Research Article

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Bio energy to power rural sector in Indian scenario

Abstract

Various developing countries have initiated a move towards shift towards dependence on renewable sources of energy not only for various farm based activities but also domestic consumption. Traditional source of energy are animal dung, agricultural waste, coal and kerosene oil. Looking at low thermal efficiency of these sources, biomass energy has emerged as a most suitable alternative. The paper presents an overview of needs of a rural sector. Present status of renewable energy is mentioned. Scope of bio energy to empower rural sector has been discussed. Challenges faced by the sector have been elaborated along with future scope of the same.

Keywords: economy, electricity, insufficient, efficiency, solar energy, domestic, power, consumption, warming, machines, filtration system

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Introduction

Energy is the basis of survival in both rural as well urban sector. In fact, the economy of a nation is driven by efficient energy utilization potential. Thus energy security is essential for the growth of not only an individual or a society but also for a nation as a whole.[1] Energy security of a rural sector is quite different than an urban section. Rural sectors are marginalised, venerable with insufficient resources. In India there are about 6,00,000 villages and out of total population of 121 crore 83.3 crore people live in rural sector Business standard report 2013,[2] where traditional source of energy are animal dung, agricultural waste, coal and kerosene oil. The thermal efficiency of these sources is very low. According to a report by Sinha and Biswas, use firewood for cooking, in rural and urban sector is about 75% and 22% respectively. The above statistics show the wide gap in energy security of rural and urban households. Ministry of Power reports the access of electricity to 82% of the villages (4.89 lakh) as on 31.12.2008, still the supply of power is not regular and fluctuation of voltage also affect their daily routine. However, power supply to a rural household varies from state to state.

The need of rural sector are different than urban sector. As per general prospection, a village needs electricity in the farm or cooking only. But in actual practice, a rural sector needs electricity for other day to day activities like running a schools, hospitals and enterprise as well. According to the Economic Census 2005, number of enterprises in rural and urban sector are 25.81million and 16.31million respectively. Thus the potential of a village to support an enterprise is huge.

Energy Consumption: Rural areas

There are three main field in which energy is consumed:

Domestic consumption includes cooking. Energy sources used for cooking are: Firewood, dung, LPG etc. Daily routine chores like washing clothes etc are based on the uses of electricity. Lightening and other activities are also based on the same.

Although, in developing countries, agriculture is still not fully mechanised, yet use of certain machines like tractor, harvester etc. require energy supply. It has been reported in a study that the total power consumption in farm activities was 88,555GWh (about 23% of total energy consumption) in India in 2005. State–wise variation study of the same shows that in the state of Gujarat about 46% was consumed which was maximum in the country, followed by Andhra Pradesh (43%) and Haryana (45%).[3]

Scope of Renewable energy

As the name suggest, renewable energy sources are obtained from sources whose supply is limitless. This includes the energy of sun, wind, earth, water, biomass etc.

However, as depicted from various studies, it has been found that the dream of facilitating rural areas with urban amities suffers due to lacuna in the sector of energy supply, which includes poor individual connectivity, quality of power and number of hours of electricity supply. While fossil fuels are highly polluting with emission of noxious gases with like CO_2, SO_2, and NO_x, renewable energy sources are clean.

As per data available from the MNRE report,[4] the major sources that fulfil India's energy requirement are oil and coal. The share of various sectors to produce energy is as follows:

a. Coal, natural gas and oil: 151.3GW

b. Nuclear sources of energy: 4.78GW

c. Hydro sources of energy: 30.49GW

d. Renewable energy: 27.54GW

Renewable energy sources provide like for like energy because once they are installed, operational costs is minimum. Fossil fuels are associated with emission of numerous toxic gasses. Sunburnt carbon particles, carbon monoxide, oxides of nitrogen and sulphur are a mater on concern for environmentalists all over the world. Various effects of these fuels are global warming, climate changes, degraded air quality. Renewable energy sources do not emit any harmful gas. This makes them green sources of energy. Renewable energy sources are based on renewable resources. This includes solar energy, wind energy, geothermal energy,[5] which are obtained from sun, wind and earth respectively. As the supply of these resources is limitless,

there is no restriction and cost on the use of these resources. Fossil fuels especially petrol and diesel are imported from the Middle East countries. Various factors like political instability, sudden increase in price, trade dispute may affect their supply. The cut in their supply can actually lead to complete non-functioning of a nation. Renewable energy sources are obtained from locally available material and with involvement of solid infrastructure they are found to be more reliable source of energy. Landowners of energy generation unit can get immense benefits in monetary terms, providing them with additional source of income. Once energy is generated in the field, this leads to cut in electricity bills. With the installation of renewable energy sources, each village can supply electricity to all its households, which will reduce pressure on their bills of electricity. Ability to generate its own electricity can boost the economy of a village. Installation of renewable energy sources can directly create jobs because man power is required for running the power station smoothly. Renewable energy can help to make rural youth entrepreneurs. A larg number of semi-skilled labourers available in rural India can help to installation, run, and provide after sales services of these systems. The man power needs to be trained to operate the power stations, so installation of renewable energy based power stations help in empowerment and skill development of youth. Women can also actively participate in these activities, which will help them to generate income. In addition to this, most renewable sources of energy require less cost of maintenance. Solar energy, wind energy require high initial installing cost. Once it is installed, further running cost is very low. There is almost no cost of maintenance is required in these sources of energy

