Study of Opportunities Associated with Biogas Energy in Jharkhand

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Abstract:

Biogas technology is an important source of clean energy, biodegradable fertilizer, and carbon mitigation potential. It providing excellent opportunity for mitigation of greenhouse gas (GHG) emission & reduces global warming by substituting firewood for cooking, kerosene for lighting and cooking and chemical fertilizers. A study was undertaken in Jharkhand to calculate the potential of (1) global warming mitigation potential (GMP) and thereby earning carbon credit from a family size biogas plant in Jharkhand. (2) Biogas production from anaerobic digestion of cattle dung and organic waste of rural households. (3) Biogas slurry, A by-product of biogas plant applied as manure to substitute chemical fertilizer for agricultural use. Total biogas potential in Jharkhand is 4099.413 Mm3. This is sufficient for the energy need of 49.28 lake households for cooking lighting and space heating of average family size 5. Biogas spent slurry a by-product of biogas technology potential is 88.3 lake ton which can substitute a similar amount of chemical fertilizer. Besides, the energy and fertilizer integration of carbon revenues will help the farmers to develop biogas as a profitable activity. Total carbon mitigation potential in Jharkhand through biogas is 18.01 Million ton CO2 equivalent with a carbon credit of US $ 180.1 million /year.

Keyword: Biogas, global Warming mitigation Potential, biofertilizer, sustainable rural development

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1. Introduction

Biogas is produced through anaerobic digestion (AD) which involve the degradation and stabilization of organic materials under anaerobic condition by microbial organisms and leads to the formation of biogas and microbial biomass [1] biogas is primarily composed of methane (CH_4) and carbon dioxide (CO_2), with the amount of hydrogen sulfide (H_2S) and ammonia (NH_4) [2] Biogas technology uses local resources as cattle dung, agricultural waste, and other organic waste to produce biogas an efficient and clean source of energy. It substitutes fossil fuels kerosene oil, cattle dung cake, agricultural residues, and firewood, which are used as fuel. According to India's 2011 census72.18% of its population lives in its rural areas [3]. This rural population is not only home to the vast majority of the country's poorest people, but the majority is also considered to be living in energy poverty which means a reliance on traditional, more affordable biomass [4] . In rural areas cooking and heating water are a major requirement of energy [5] and a lack of access to efficient technologies and clean cooking fuels presents particular challenges [6]. Rural populations depend upon biomass for fuel often due to diminished access to modern alternatives, driven in part by family income [7]. The impact that energy poverty is having upon the country's economic development has prompted the Indian government to take action in providing affordable energy access to the entire population (IEA, 2012) Burning of traditional fuels leads to atmospheric pollution due to emission of air pollutants such as CO, NOx, SO2, volatile organic compounds and particulates [8,9,10]. It also emits greenhouse gases (GHG) such as carbon dioxide, methane, and nitrous oxide (N2O), which add to global warming and releases soot particles causing human health problems such as asthma[11].

Bioenergy is the most promising for the developing countries as its mobilization can provide large employment generation schemes, can be linked to ecosystem conservation, and even rehabilitation; furthermore, investments in biomass energy can be an effective tool to combat desertification, can have a significant impact on global climate change and can become a valuable tool in promoting gender equity within the associated natural resources management activities.[11] Besides these benefits, biogas energy has an important opportunity for Global warming mitigation potential and earn carbon credit for developing countries. Global warming mitigation potential involves reductions in the concentrations of greenhouse gases (GHGs) either by reducing the sources or increasing their sinks. In the world of a carbon market, the emission reduction will translate into a currency called 'carbon credits'[12]

The anaerobic fermentation Biogas digesters can be fed with a range of feedstocks including poultry manure and pig slurry [13], toilet waste [14,15] food waste [16] , flower waste [17], dairy waste [18] and agricultural residues [19,20] , cattle dung is known to be particularly suitable since methanogenic bacteria are naturally present in the stomachs of ruminants [21], etc. These sources are a cheap way of getting energy and at the same time handling waste products [22] Biogas has 20–40% of the lower heating value of the feedstock and can be used directly in spark-ignition gas engines s.i.g.e. and gas turbines to produce electricity and can be upgraded to higher quality i.e. natural gas quality, by the removal of CO2 [23]. The gas can also be used to power engines, in a dual fuel mix with diesel (http://mnes.nic.in/achl.html) and can aid in pump irrigation systems.

