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Energy Procedia 88 (2016) 71 – 75

Energy

Procedia

CUE2015-Applied Energy Symposium and Summit 2015: Low carbon cities and urban energy systems

Overview of energy portfolio in Pakistan

Muhammad Wakeel^a, Bin Chen^{a*}, Soomro Jahangir^a

a. State Key Joint Laboratory of Environmental Simulation and Pollution Control, School Of Environment, Beijing Normal University, Beijing100875, P.R. China

Abstract

Sustainable and affordable energy supply has strong correlation with the socioeconomic activities of developing countries. Pakistan is an energy deficient country with a shortfall within power output of around 6500MW in the form of load shedding. This paper aims to provide an overview of current energy mix, key dimensions, gap between supply and demand and potential of energy sources to meet the future demand in Pakistan. Except for the nonrenewable energy, Pakistan has a renewable energy potential of 2,900,000MW for solar, 346000 MW for wind 3000MW for biogas, 2000 for small hydropower and 1000MW for waste-to-energy, with its share in total present energy scenario being less than 1%. It is suggested to manage existing resources and infrastructures, optimize the energy planning, and enhance the partnership with private sectors and international agencies. Local policy makers and planners should also give priority to the renewable energy to increase its share in the total energy mix and promote the sustainable energy profile of Pakistan

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Peer-review under responsibility of the organizing committee of CUE 2015

Keyword: Renewable energy, fossils fuels, energy planning, Pakistan.

* Corresponding author. Tel.: +86 10 58807368

E-mail address: chenb@bnu.edu.cn.

1. Introduction

Sustainable and affordable energy supply has strong correlation with the socioeconomic development of any country due to increasing population, urbanization and industrialization [1, 2]. Most of the countries throughout the world rely on Fossil fuel to meet energy requirement , 87% of which was met by non-

renewable fossil fuels such as coal, oil and gas, while 9% by renewable energy and 4 % by nuclear power in 2014 [3]. Pakistan is a developing country, where energy demand has risen dramatically due to population explosion and modern development. Like most other countries, Pakistan mainly relies on fossil fuel to meet its energy requirement. The exhaustion, accelerated demand and adverse effects on environment of non-renewable energy have forced policy makers and planners to think about environment friendly alternatives. Therefore, many innovations are undergoing to increase the renewable energy supply globally.

Unfortunately, in the current energy supply scenario of Pakistan, the renewable energy contribution is just a small part of the total percentage. In the past decades, very few serious and remarkable efforts for renewable energy sources have been made in Pakistan, which has resulted in great challenges: particularly in electricity and gas load shedding (more than 8-10 hours), price risen, law deterioration, unemployment and food deficiency are impeding the sustainable development of national economy. In fact, Pakistan has a great potential for renewable energy utilizations if a suitable infrastructure implementation is adopted as a possible option like those of Ireland and Denmark [4, 5].

This paper intend to present an overview of current energy portfolio of Pakistan in energy supply and demands, pinpoint energy crises in the context of energy shortfall, challenges, comparison of different sectors (domestic, commercial, agricultural and industrial), which are presented to rank the priority in terms of energy consumption, renewable and nonrenewable energy potential with possible recommendations. Various renewable energy sources including hydropower, solar, wind power have been explored to find an option for secure and sustainable energy.

2. Current energy status of Pakistan

In Pakistan, primary energy sources are mainly thermal (87%), hydropower (11%) and nuclear power (1.7%). The total energy supply in 2013 was 64.5 million tons of oil equivalents (MTOE). The primary energy sources were Oil (20.96 MTOE), Gas (31.1 MTOE), LPG (0.3 MTOE), Coal (3.8 MTOE), Hydroelectricity (7.1 MTOE), Nuclear electricity (1 MTOE) and imported energy (0.08 MTOE) with different level of share. The share of gas was 48.2% in total energy mix of country, followed by oil 32.5%, hydro 11%, coal 6, nuclear 1.7%, Liquid Pressurized Gas (LPG) 0.5%, and imported energy 0.1%. In 2013, industrial sector was the largest energy consumer, which accounted 35.5% of the total 40.18 million TOE energy consumption, followed by transportation sector of 31.6%. Domestic sector was the largest consumer of electricity, accounting for 47% of the total 76789 GWh electricity consumption, followed by industrial sector with 29.05% [6]. Pakistan electricity generation capacity at the time of independence was only 10.7MW, which increased significantly from 7000MW in 1980 to about 16000MW in 2013-14, but this supply amount is still much less than the rising demand. Currently, Pakistan is facing serious electricity shortfall, about 6-8 hours in urban areas and 8-10 hours in rural areas in 2012. The electricity gap between supply and demand is depicted in Figure 1

