakistan can earn financial benefits if pipeline is extended to India and Bangladesh
- Help to preserve the gas reserves in Pakistan
- Natural gas can be used as alternative of furnace oil to produce electricity
- Provide employment opportunites for Sindh and Baluchistan
- Can bring peace and prosperity in the region

B. Turkmenistan, Afghanistan, Pakistan and India gas pipeline (TAPI)

The TAPI project involves gas import from Yoloten and its adjacent fields in Turkmenistan to Afghanistan, Pakistan and India. To build a pipeline, one of the U.S. based oil company name Unocal, made an agreements with the Afghan Taliban during the 1990s, but later on due to security issues they withdrew. Following the 9/11 attacks and the subsequent US-led invasion of Afghanistan and installation of a pro-Western government, interest in building TAPI was revived. The imposition of sanctions on Iran and efforts to isolate that country were additional reasons for the revival of TAPI; the project was supposed to be alternative of IPI.

The pipeline starts from Dulatabad gas field and covers 145 km in Turkmenistan, 735 km in Afghanistan, 800 km in Pakistan and enter into India [16, 17]. The capital investment on the project was estimated US$ 3.2 billion which was revised to US$ 7.6 by PENSPEN, UK in 2008. The proposed project would generate 5000-6000 MW of electricity and reduce the electricity short fall. Additionally, the project will cause earning form transit revenue for gas supplies to India. In spite of economic and commercial viability of TAPI, it faces many challenges [18].

C. CASA-1000

The Main goal of the CASA-1000 project is to import electricity from Tajikistan and Kazakhstan Republic to Pakistan and Afghanistan. Both Tajikistan and the Kyrgyz Republic have about 80,000 MW hydropower potential, only a relatively small proportion of which (about 10 %) has been developed till date. The CASA-1000 project would enable a trade of 1000-1300 MW of clean electricity between Pakistan and Afghanistan. In initial stage Afghanistan will import only 300 MW while the major portion i.e. 1000 MW will be used by Pakistan.

For a number of years Afghanistan, the Kyrgyz Republic, Pakistan and Tajikistan have been looking for enhanced trading, especially in electricity. For this purpose they established a Central Asia-South Asia Regional Electricity Market (CASAREM). The feasibility study commissioned by the World Bank to address residual issues and update the costs and economic analysis of the CASA-1000 project has recently been concluded by the Consultants (SNC-Lavalin of Canada) [19] . The recommendations for optimal utilization of this project are as follows:

- AC line of 500 kV, 477 km long from Datka to Khoujand to transfer the surplus power from the Kyrgyz Republic to Tajikistan with Tajikistan internal network transferring this power to Sangtuda;
- AC line of 220 kV, 80 km long in Tajikistan between Nurek and Sangtuda substations
- A 1300 MW AC-DC Convertor Station at Sangtuda;
- 750 km HVDC line from Sangtuda to Peshawar via Salang Pass and Kabul;
- A 300 MW DC-AC Convertor Station at Kabul

- A 1300 MW DC-AC Convertor Station at Peshawar.
- High voltage DC line has a length of 117 km in Tajikistan, 562 km in Afghanistan and 71 km in Pakistan.

The project is approved by World Bank on 27th March 2014 and expected to be completed on 30th June 2020. The total project cost is estimated to be 953 million USD.

For Pakistan, shortage of electricity is a major constraint to economic growth and consumers are subject to frequent and extended blackouts. The CASA-1000 imports will be quite beneficial in eradicating this shortfall.

D. LNG import form Qatar

The transportation of gas through long pipelines is a very challenging and time consuming task. However, liquefied natural gas (LNG) can be a very effective alternative to long distance gas transportation. In global market the trend of LNG import is increasing as compare to long distance gas pipelines [20]. With the global trend and present geopolitical situation, LNG import from Qatar is the best short term solution to meet the current energy shortage in country due to following reasons.

- Natural gas production is 4,000 MMCFD while the unconstrained demand is 8,000 MMCFD
- IPI is delayed due to international sanctions while availability of LNG is possible before 2017
- No major success in search of new oil and natural gas reservoirs
- International oil price is increasing day by day
- TAPI is delayed due to instability in Afghanistan [21]

In the current situation Government of Pakistan is seriously considering the LNG import from Qatar and singed a long term LNG sale and purchase agreement terms as (LNG SPA) between Pakistan State Oil (PSO) and Qatar gas. The first fast track LNG import terminal with the base capacity of 690 MMCFD was constructed at Port Qasim Karachi with the help of Engro Pakistan in 2015 [22]. 14 LNG ships have already been regasified at Port Qasim LNG terminal, however the yearly agreement is 24 shipments. The use of 4000 MMCFD of regasified LNG in electricity power sector will increase the annual generation up to 10%. It will increase the efficiency of IPPs as alternative of diesel with the potential saving of 0.6 to 1 billion dollars [23].

E. Gulf-South Asia/ Qatar-Pakistan gas pipeline

The idea of importing natural gas from Qatar was initiated by Crescent Petroleum International (CPI) in 1990. The proposed pipeline named as Gulf-South Asia (GUSA) and would deliver natural gas from Qatar to Pakistan and other parts of the subcontinent. The complete route survey of the pipeline is carried by CPI with the cost of 4 million USD. Brown & Root, a US based company proposed the engineering design of the GUSA pipeline project. The route starts form northern gas field of Qatar, passes through Dibba on the eastern coast of UAE reaching Pakistan at Jiwani near Gwadar [24]. This pipeline covers the total distance of 1186 km and will be able to supply 1600 MMCF per day.