Bioenergy sources: Indian perspective

In Indian sector, Solar and wind energy are widely used. There are a number of solar energy based equipment that are available in the market. Solar energy based fans, light, balloon, chimney, furnace, calculator, refrigerators, watch can be found in the market. Solar car, bus, train, rocket are in stage of development. Various successful examples, where the whole village has been converted into solar energy based green village can motivate others as well. There are various NGOs that are already in this field to help rural people to install solar panels. They have installed solar panels in the villages that can supply electricity to agricultural field, houses and industries. They also have a battery to store surplus energy to use during sunless hours. In certain villages, solar powered agri pumps, are in use as an economic and environmentally-friendly alternative diesel-fired pumps which are highly polluting. Emission of unburnt carbon particles through these pumps is noxious for the farmers handling them. An agri-pump works on the principle of solar energy. When the rays of sun falls on solar panel, the agri-pump starts working. During the day, as intensity of solar radiation increase, the pumps start working at higher rate. The water is pumped through these equipment throughout the day. Since the system requires no battery, there is no cost of maintenance is involved. There are high amount of financial inputs are required to install a water treatment plant. So the supply of clean water is a big problem in rural India. With the application of solar energy, villagers in Tsiesma, village near Kohima district in Nagaland, have developed a water treatment plant. This plant uses solar energy along-with an advanced membrane filtration system to give pure water. One of the other important field of application of solar energy is Information and technology (IT). Solar-powered computers, tablets, telecom towers can help to educate the rural youth and provide them better employment opportunities.

A wind turbines uses the kinetic energy of the wind to generate electrical energy. It has been reported that wind energy has capability to supply 10% electricity the year 2020. However, there are certain hindrances in this field. A large area of land, with fast speed of wind is a prerequisite to install a wind power plant.[6] Further, the cost of wind blades is added to the fixed cost. Research efforts are need to make the process, more efficient, more robust and less costly than current turbines. Ministry of Non-conventional Energy Sources (MNES),[7] Indian Renewable Energy Development Agency (IREDA) and the wind industry are working together to accomplish these improvements through various research and development programs.

Biomass being ligno-cellulosic material consists of carbon, nitrogen, hydrogen and oxygen. Cow dung, firewood, husk are used to produce energy since ancient times. Recently, with the development of new gasification biomass is finding application in energy generation research activities extensively. Being widely available, it can be used to generate energy in rural sectors.

The available sources of energy with potential to generate power are:

Agricultural residues: In a village, rice straw, wheat straw, sugarcane tops etc are primary residue, which are used as animal feed, fertilizers. The secondary sources are rice husk and bagasse, which are generally burnt by farmers, giving rise to environmental pollution and a matter of great concern for government, NGOs and environmentalists world-over. They hold great potential to generate power.

Agricultural feed: Crops like corn, sugarcane, grains, pulses and rubber are grown to generate bio-oil by direct gasification techniques.

Biomass waste: animal waste, food waste, industrial waste, municipal solid waste can be converted into energy using various technologies.

Biomass conversion techniques include pyrolysis, thermo chemical conversion techniques, gasification, combustion, fermentation etc.[8] Presently, many of these techniques are under development state. With the help of technological and infrastructural inputs, training of manpower, biomass can be used extensively in rural areas.

Energy from biomass can be generated using following two techniques: production of electricity: Bio-oil and biogas can be used to generate electricity and production of heat: burning of coal, and produce gas produces thermal energy. Breakdown of organic matter under anaerobic conditions (i.e. in absence of air) results in the production of biogas, which is primarily consists of following components: methane (60-65%), carbon dioxide (35-40%), hydrogen sulphide (0.5-1%) and water vapours (rest).

Agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste can be used for the same. Agriculture produces like animal faeces, or husks of rice, grains etc. can be uses as a fuel for cooking or raw material to generate electricity, to lessen the dependence on fossil fuels in rural India. India with annual agricultural waste generation of 350 million tons has a capacity to generate about 17,000MWe power and can leads to financial gains in terms of Rs. 20,000crores annually. It is expected that this trend will continue to improve with enhancement of agricultural productivity Sinha and Biswas. According to Ministry of New and Renewable Energy report 2008, only 656.6MW of power was generated till 2008.

An agricultural farm, with lots of agricultural waste is an ideal location to install a biogas plant, as there is continuous supply of raw

material. In areas, where paddy, cotton and wheat grows are a major source of raw material for biogas, agri-based biogas plants should be set up in these areas.