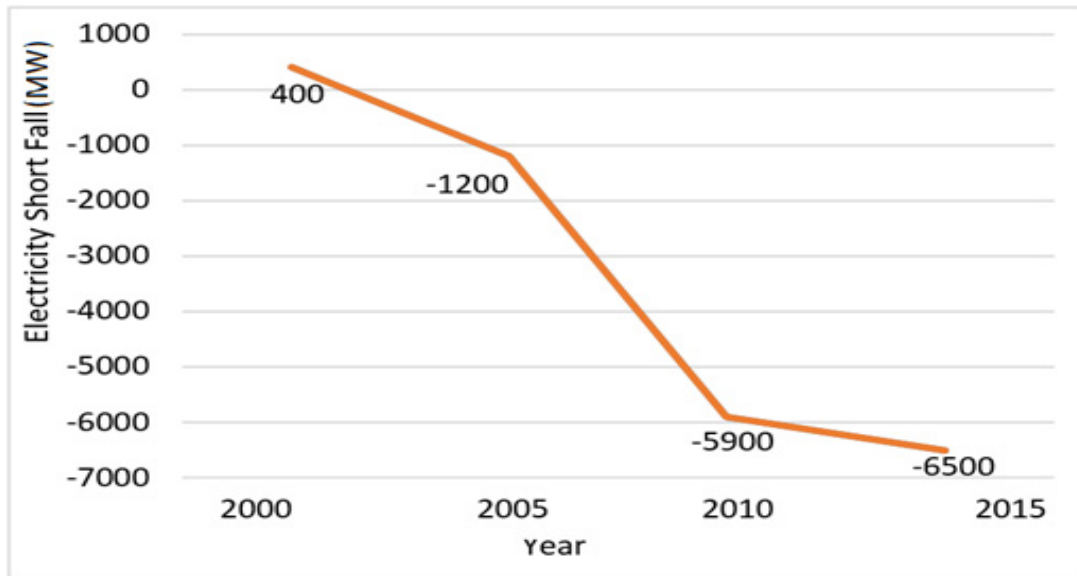


Fig. 1. Difference b/w power supply and demand in Pakistan Source: [7]

3. Renewable energy potential of Pakistan

Pakistan has potential for many types of renewable energy like solar, wind, hydropower, bio-gas, geothermal and waste-to-energy. But most of them are still under development.

3.1. Solar energy

There is a 2,900,000 MW solar energy potential due to Pakistan's geographical location with more than 300 sunshine days, 26-28°C average annual temperature and 1900-2200 kWh/m³ annual global irradiance [8]. In 1980, Pakistan has the 18 photovoltaic (PV) systems with 440kW installed capacity. However, due to poor maintenance, carelessness and lack of knowledge, these systems did not remain functional for a long period. The government after that introduced prime minister solar villages in remote areas like villages in Baluchistan, Cholistan and some in Sindh, where electricity grid was not possible. Solar photovoltaic systems of 100-500W/unit have been installed for electricity generation and water heating because water heating is energy intensively consumed almost 10% of total primary energy supply [9]. That is why in 2013 import for solar water heaters increased from 260 in 2007 to 16715. Pakistan council of renewable energy technologies (PCRET) and Alternative energy development board (AEDB) are renewable energy development organization. AEDB has 200 kW total PV power generation, PCRET has 80 KW, while private sectors have 500kW total power generation [10]. So far, Pakistan has been increasing share of solar energy but remarkable and giant steps are still required for this sector to decrease the load shedding duration.