Unlike IPI, the GUSA pipeline project has less international political opposition, however, the project is very costly due to underwater route. The rough estimate suggests that the cost of the offshore pipeline is twice of the overland pipeline. The GUSA Project carries enormous financial as well as environmental benefits for Pakistan. This project can be extended to China and India which enables Pakistan to earn transit fee. The GUSA pipeline project is still on paper, however, it will be very effective in near future as an alternative of TAPI if the security situation in Afghanistan gets improved.

IV. COMPARISON OF THE PROPOSED ENERGY IMPORT OPTIONS FOR PAKISTAN

Pakistan has various energy import options with certain challenges and limitations. The IPI is the only project without the international cooperation however, the present nuclear deal between US and Iran has a ray of hope for Pakistan. This pipeline is the most viable and secure route for Pakistan. With the increasing energy demand, China and Bangladesh can also be considered as the future consumers. The working on the pipeline on the Iranian side has already been completed and they are willing to help Pakistan to complete the remaining part. TAPI is an alternate of IPI with US support but Afghanistan current security situation and Russian opposition are the biggest barriers in the path of this project. Russia has an alternate plan of transporting natural gas from Turkmenistan to the European countries by providing them a transit route. GUSA gas pipeline is also a very secure route for natural gas import however, cost constraint is the biggest issue. This project can be

economically beneficial by providing energy corridor for China and India. LNG import from Qatar is essential to meet the current energy requirement but the price constraint is biggest challenge in this regard. LNG import would not only reduce the dependency on the imported oil but also meet the shortage of gas in energy sector. The complete comparison on the energy import options for Pakistan is presented in table 1. A summary of the available energy import options is as follows.

Table 1. Projects Comparison

Project	**IPI**	**TAPI**	**CASA-1000**	**GUSA**	**LNG**
Benefits	200 Million USD	217 Million USD	NA	NA	NA
Status	75%	On Paper	On Paper	On Paper	25%
Route	Iran-Pakistan-India	Turkmenistan-Afghanistan-Pakistan-India	Tajikistan-Kazakhstan-Afghanistan-Pakistan	Qatar-UAE-Pakistan	Qatar-Pakistan
Challenges	US, Saudi Arabia	Russia, Afghan Security	Cost, Afghan Security	Cost	Cost
Cost (Billion) (USD)	7.6	7.5-10	0.950	1.88	NA

Option 1, IPI: Iran is a friendly state which shares common border of 850 KM with 2nd largest natural gas reserves in the world. This project is very beneficial for growing energy demand. It will mitigate the shortage of natural gas and produce additional electricity of 4000 MW. After the US-Iran nuclear deal, Pakistan has to exploit this golden opportunity and make energy cooperation agreement with Iran. If India and Bangladesh join this project, it will be a breakthrough in the context of regional peace and prosperity. Unfortunately, in our country, political parties' interest are more value able than country's policies since many decades, so IPI is more viable because it has very low resistance to implement.

Option 2, TAPI: Turkmenistan is an important central Asian state with 3rd largest natural gas reserves in the world after Russia and Iran. This project will open new horizon for cooperation between central Asia and south Asia. This is also a very beneficial project for future energy demand for south Asia. It will also help in building strong economic relation between India and Pakistan. TAPI is challenging task due to concerns of Russia and internal security of Afghanistan.

Option 3, CASA-1000: Kyrgyz Republic and Tajikistan have one of the most abundant clean electricity resources in the world. Both of these states have surplus electricity whereas Afghanistan and Pakistan have a huge energy short fall during summers. This project will provide 1000 MW of clean hydroelectricity to Pakistan however, capital investment and Afghanistan security situation are the major barriers.

Option 4, GUSA: This is one of the most expensive and challenging project due to under-sea pipe line. GUSA will pass through Iranian water which may cause interstate rivalry among the two countries. The feasibility of this project may be improved by involvement of China and India.

Option 5, LNG from Qatar: Qatar has 4th largest natural gas reserves with world largest LNG export capacity. Furthermore, Pakistan enjoys strong brotherly and trade relationship with Qatar. LNG import is the best possible short term solution for energy shortfall because it doesn't require large capital cost and time frame to build infrastructure.

V. CONCLUSIONS

To cope with growing shortfall in energy sector, Pakistan has to import energy from its neighboring countries. The import options should be evaluated on the basis of economic feasibility, total potential, technological requirement and security concerns in order to draft a short, medium and long term energy plan. Our work finds that LNG import from Qatar is the best short term option to deal with energy crisis. In medium term plan IPI, TAPI and CASA-1000 are the possible candidates while GUSA gas pipeline should be considered for long term energy plan. In comparison of IPI and TAPI our study reveals that priority should be given to IPI gas pipeline because a lot of work has already been done on this project. TAPI gas pipeline is also a very good project, with greater international support, however Afghanistan security situation is a major hurdle. GUSA under water pipeline has good potential to be a future energy import option. The challenge of capital

investment on infrastructure building can be balanced by transit fees from other countries with energy needs such as China and India.

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