First steps required to install a biogas plant is the election of appropriate raw material. A digester is needed to an aerobically digest the waste. A feed pipe allows the entry of organic waste into the digester tank. Organic material is stored here. Microorganisms that can live in absence of air, are used for the process of digestion. Gases mainly Methane (CH_4) and carbon dioxide (CO_2), Nitrogen and Hydrogen sulphide are produced in this process. This process is known as anaerobic digestion. Methane is colourless, odourless, no-poisonous, highly flammable gas. A biogas plant collects this gas to use it as a fuel. A gas collector issued to collect biogas. Outlet pipe is used to drain the digested slurry, which can be diluted and collected to use as fertilizer for the field. A pipe through gas collector tank can be connected to the cooking media to utilize it as a fuel.

Biogas can also be compressed to provide continuous fuel supply (just like compressed natural gas). Biogas with no net carbon dioxide generation is considered to be a clean fuel. Organic material grows, is converted and used and then re grows in a continually repeating cycle. The slurry (contains Nitrogen, potassium, zinc and micro nutrients like iron and zinc) obtained from biogas plant can be used as organic manure, which can enhance the fertility of soil and is an ideal substitute for chemical fertilizers.

Present status of Renewable energy in India

With initiation of Government of India's various schemes, several self-help groups, individual and community participation has achieved a great milestone in the field of renewable energy. At present, biomass is the largest source of renewable energy in India. At present, Non-edible oil plants, lignocellulosic woody materials, leaf litter, domestic and rural waste like bagasse, marine and freshwater algae, are the major sources of biomass energy in India (Table 1).

Table 1 Status of energy generation from renewable sources in India

No.	Sources / Systems	Achievement (as on 30.09.2008)
A. Grid-interactive renewable power		
1	Biomass Power (Agro residues)	656.60MW
2	Wind Power	9521.80MW
3	Small Hydro Power (up to 25 MW)	2220.99MW
4	Cogeneration-bagasse	993.83MW
5	Waste to Energy	55.75MW
6	Solar Power	2.12MW
	Sub Total (in MW) (A)	13,450.59MW
B. Off-grid/Distributed Renewable Power (including Captive/CHP plants)		
7	Biomass Power / Cogen.(non-bagasse)	136.70MW
8	Biomass Gasifier	102.21MWeq
9	Waste-to- Energy	31.07MWeq
10	Solar PV Power Plants and Street Lights	8.01MWp
11	Aero-Generators/Hybrid Systems	0.72MW
	Sub Total (B)	278.71MWeq
C. Remote Village Electrification		4237villages +1142 hamlets
D. Decentralized Energy Systems		
12	Family Type Biogas Plants	40.32 lakh
13	Home Lighting System	4,34,692 nos.
14	Solar Lantern	6,97,419 nos.
15	SPV Pumps	7,148 nos.
16	Solar Water Heating - Collector Area	2.45Mln.sq.m.
17	Solar Cookers	6.37 lakh
18	Wind Pumps	1342 nos.

MWe, Megawatt equivalent; MW, Megawatt; kW, kilowatt; kWp, kilowatt peak; sqm, square meter

Challenges for wider acceptance of renewable energy

In spite of numerous benefits, non-renewable energy sources, face mammoth challenges**.** Following factors highlight the lacuna in the wider acceptance of non-renewable energy sources in the field. Although government has introduced numerous policies to support the development and utilization of renewable energy, advanced development technologies are required to support geothermal energy utilization, which is in nascent stage from Indian point of view. Capital investment, large scale protocols, research and development activities are required for the same. As India is developing at a fast rate, the demand for energy for rural sector is continuous increasing. Indian villages are merging pint for utilization of renewable energy sources. Cheapo availability of fossil fuels like coal increases the unwillingness of common people to utilize other sources of energy. Great importance to the development of wind power,[6] and solar energy,[9] based power plants has been given. Still there is a need to generate awareness among rural people to make renewable energy sources socially acceptable.

Although India has made considerable progress in the field of development and utilization of renewable energy sources, still a complete technical system has not yet been formed yet development. Technical inputs are required by various research institutes to reduce the cost of installation further to make it more attractive for common man.

Here are certain environmental concerns associated with geothermal power generation. The discharged water, is at relatively high temperature, causes concern for the heat pollution on the ground. There is a need to carry out research activities to reduce that temperature to make the process more acceptable.

Conclusion and future direction

The raw materials to generate renewable energy are easily available, cheap with no confinements. In fact, every village can be self-sustaining, eco-friendly along with helping neighbouring village by networking into the grid systems. With the help of self-help group, each power station can help to generate employment for the youth of the country. The clean sources of energy will definitely help to mitigate the impact of climate change and global warming. They are conceivable alternative to fossil fuels.

There needs of paradigm shift in the perception of rural energy needs and sources. More research activities should be focused on renewable and sustainable sources of energy. Still, fossil fuel is widely used in rural sectors due to lack of awareness and acceptability of renewable energy sources by power consumer. There is an immediate need of awareness generation among rural areas about the vast sources they possess to make Indian villages smoke-less, green and clean using renewable sources of energy. It is evident that adoption of renewable energy sources could help to improve the socio-economic fabric of rural India.

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Conflicts of interest

Author declares that there is no conflict of interest.

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