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Pakistan's overall energy potential assessment, comparison of LNG, TAPI and IPI gas projects

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ABSTRACT

Pakistan is facing severe energy crisis in spite of the fact that nature has blessed her with huge energy potential. Short fall of electricity supply in the country is increasing and has been recorded up to 4522 MW in 2010. This deficit reached to 7000 MW in May, 2011. A comprehensive review of Pakistan's energy sector is presented in this paper. Energy potential, major issues of energy sector and energy import options are discussed. Issues like poor management, combined cycle capacity, low hydro power share, circular debt and energy security have been covered. Energy potential assessment includes hydro solar, wind, coal, nuclear, hydrogen cells, geo-thermal, ocean resources and bio mass. Future prediction calculations are based upon country's current and world's average per capita energy consumption. Current oil and gas reserves of the country contribute to only 5 percent and 48.8 percent of the energy mix and at the current rate will be exhausted by 13 and 16 years respectively. The overwhelming dependence of the energy sector on imported fossil fuels may create a situation of energy security threat. However dependence upon the energy import options cannot be avoided in order to lessen the severity of energy crisis in near future. Some of the energy import options are: Turkmanistan, Afghanistan, Pakistan and India (TAPI); Iran, Pakistan and India (IPI) gas pipelines; Liquefied Natural Gas (LNG) from Qatar etc. On the other hand exploitation of vast renewable potential like hydro, solar and wind requires serious attention. Exploitation of indigenous coal resources would also be a key for solving energy crisis in the long run. In summary, this paper presents energy potential assessment in context of major issues, future predictions and impact of energy import options. This in turn provides a big, clear and brighter picture of the country's energy sector.

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1. Introduction

Energy is the soul of modern machine age. Human race has progressed to implausible heights during this period. Machines have automated human life but they require continuous and reliable energy supplies to maintain the progress of development. A short brownout shows the significance of reliable electricity supplies in each and every walk of life, especially in urban areas. Higher the energy consumption in a country, higher is the development and overall progress. That is why the per capita energy consumption of a country is taken as a measure of its socioeconomic development.

According to the International Energy Agency (IEA), the total primary energy supply of the world has increased to 12,717 Million Tons of Oil Equivalent (MTOE) in 2010 as compared to 6107 MTOE in 1973. The main contributors in this primary energy mix are: oil, 32.4%; coal/peat, 27.3%; bio fuels, 10%; hydro, 2.3%; nuclear, 5.7%; natural gas, 21.4% and other resources, 0.9% [1]. The worldwide fossil fuel resources are declining at an escalated pace and their prices are unpredictably volatile which have negative effects on the global economy. In addition, adverse effects of their abundant use include: increased pollution level, depletion of ozone layer, damage to the eco system and unprecedented change in the climate of the planet. The fossil fuels are irreplaceable at present and they will of course be of high value to the future generations as well. This scenario has stressed the world to search for new and efficient methods for harnessing the renewable energy resources in order to decrease the dependence on fossil fuels. Renewable energy resources are inexhaustible, indigenous, cleaner and ubiquitous in nature. The integration of these renewable resources to meet the 21st century energy requirements and the digitization of existing grid in order to enhance the reliability has enhanced the scope of smart grid. In olden days electricity was denoted as a sign of luxury, but now it is a basic necessity of everyday life. Limited electricity and gas supplies have administered devastating effects in every field of life in the country. Still around 40,000 villages are without electricity in Pakistan [2]. Long lines of vehicles in front of Compressed Natural Gas (CNG) stations are an indication of the severity of the on-going energy crisis. Violent protests are one of the serious consequences of this energy shortfall.

The paper is organized as follows: a review of similar research work is given in the next section. The prevailing situation of energy crisis in Pakistan has been presented in Section 3. Major issues of the energy sector are explained in Section 4. Regional energy security, TAPI, IPI and LNG import options are elaborated in Section 5. Future predictions and energy potential of the country are presented in Sections 6 and 7 respectively. Assessment of overall potential has been presented in Section 8 and conclusions are drawn in Section 9. Abbreviations used in the rest of the paper are summarized in Table 1.

2. Literature review

Shortage of conventional energy resources due to expanding population has been the main thrust behind many research papers. In [3], the energy supply situation in the rural sector of Pakistan has been discussed and energy shortage problem has been identified through a survey. It has been concluded that

Table 1
Abbreviations used.

AJK	Azad Jammu and Kashmir
CNG	Compressed natural gas
LNG	Liquefied natural gas
TAPI	Turkmanistan, Afghanistan, Pakistan and India
IPI	Iran, Pakistan and India
CSP	Concentrated solar power
GoP	Government of Pakistan
FATA	Federally administrated tribal area
GWEC	Global wind energy council
GWh	Giga watt hour
HDIP	Hydrocarbon development institute of Pakistan
IMF	International monetary fund
IPP	Independent power producer
KANUPP	Karachi nuclear power plant, Pakistan
KW	Kilo watt
KWh	Kilo watt hour
MWh	Mega watt hour
TWh	Tera watt hour
MAF	Million acre feet (a unit used for water storage capacity)
Mcft	Million cubic feet
MoU	Memorandum of understanding
MoWP	Ministry of water and power
MTOE	Million tons of oil
NTDC	National transmission and despatch company Pakistan
PAEC	Pakistan atomic energy commission
PEPCO	Pakistan electric power company
PKR	Pakistan rupee
PPIB	Private power infrastructure board, Pakistan
PV	Photovoltaic
REN21	Renewable energy policy network for 21st century
USD	US dollar
WAPDA	Water and power development authority, Pakistan
BCFD	Billion cubic feet per day
MMSCFD	Million standard cubic feet per day
TCF	Trillion cubic feet
AMI	Advanced metering infrastructure
HEMS	Home energy management system
MMBTU	Million British thermal unit