

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/ijhydene

A comparative study of biomass resources utilization for power generation and transportation in Pakistan

M. Jibran S. Zuberi ^{a,*}, Mehdi A. Torkmahalleh ^b, S.M. Hassan Ali ^a

^a Sustainable Environment & Energy Systems, Middle East Technical University – Northern Cyprus Campus, Guzelyurt, Kalkanli, Mersin 10 Turkey

^b Chemical Engineering Program, Middle East Technical University – Northern Cyprus Campus, Guzelyurt, Kalkanli, Mersin 10 Turkey

ARTICLE INFO

Article history:

Received 24 October 2014

Received in revised form
25 May 2015

Accepted 26 May 2015

Available online 19 June 2015

Keywords:

Biogas

Bio-methane

Power generation

Transportation

Pakistan

ABSTRACT

Abstract: Sustainable energy technologies increase energy security, bring environmental friendliness and now getting economically attractive with every single passing day. Specifically, biomass energy is a viable substitute to meet the trekking demands of energy in the Pakistani scenario. This study investigates the potential of three major biomass energy resources available in Pakistan: Livestock, Bagasse and Municipal Solid Waste for either power generation or sustainable transportation. These origins may yield up to 29.7 million cubic meter of biogas daily. The results of this study also suggests that biomass energy can contribute a fraction of approximately 24% in the total electric power generation in the current situation while the potential contribution is very low i.e. 0.2% for transportation when compared at the same node. Detailed feasibility studies and technological advancements are needed to introduce biogas into transportation as an alternate fuel. The outcomes of this comparative analysis might also be applicable to other developing countries having similar resources.

Copyright © 2015, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

Introduction

Overview

Pakistan is an agrarian country lies between latitude 23°N and 27°N and longitude 60°E and 76°E. Pakistan also has the world's sixth largest population i.e. 184.35 million as of 2012–2013 with an annual growth rate of 2%. Rural population is almost

62% of the total population of the country [1]. A rapid growth in population and economy of the country has put an enormous pressure on the federal government to invest and revise its energy portfolio. Pakistan is rich in renewable energy resources but due to lack of policy and technological advancement, these resources have not yet been utilized significantly. Agricultural sector is the key component of the economy of Pakistan contributing 21.4% to the GDP and providing employment to 45% of the total labor force of the country [2].

* Corresponding author. Tel.: +90 5338620116.

E-mail addresses: jibran.zuberi@metu.edu.tr (M.J.S. Zuberi), tmehdi@metu.edu.tr (M.A. Torkmahalleh), ali.muhammad@metu.edu.tr (S.M.H. Ali).

<http://dx.doi.org/10.1016/j.ijhydene.2015.05.166>

0360-3199/Copyright © 2015, Hydrogen Energy Publications, LLC. Published by Elsevier Ltd. All rights reserved.

Therefore, it is anticipated that out of all the renewable resources, biomass is a potential source that can serve immensely to the current energy crises faced by the country as it is de-centralized and widely available throughout the country.

Energy from biomass resources especially for power generation and heating purposes is now considered a well-known technology as a lot of work has already been performed to extract maximum benefit out of it. During 1992–93, biomass fuels have constituted approximately 92.2% of the total energy consumption of Nepal [3]. Also, in the same year, Netherlands' Director-General for International Cooperation (DGIS) initiated a scheme in Nepal entitled as Biogas Support Program (BSP) with an aim to save approximately 2000 kg of firewood and 32 L of kerosene oil per year for an average biogas plant. This scheme also helps to reduce 4600 kg of greenhouse gas (GHG) emissions approximately mitigating climate change. More than 180,000 biogas plants have been installed all over the country since 1973–74 to 2006–07 [4]. By 2007, China has produced approximately 2 million cubic meter of biogas from 6.8 million households and 1000 digesters which corresponds to 5% of their total gas energy [5]. By 1996, 2.7 million biogas plants had been setup in India and the research is still in progress to harness the maximum potential out of their biomass resources [6]. In 2002, Denmark produced about 2.6 PJ of energy from 20 centralized biogas plants and over 35 farm scale plants. Denmark is also keen to promote biogas utilization even more within its territory [7]. Presently, biomass contributes to 70% of the total renewable energy used for fuel, heat and electricity production in Germany [8]. Despite having successful examples from several parts of the world and even its neighboring countries, Pakistan is lacking behind harvesting its own biomass energy resources for power generation to an extent that makes difference.

