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"BIOENERGY-CHALLENGES AND OPPORTUNITIES IN PAKISTAN"

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ABSTRACT

Energy being significant environmental issue globally plays a key role in modern society and can serve as an important component in socio-economic development of a country. For the establishment and development of bio-energy production, we require many biotechnological tools at the grass root level. Some developing countries have already been established similar facilities. Despite advancements in technology, people continue to meet their energy requirements for cooking through conventional means by burning biomass resources (i.e., firewood, crop residues and animal dung). Such practices are known to be the source of environmental, social, economic and public health issues. For the achievement in sustainable development, it is important to access clean and affordable (renewable) energy availability for preserving the local and global environment. Country like Pakistan, facing severe energy crush which is extremely affecting the lives of people. In Pakistan, being potentially strong in harnessing different renewable energy resources (i.e. biofuels/bioenergy, hydropower, solar power and wind energy), these resources have not been sustainably taken due to geographical, technical, political and economic reasons. Within this context, Renewable energy (RE) can play an important role to minimize this energy issue and the biggest challenge is the pragmatic renewable energy policy, its implementation through an independent national or energy authority. So there is need of upgrading existing biomass resources (i.e., animal manure, crop residues, kitchen waste and green wastes) for cleaner and more efficient energy carriers having unique potential to provide clean and reliable energy to serve developing nations. However, high costs and lack of expertise in installation and maintenance of sustainable energy technology impede its wide applications in geographically isolated communities. Intensive efforts in facilitating modernization and distribution of bioenergy technology to harness the inherent potential at both governmental and non-governmental sectors that is currently underutilized and unemployed. The intent of this paper pursues the highlights of present status, challenges, and potential of bioenergy technology for further research and development.

KEYWORD: Country like Pakistan, facing severe energy crush which is extremely affecting the lives of people.

INTRODUCTION AND BACKGROUND

Energy is the most vital instrument of life. There has been rapid increase in the demand of energy as a result of industrial development and population explosion, in comparison to enhancement in energy production. Due to expansion in global economy energy demand has increased tremendously (Banos *et al.*, 2011). Energy crisis has emerged due to gap in supply of energy and its actual demand. The global energy resources, mainly fossil fuels, in order to meet the desires of growing human population are under immense pressure due to over exploitations. Therefore, fossil energy resources are facing a threat of rapid depletion in near future. Despite the risk of depletion, fossil fuels are also associated with many environmental issues like green- house gases (GHGs) emissions, which is usually responsible for global warming and climate change (Langan *et al*., 2011) Thus, non-renewable (i.e. Secure and sustainable energy) supply ensures option on long term basis due to their depletion and environmental risks (Bhutto *et al*., 2011). These two challenges, energy resource depletion and emerging environmental issues, can only be overcome by the use of sustainable energy. So, the next important commodity is Combustible Renewable Energy (CRE), which contributes around 10% of the world's (Total Primary Energy Supply (TPES) share. Conventional biomass energy or CRE, constitutes 80% of the total renewable energy consumed mainly in developing countries while other sustainable energy resources (i.e. hydro, geothermal, solar and wind power are consumed mainly in developed countries (OECD/IEA, 2007). Thus, it is necessary to address the energy crisis through the over exploitation of abundant renewable energy resources, such as biomass, solar, wind energy and geothermal energy (Pode, 2010). Within this context, due to the reduction on the imported forms of energy, the potential of biomass to meet the world's energy demand has been extensively recognized (Kirubakaran, *et al*.,

2011). Presently, the traditional biomass energy resource (i.e. old one) such as hydropower supplies 6 and 9% of global primary energy demand and the ―new‖ renewable sources such as wind, photovoltaic and mini and micro-hydro only provided around 2% of the world's primary energy (Pode, 2010). The global share of renewable energy was 20.3% in the power sector at the end of year 2011 (Viswanathan, *et al*., 2011). Being the oldest and most mature form of the hydroelectric generation has a share of 15.3% power generation whereas only 5% was contributed by other renewable generations. Renewable energy generation has total disadvantages when compared with non-renewable fossil fuel resource of energy production (Tongsopit, 2013). In South Asia, the household's energy usage comprising fuels like animal dung, crop residue, firewood, kerosene, gobar gas, LPG, and electricity for cooking purposes. It is a known fact that there is 10% or less thermal efficiency operations by using conventional mud stoves (Kishore *et al*., 2004 and 2011). Some other disadvantages of the traditional fuels are also reported which includes laborious and time-consuming nature of fuel collection, difficulty in controlling combustion process and heat exchange inefficiency (Viswanathan, *et al*., 2011). Moreover, serious health threats also poses by the use of traditional fuels like open fire responsible for acute respiratory problems, particularly for women and children (Bhutto *et al*., 2011, Viswanathan, *et al*., 2011). Evidence suggests that the transition from urban to semi-urban areas but this change is very slow in rural areas (Bhutto *et al*., 2011). These traditional forms of energy leads to significant health impacts as well as other major drawbacks, yet there has been little progress in meeting this challenge.