There is a strong possibility to enhance biogas production under field conditions. Use of certain inorganic, organic additives seems to be promising for enhancing biogas production. Among different types of biomass (plant and crop residues) used as additives, some have been found to enhance the gas production [24] Crop residues like maize stalks, rice straw, cotton stalks, wheat straw and water hyacinth each enriched with partially digested cattle dung enhanced gas production in the range of 10– 80% [25,26] . Powdered leaves of some plants and legumes (like Gulmohar, *Leucaena leucocephala*, *Acacia auriculiformis*, *Dalbergia sis*soo, and *Eucalyptus tereticonius*) have been found to stimulate biogas production between 18% and 40% [27, 28]. An increase in biogas production due to certain additives appears to be due to adsorption of the substrate on the surface of the additives. This can lead to high-localized substrate concentration and a more favorable environment for the growth of microbes [29]. The additives also help to maintain favorable conditions for rapid gas production in the reactor, such as pH, inhibition/promotion of acetogenesis and methanogenesis for the best yield, etc

Biogas spent slurry, a by-product of the biogas plant, serves as manure and can substitute chemical fertilizers for supplying N, P, and K [11]. The slurry that has been digested is a high-grade fertilizer. The processed substrates are better fertilizer than before the procedure. The effluents that are produced through the operation of a biogas plant are biodegradable fertilizer [30]. Biological fertilizers that come from biogas plants have superior nutrient content and have also a pesticide effect without the harmful effects of pesticides [31]. Slurry from 1 kg digested dung can yield up to extra 0.5 kg nitrogen compared to fresh manure [32] It helps in soil conservation.

2. Fuel Status of households in Jharkhand

In Jharkhand, total numbers of households are 6181607 where only below 12% of households using a modern source of energy 57.6 % depends upon firewood. In Jharkhand 22.733 million people depend on fuelwood for a household purpose which comprises 4.844 million tons of fuelwood per year out of which 2.849 million tonnes Quantity of Fuel Wood used from Forest [33]. 4099.413Mm3 (Table 2) biogas will replace 10.313 million ton equivalent fuelwood. It removes dependence on forest and enhances greeneries leading to improved environment conditions [34] by reducing extra pressure on forest cover of Jharkhand for the fuel requirement. The state of Jharkhand is a part of biodiversity-rich regions of India because of its diverse physiographic and climatic conditions. The largest component of harvest from the forest is by way of removal of biomass in the form of fuel for domestic use increase in the human population has put tremendous pressure on the forests, impacting their regenerative capacity. It presents a threat to the biodiversity of the state.

Table: 1 Distribution of Households by type of fuel used for cooking.

	India	Jharkhand
Total households	246692667	6181607
Fuel used for cooking		
Firewood	49.0	57.6
Crop residue	8.9	4.0
Cow dung cake	8.0	7.2
Coal, Lignite, Charcoal	1.5	18.1
Kerosene	2.9	0.2
LPG	28.6	11.7
Electricity	0.1	0.3
Biogas	0.4	0.1
Any other	0.5	0.6

In India alone, there are an estimated over 250 million cattle and if one-third of the dung produced annually from these is available for the production of biogas, more than 12 million biogas plants can be installed [35]. Jharkhand is a state where most of the households are depends upon agriculture and cattle raising for their livelihood and use biomass as their energy requirement for cooking and lighting. In Jharkhand total rural households are 4,729,369 and having average household size is 5.3 /household. It is estimated that the per capita requirement of gas for domestic purposes is about 0.34-0.43m3 day-1. Biogas demand is computed by multiplying the adult equivalent of a village population and per capita biogas requirement [37] .Total biogas energy required in Jharkhand is 3711.37Mm3 annually for cooking and lighting. Biogas technology offers a very attractive route to utilize certain categories of biomass for meeting partial energy needs. Proper functioning of the biogas system can provide multiple benefits to the users and the community resulting in resource conservation and environmental protection. It drastically reduces the depletion of natural resources like forests, which are otherwise the prominent and traditional source of energy for cooking and lighting. It removes dependence on forest and enhances greeneries leading to improved environment conditions [34].