Specifically, when it comes to transportation, the world relies heavily on the use of fossil fuels. In Pakistan, natural gas is being widely used as a fuel for transportation along with the petroleum products. Although Pakistan had plenty of natural gas reserves when it was discovered in 1952, its massive exploitation in the form of Compressed Natural Gas (CNG) over the last two decades has raised concerns over its sustainable future. Bio-methane is a decent alternative to overcome the current shortage. Sweden is a successive example which is the world's leader in upgrading biogas produced from biomass resources to bio-methane for transportation. The country has several biogas vehicles moving on roads which not only include cars and buses but even trains as well [9].

Highlights of power sector of Pakistan

Pakistan is in the midst of one of the worst energy crises in its history. This is both slowing down the pace of economic activity and causing public unrest with prolonged outages of electricity. Capacity utilization in some key industries has fallen to nearly 50 percent [10]. The country consumed 76,761 GWh of electricity during 2012. Fig. 1 shows the percent contribution of various technologies for power generation within the country. Hydel shared 31.9% of the total power generation in 2012–2013. Oil and gas contributed 35% and 29%

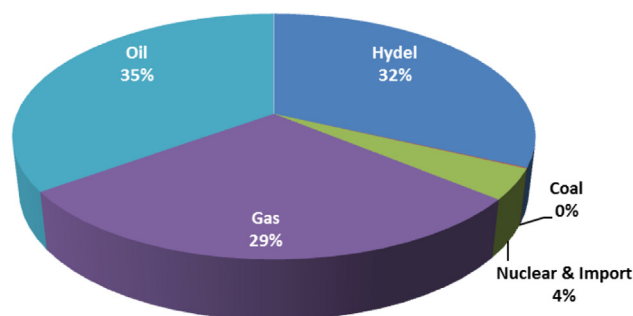


Fig. 1 – Pakistan's current portfolio of electricity generation by source.

respectively in the same year while share of coal remained stationary i.e. 0.1% as compared to the last year. It is evident that Pakistan is heavily dependent on oil and gas supplies. Approximately 14.5 billion USD have been paid by the government of Pakistan on oil imports for the past few years, most of which is used for power generation [11]. Fig. 1 also reveals that the percent share of renewable energy i.e. Biomass, Solar, Wind and Geothermal is so low that it is not even shown in the portfolio. It is obvious that without exploring its own renewable resources, Pakistan cannot resolve its energy issues. Therefore the country urgently needs to make some strategic decisions and change the national energy mix.

Fig. 2 shows that the electricity demand grows exponentially every year while the supply remains low due to the fact that the installed capacity that Pakistan has is at a halt for the past few years. Growth in demand intensify power deficit every year resulting into power crises and load shedding [8]. National Transmission and Dispatch Company Limited (NTDC) reported the electricity peak demand during July–March 2011–2012 to be 18,860 MW while the supply remained 12,755 MW i.e. a deficit of almost 6000 MW [12]. To estimate the peak demand every year up to 2030, Zuberi et al. [8] extrapolated the trend and fitted an exponential curve over the data shown in Fig. 2. The model has determined predictive power for next 16 years with R^2 of 0.9997 as shown in Fig. 3. The demand is expected to exaggerate more than 66000 MW approximately by 2030 [8].

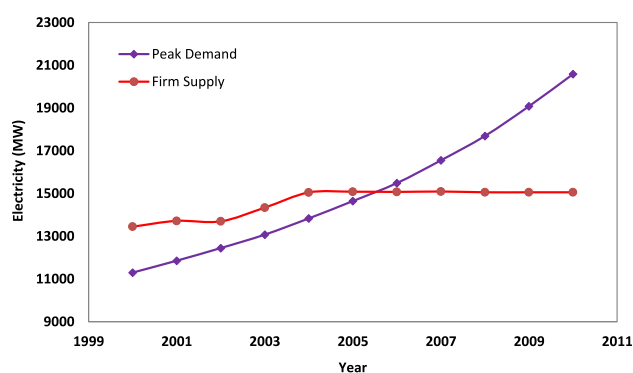


Fig. 2 – Annual demand and supply of electricity in Pakistan from year 2000–2010 [8].

Download English Version:

<https://daneshyari.com/en/article/7714835>

Download Persian Version:

<https://daneshyari.com/article/7714835>

[Daneshyari.com](https://daneshyari.com)