The Pakistan perspective

Pakistan is situated in the South Asian region. Its annual growth rate is 2.05%, with expecting that Pakistan in population terms will become the fourth largest nation on earth by 2050 (Economic Survey of Pakistan 2010). Pakistan with very low forest cover of about only 5.17% of total land area. So, in order to reduce the stress on natural forests, there is a need of utilizing sustainable energy resources like micro-hydropower generation, energy plantations, bio-gas, solar and wind energy, liquid petroleum gas (LPG) and natural gas. Pakistan has been one of the fastest growing power markets in the world for nearly two decades. However since five years, the economic progress has been greatly hampered by acute energy scarcity (HDIP, 2011). (Sahir and Qureshi, 2008) concluded that, renewable resources may serve to supplement the long-term energy needs of Pakistan to a significant level after evaluating new and renewable energy resources potentials of Pakistan. People of Pakistan while accessing to commercial energy resources utilizing traditional or non-scientific conventional technologies which reduces its potential and efficiencies. Chaudhry *et al.*, 2009 presented a review highlighting the importance and challenges of new era technologies in Pakistan, concluding how renewable energy sources can be used to overcome energy shortage in Pakistan.

Pakistan's Energy Supply and Consumption

Energy crisis in Pakistan facing economic crunch due to the worst energy shortage (Chaudhry *et al.*, 2008). Load shedding power has not only effected the quality of life but it also worsened national economy of the country (IRG, 2010). National growth rate decreased by 2% during 2009–2010 due to energy shortage. During same year corresponding to 53% of total energy requirements, Pakistan has produced 4063 million ft^3/day of natural gas and 65,000 barrels/day of crude oil (Amjid *et al.*, 2011). Besides these, other energy resources contribute up to 19% to the total requirements. According to IPRI, 2008 (Islamabad Policy Research Institute), energy supply and per capita availability of energy observed a decline of 0.64% and 3.09% respectively in contrast to previous year. Currently, Pakistan is able to produce about 11,500 MW electricity per day although its needs are about 15,000 to 20000 MW per day, hence there is a shortfall of about 4000 to 9000 MW in each day. This shortage is badly impeding the economic growth of the country. Pakistan's energy consumption is met by the use of gas, oil, coal, and electricity and LPG sources with different level of shares. Indigenous conventional energy resources are already exploited at their maximum (MPNR, 2011) and in order to meet future growing energy desires, renewable energy resources need to be given representatives have no order to attain Millennium Development Goals. Otherwise, these energy crises will probably cause economical halt, social insecurity and terrorism in the country in future. Pakistan mainly depends on conventional sources for electricity production. Approximately 94, 653GWh of electricity was generated in the country during 2010–11 including main contributors in the energy mixture are thermal power (62.5%), hydal (33.6%) and nuclear (3.9%) and the total energy mixture is virtually negligible in the share of renewable energy (HDIP, 2011). The common perception about the renewable energy generation is the cost disadvantage but the growing prices of fossil fuel in Pakistan and the abundant availability of renewable energy resources may help in achieving the grid parity.

Opportunities in Pakistan

Non-renewable resources (Fossil fuels) limited or expensive in nature) are primarily coal, petroleum, natural gas and liquefied petroleum gas (LPG). Petroleum products contributed 29% of total share of energy in 2009-10. Reserves of crude oil in our country have been expected at 303.63 million barrels and we are extracting roughly 24 million crude oil annually, meaning if we are not going to explore new wells, we will exhaust our current crude oil reserves in 12-13 years. The average production of natural gas is 4,048.76 mf^3 per day as against 3,986.53 m previously, showing an increase of 1.56 percent used as CNG as 43.7 percent and LPG as 0.7 percent and currently Pakistan is the largest CNG user country in the world. Coal reserves in Pakistan has estimated at over 185 billion tons, including 175 billion tons explored at Thar coalfields. Nearly 67 percent coal is imported because native coal is not

considered to be of good quality. Guddu plant is largest thermal plant operated with a capacity of 1,650 MW, while two largest Power Plants (IPPs) are Kot Addu with (1,600 MW) production and Hubb River with (1,300 MW) production in Pakistan working independently. In order to improve growth rate and stabilize economy of Pakistan, sustainable energy supply will play a vital role. Pakistan spends almost 20% of its foreign exchange to import fossil fuels, whereas traditional fuel export adds up to 40% to the total imports (Ghaffar *et el.,* 1995). Probably, in order to maintain an average GDP around 5.6% between 2011 to 2030, the energy requirements of the country will increase thrice (6.2– 18 Mtoe) of the present requirement, and energy imports will increase from 27 to 45% (IRG, 2010). Pakistan will require approximately 1500 Mtoe energy leaving an energy gap of 214 Mtoe against estimated available energy of 1286 Mtoe by 2050, (Heedge *et al.,* 2008). Furthermore, Pakistan will face a 29% energy shortfall during the start of next decade (Khan, *et al.,* 2011). In order to meet current and future energy needs, it is obvious to include renewable energy sources in the traditional fuel supply. Hydro power is generated by using electricity generators to extract energy from water flow. Pakistan being rich resource of energy in hydel power, however, only 34 % of total electricity production comes from hydro power. Currently we are having 6555 MW against the potential of 41000 to 45000 MW.

