Renewable Energy 108 (2017) 19–25

Contents lists available at ScienceDirect

Renewable Energy

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

Review

Socio-economic, health and agriculture benefits of rural household biogas plants in energy scarce developing countries: A case study from Pakistan

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ARTICLE INFO

Article history:
Received 6 April 2016
Received in revised form
12 January 2017
Accepted 16 February 2017
Available online 20 February 2017

Keywords:
Biogas
Fossil fuel
Renewable energy
Animal dung

ABSTRACT

Biogas can be used as main component towards energy scarcity. It is important to find out social and economic assessment of different commonly adopted biogas plants in deprived rural areas at domestic level. The study design was based on questionnaire, field visit, observation and manipulation in terms of change in energy usage, kind of benefits, incidence of disease, change in sanitation, gender empowerment and operational activities of biogas plant. The results of questionnaire showed that installation of biogas plant has resulted in economic, social and health improvements by reducing expenditure of fuel and fertilizer along with time saving and lessen cases of disease. Biogas plants were mostly installed in those houses that have higher number of family members ranged from 12 to 15. Saving on energy expenditure was 53.3% due to use of biogas. It appeared that 43% women were getting more benefits from biogas by saving 50% of their time which was previously used for collection of wood. Total monthly saving in term of socio-economic and health was 48$ by the use of biogas plant of single household. There was 25% reduction in respiratory ailment and cardiovascular disease due to the reduction in air pollution by the use biogas plant.

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http://dx.doi.org/10.1016/j.renene.2017.02.044
0960-1481/

1. Introduction

According to a special report by the International Energy Agency more than 1.3 billion people live without access to electricity and more than 2.6 billion use wood, charcoal or animal dung for their daily cooking. As modern energy is seen as a key element to reduce poverty and enable human development, various international programs now focus on the distribution of access to appropriate modern ways of energy worldwide. One of these promising technologies is the household digester to provide biogas for cooking from the anaerobic digestion of fresh manure. In recent years many National Biogas Programs (NBP) were developed in South Asia, India and Africa and more than 45million systems were installed. Since 1992, when the first NBP started in Nepal, all the upcoming programs mainly focused on biogas production, in order to replace wood as a cooking fuel, improving family health through a smoke free indoor environment, reducing deforestation and water contamination [1]. In today energy demanding life style there is need to explore new energy source that are renewable and eco-friendly [2].

Reduction of environmental impacts along with resource policy involvement are linked with energy production from fossil fuels has increase the chances of the development of renewable energy such as biogas. There are many beneficial environmental aspects related to biogas such as generation of energy from waste, waste treatment and bio fertilizer [3].

Traditional energy sources refer to biomass which rank fourth position after oil, coal, and gas, in terms of contribution to the world total energy production [4].

Energy demand is continuously rising by increase in population and industrial development. Currently there is huge difference in consumption and availability of energy resources [5]. In Pakistan almost 20% of the foreign exchange is spent on import of fossil fuels [6]. Socio-economic sector has sound relationship with energy as it determines standard of living [7]. Affluence of any society is measured by key of per capita energy consumption. Traditional energy resources like coal, oil and natural gas are fulfilling the major demand of energy worldwide. But their usage pose two main problem, their reserves are shrinking and they are deteriorating the environment [8]. Conventional energy resources like coal, oil, natural gas etc. are playing significant contribution in accomplishing energy demand but at the same time they are a continuous threat due to alarming damage to environment and human health as well as there is risk of their depletion [9]. Agricultural residue is the major fuel source for the potential of energy in many developing countries [10]. Biogas is an efficient replacement of traditional wood fuel and dung as fuel for domestic use [11,12]. Biogas plant runs on various agricultural waste feed stocks like; animal manure, vegetable, poultry and sugar waste etc [13]. Due to increasing oil prices and other health impacts, it is critical to consider this sustainable energy resource. Biogas is produced as a result of anaerobic digestion of organic material like animal manure, kitchen waste, agriculture residue poultry dropping, sugar molasses etc. [11,12].

Pakistan's livestock account about 159 million animals creating nearly 652 million kg of manure on daily bases from cattle and buffalo only, which could have the potential of 16.3 million $m^3$of biogas daily over 20 million tons of fertilizer per annum [14,15]. Biogas plant installation at domestic level was started in 1959 in Pakistan. Biogas Support Program (BSP) was initiated by Pakistan government in 2000. Up to now it has completed the target of installing 1200 biogas units, whereas another 10,000 units are estimated to be set up in coming five years that will produce almost 27% of country's biogas potential [16]. Currently Pakistan Dairy Development Company (PDDC) has started biogas unit's installation in its horizon-3 started with an objective to provide alternative renewable energy in very low price to rural groups [17]. Up to 2009 nearly 450 biogas plants were installed [18].

Biogas technology is a useful technology in the production of renewable fuel i.e. biogas. In rural areas people uses biomass (dried dung and firewood) to meet their energy needs. This demand is satisfied by land degradation and deforestation which result in different health and societal and also releases sufficient amount of green-house gases. Factors that lead to adaptation of biogas digesters are dire need of rural population to meet the needs of cooking, lightening, heating and feed stock [16]. Also the outputs of biogas digester i.e. gas and slurry. Gas is valuable as source of energy and slurry has importance as fertilizer. It is considered as clean, gender friendly, cost effective source of energy and has many environmental, economic and health benefits [19]. In addition, installation of biogas digesters creates new employments because it requires several skilled personnel for designing, micro financing and fabrication/construction along with other unskilled employment required for daily operation.

A biogas unit of 10 m^3 size is expected to save nearly 150$US per year on account of conventional fuels spent otherwise [16]. Health maintenance cost accounts 10 $US per month. Bio slurry can replace chemical fertilizer to an amount of 10$US per month [20]. The installation cost of each biogas unit is reported between 565$US and 650$US and manure of 4–6 buffaloes and/or cows is sufficient to run every of these domestic units. Government is providing 50% subsidy to the client farmers as well [17].

So it is also essential to trace out impacts of this technology on community and their willingness to adopt the technology. There are certain problems with biogas plant. One is relatively high investment cost for poor household who usually hesitate to invest as there is no apparent direct cash generation from biogas plant. There is an immense shortage of training and knowledge on side of farmers, which is one of the triggering reasons of hesitation. Most of the farmers are generally not aware of safety and management procedures. Another reason is the selection of wrong size of bio digester through the offered government subsidy schemes as opposed to the need of the family [21]. Although the feed stock and water availability are not the barriers but the social and religious concept of cow dung and urine to be unholy. There is no concept to follow up consultant to monitor the digester and carry out technical services. The broad objective of the study is to find out prospects of biogas production efficiency along with socio-economic, health and environmental benefits to the rural community.

2. Methodology

2.1. Description of the study site

Suburbs and slums of mega city of Lahore that included villages Jallo, Bedian, Mehmood boti, Mandiawala, Jia Bagga, Ghanikey, Mouza Korian Barki, Mouza Opal Barki, Guru Manget, Mouza