3. Material and method

GMP and carbon credit is calculated in three-level (1) A family size biogas plant. (2) existing biogas plant and(3) potential biogas plant When all the collectible cattle dung is used for biogas production (GMP Potential). GMP and Carbon credit is calculated with the following equation [38] considering five factors-

GMP (CO2 equiv.) = GWP of CO2 emission reduction from kerosene and firewood savings+ GWP of CH4 emission reduction from firewood saving+ GWP of CO2 emission reduction from N, P and K fertilizer production+ GWP of N2O emission reduction from NFertilizer application – GWP of CH4 leakage from biogas digester ....equation - 1

Biogas produced through a family-sized biogas plant of 3m3 by using dung collected from locally reared cattle was calculated using the relationship of 0.5 m3 biogas kg−1 dry dung [38]. There is a strong possibility to enhance biogas production under field conditions. Use of certain inorganic, organic additives seems to be promising for enhancing biogas production. Among different types of biomass (plant and crop residues) used as additives, some have been found to enhance the gas production [24] Crop residues like maize stalks, rice straw, cotton stalks, wheat straw and water hyacinth each enriched with partially digested cattle dung enhanced gas production in the range of 10– 80% [25] Biogas produced is replaced by 80% of fossil fuel and 20% kerosene for lighting. Carbon dioxide emissions from the burning of kerosene and firewood were taken as 2.41 kg l−1 and 1.83 kg kg−1, respectively. Firewood burning also emits CH4 at 3.0 g C kg−1 burning efficiency of kerosene and fossil fuel is 80% and 40% respectively. [11] Leakage of CH4 from the digester was taken as 10%, a conservative estimation based on the IPCC range of 5–15% (IPCC 2001).

Biogas slurry is produced as a by-product is used as manure which substitutes chemical fertilizer. The substitution of chemical fertilizer with spent slurry reduces CO2 emission, which would emit for the production of fertilizer. The emission of CO2 was calculated using the following equation [37, 39, 40].

$$Emission\ of\ CO2 = N\ fertilizer \times 1.3 + (P\ fertilizer + K\ fertilizer) \times 0.2 \quad \text{…equation 2}$$

Saving of N fertilizer due to replacement by biogas slurry would also reduce the emission of nitrous oxide at a rate of 0.7% of the applied N [41, 42] The GWP for CH4 (based on a 100-year time horizon) is 21 while that for N2O is 310 when the GWP value for CO2 is taken as 1. The GWP of the calculated GHG emission reduction was calculated using the following equation -

$$GWP = CH4 \times 21 + N2O \times 310 + CO2 \times 1 \quad \text{............3}$$

Total dung collected in Jharkhand is based on the total cattle population including sheep, pig, goat, and poultry (Table 1.). The total production of dung (*DT*) in the country was calculated as follows.

$$\text{Total dung (DT) =\_T (NT} \times \text{DEX) ………………4}$$

Where, *T* is the number of the livestock category (cattle, buffalo), NT is the number of animals in each category, *D*EX is the annual average dung excretion per head for each livestock category. However, some amount of dung is lost during collection and used for construction. Thus actual availability of dung for biogas production (*D*BG) was calculated as follows:

Dung available for biogas production

$$(DBG) = DT \times [1 - (DCL + DCN)] \quad \text{......................5}$$

Where *D*CL and *D*CN are the fractions of dung that are used for construction and lost during collection, respectively .Data on dung produced per cattle and buffalo were reported by [43] Gaur (1995).

Dry matter content in the fresh dung was taken as 18% [41,44] Data on dung that is used for construction were obtained from Gaur (1995), whereas loss of dung during collection was taken from TERI (2001) [45].

4. Result and discussion

4.1. Biogas Potential in Jharkhand

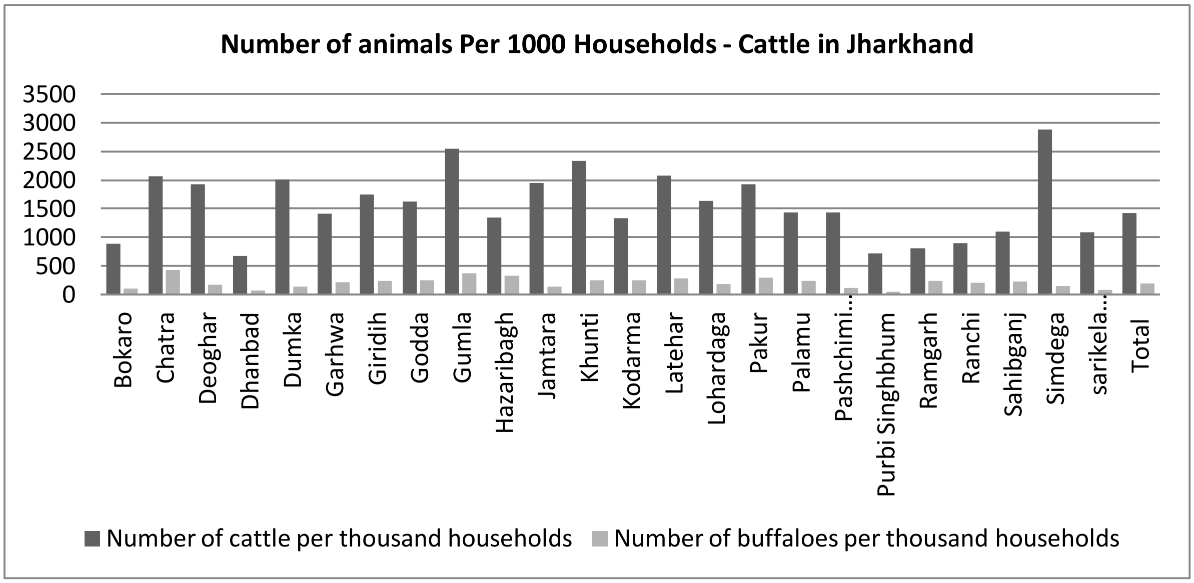
Biogas is produced through the locally available resources where the main resources used in Jharkhand are cattle dung. It is estimated from table 2. That total dung yield for biogas production from different sources is 88.3 lake ton which can produce 4099.41Mm3 biogas it does not include municipal waste, agricultural waste, human excreta, and other resources. However, the availability of cattle dung in Jharkhand varies with a place to place fig. 1. Cattle density per 1000 households is greater than 2000 in Simdega, Gumla, Khuti, Chatra, Latehar, Dumka and less than 1000 is Dhanbad, Bokaro, Purbi Singbhum and Ranchi.