Current Hydropower stations

Tarbella Dam:	3,478 MW
Ghazi Brotha:	1450 MW
Mangla:	1,000 MW
Warsak:	240 MW
Chashma:	184 MW

Potential Hydropower stations

Diamer-Bhasha Dam:	4500 MW
Munda Dam:	740 MW-Swat river in Mohamand Agency
Kalabagh Dam:	2400-3600 MW
Bunji Dam:	5400 MW
Dasu Dam:	3800 MW

One of the most viable options for future energy security of Pakistan is ―Biomass‖ among many renewable energy resources (Amjad *et al.,* 2011). The government of Pakistan has decided to increase its renewable energy share from 0 to 2.5% of its total energy demand by 2030. Production of bioethanol has been expected to grasp 0.288–1.15 million tons by the same year in Pakistan under different scenarios which will save about US $200–400 million. Production of biogas will be increased 4000 MW by 2030 under Pakistan Energy Security Plan (Khan *et al.,* 2008) which will facilitate people living in the rural areas of Pakistan (Amjad *et al.,* 2011). Among unconventional sources of energy, Pakistan has potentials of producing wind energy ranging from 10000 MW to 50000 MW, yet power generation through wind is in preliminary stages in Pakistan and currently 06 MW has been mounted in first phase in Jhampir through a Turkish company and 50 MW will be installed soon. Additional wind power plants will be built in Jhampir, Gharo, Keti Bandar and Bin Qasim Karachi. Solar power potential in Pakistan is of more than 100,000 MW. Building of solar power plants is underway in, Punjab, Sindh, Kashmir and Balochistan. Though, private vendors are importing panels / solar water heaters for consumption in the market. In Gilgit Baltistan, AEDB-Alternative Energy Development Board is working for 20,000 solar water heaters. Mobile companies have been asked by the government to shift supply of energy to their transmission towers from petroleum to solar energy panels. Pakistan has planned to generate 10 MW of electricity from municipal waste by using agricultural biomass /biodiesel, in Karachi, similar projects also introduced in twenty cities of country. Another renewable energy source which is clean, free and sustainable energy resource is the ―Coastal tides‖. In Pakistan, different plans are in progress to harness tidal energy, however, no implementation has been made so far. Nuclear fission reaction in nuclear power stations are used to generate energy by the use of uranium. Currently, Pakistan has a small capacity of nuclear power program with 425 MW but there are plans to increase this ability significantly. Since Pakistan is excluded from the Nuclear Non-Proliferation Treaty trade in nuclear plant or materials, which hinders its development of civil nuclear energy. Enduring issues in development of nuclear energy are improvement of uranium from U^{235} to U^{238}, controlling chain reaction and removal of solid waste.

Pakistan Nuclear Power Reactors

Reactor	Type	MW	Construction started	Commercial operation
Karachi	PHWR	125	1966	1972
Chashma 1	PWR	300	1993	2000
Chashma 2	PWR	300	2005	expected 2011
Total		425 MW		

CONCLUSIONS

Pakistan is challenged with the worst ever energy crisis which have severe impacts on its economic growth and sustainability. On the other hand, energy demand is increasing rapidly and has caused a big space between energy demand and supply. Alternative or Renewable energy resources are emerging in energy market of Pakistan. There are unlimited opportunities in renewable energy sector but challenges are many. The biggest challenge is the use of renewable energy resources and then its execution through a self-regulating energy authority or national task force having full authority for its implementation. Solar opportunities exist in Punjab province, wind opportunities exist in Sind and Baluchistan, Nearly all provinces have coal opportunities, Hydro opportunities exist in north of Pakistan and Bio-energy exists in all provinces. Government looks committed to resolve the energy crisis but all factors causing energy crisis are not under its

control up till now. There is need for cohesive energy policy and control mechanism to overcome the crisis and National Energy Authority can be instrumental to join all the pieces together. Constant development policy may not work now as things have gone worst and radical program can only guarantee its resolution. Pakistan Council for Renewable Energy Technology ensure the development of renewable energy projects in the country in 2001. Alternative Energy Development Board (AEDB) join such efforts in 2003 but unfortunately both of the government organizations were failed to achieve any major breakthrough due to technical man- power and weak financial recourses. National Renewable Energy Policy (NREP) 2002 set some following targets:

1) The renewable energy stake in national energy mix will be of 3%.
2) The annual development budget will be of 2% for the development renewable energy technologies.
3) All localities are to be reserved for renewable energy resources which are anticipated to be integrated in the national grid in next 30 years.

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