3.2. Wind power

Pakistan has about 346000MW potential for wind energy [11]. Due to this favorable weather condition, the shortfall of electricity can be overcome by wind power like other countries, e.g., China and India. In the 1960s,

wind share for electricity was 60% but now days its share for electricity contribution has decreased to 30% due to poor maintenance and lack of relevant experts. Pakistan Meteorological Department reported that commercially wind resources are presented especially along the coastline area in southern part of country with average monthly wind speed 7-8 m/s [12]. According to this report, coastal belt of Sindh and Baluchistan has more than 50,000MW wind power potential but unfortunately no commercial wind power plant had been developed until 2013. Only few micro level plants with capacity of 300-500W for electricity at domestic level are functional. Wind power system in Baluchistan and Sindh are also used for water pumping at small levels. But current situation related to wind power projects are better because 5 projects (255.4 MW) are operational, 9 projects of (500 MW) are under construction and 11 projects (800 MW) are applied to financial demands. Based on this trend, the current government has been trying to add 3000MW by wind power till 2015.

3.3. Biogas

As an agricultural country, biomass is commonly used in Pakistan in the form of animal dung, sugarcane bagasse, and pulp and paper residues. The biogas potential is estimated to be 19.125 million m³ per day [13]. It is cheap alternative energy source: especially for cooking purpose because in Pakistan mostly population lives in rural areas. This is why PCRET has installed more than 1600 plants with capacity of 5m³/day before 2010 because biomass along with biogas also produced bio-fertilizer. Thus, it gained high popularity among farmers of various districts of Punjab especially in northern part. People built small biogas plant by on their own or with the help of government. AEDB is also working on biogas projects especially in Sindh with the help of New Zealand, and has completed project in landhi cattle colony in Karachi, which consumed about animal dung of 400,000 for the production of electricity in that area. Most small level biogas plants are installed in past but now with capacity of 10m³ -20m³/day have been installed in southern Punjab especially in Sialkot, Jung etc. Some biomass plants, for example SSJD (12MW) in Sindh, Lumen Energy (12MW) Shahkot, Biomass power generation limited 12(MW) Faisalabad in Punjab and green sure environmental solution 129 (MW) Mardan in KPK, are in various stages of implementation. Government also has been trying to set up co-generation with private sectors, especially with sugar- mill industry so that 1500-2000 MW power would be supplemented in energy supply till 2017.

3.4. Geothermal energy

Pakistan has great potential for geothermal resources in northern areas especially in Kashmir, KPK, Himalayas and Baluchistan with temperature ranging from 30-170 C° [14]. No effort has been done to make use of geothermal energy a lot of work and investment are greatly needed for real implementation.

4. Conclusions

Pakistan is facing serious challenges of energy due to poor planning, population explosion and old infrastructure. However, the present gap 6500MW and future demand can be compensated by managing existing resources, optimization of infrastructures, reasonable planning, strong financing, and partnership with private sector and international agencies. There is also a great potential of renewable energy, e.g., 2,900,000MW for solar, 346000 MW for wind, 3000MW for biogas, 2000 for small hydropower and 1000MW for waste-to-energy. Since the percentage of renewable energy is still less than 1%, the government, policy makers and planners should give the priority to outsourcing new alternatives so as to achieve the share of 15% in the nearest future.

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Acknowledgement

This work was supported by the Fund for Innovative Research Group of the National Natural Science Foundation of China (No. 51421065), Major Research Plan of the National Natural Science Foundation of China (No. 91325302), National Natural Science Foundation of China (Nos. 71573021, 41271543), and Specialized Research Fund for the Doctoral Program of Higher Education of China (No. 20130003110027).

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Biography

Bin Chen is a professor of energy science at Beijing Normal University. Dr. Chen has published over 200 peer-reviewed papers in prestigious international journals. He is also serving as subject editor of *Applied Energy* and editorial board member of more than ten journals.