Table1. The population of livestock, dung for production of biogas, and biogas potential in Jharkhand.

	*Total population in lakh	Dung Yield annually in Kg	Total dung Yield annual in lakh ton	Total dung for biogas production in lakh ton	Biogas production in Mm3
Bovine	99.16	1100	109.07	66.53	3326.82
Buffalo	11.86	1350	16.01	09.76	488.311
Sheep	05.83	197.1	01.14	07.01	35.042
Goat	65.81	65.7	04.32	02.64	131.82
Pig	09.62	164.25	01.58	00.96	48.21
Poultry	103.62	21.9	02.26	01.40	69.21
			Total	**88.3**	**4099.413**

*Source: 19th livestock census Government of India 2012

Figure-1. Number of animals per 1000 Households –Cattle in Jharkhand



4.2. Availability of additive in Jharkhand

Certain additives, when mixed with cattle dung, enhances the biogas production under field conditions by providing high-localized substrate concentration and a more favorable environment for the growth of microbes [46]. Certain plant and crop residues used as an additive for enhancing Biogas production [24] Powdered leaves of some plants and legumes (like Gulmohar, Acacia auriculiformis, Dalbergia sissoo, and Eucalyptus tereticonius) are easily available in Jharkhand[[33] which stimulate biogas production between 18% and 40% [27,28].Crop residues like maize stalks, rice straw, cotton stalks, wheat straw, and water hyacinth each enriched with partially digested cattle dung enhanced gas production in the range of 10– 80% [25,26]. According to a study conducted by Idnani and Laura (1971), biogas production from 0.5 kg of cow dung was almost doubled from 17.2 to 31.5 l by the addition of 200 ml of urine [46]. The use of urine-soaked waste materials is particularly advantageous during winter months when gas production becomes low. The mixture of 1% onion waste storage with cattle dung increases 30-40% biogas production in floating dome biogas plant[47] . Mahua (*Madhuca Indica*) is easily available in Jharkhand and de-oiled cake of it has a mean biogas generation potential in the range of 198 to 233 l/kg. The seedcake sludge and the slurry coming out of the reactor as waste have very high manorial value under its high nitrogen content and a good amount of other secondary and tertiary nutrients [48].

4.3. Annual GMP of the existing & potential biogas plant in Jharkhand

A family size biogas plant of 3m3 utilizes 4400 kg dung (Dry weight) Produces 2200 m3 biogas with 316 liters of kerosene and 5,535 kg of firewood, the GWP of which is 762 and 10,571 kg CO2 Equiv. respectively Biogas slurry generated by the biogas plant is 1,725 kg C which substitutes 62, 22, and 35 kg N, P, and K fertilizer, respectively. The GWP for producing equivalent amounts of chemical N, P, and K fertilizer is 302 kg CO2 Equiv. Moreover, the application of 62 kg N fertilizer in soil emits 0.43 kg N2O-N with the GWP of 210 kg CO2 equivalent[41,42]. The biogas plant leaks methane of 94 kg from its exposed areas and contributes to global warming. The net GMP of a biogas plant is 9,667 kg CO2 Equiv. with a carbon credit of US $97 year−1 at the current price of US $10 t−1 CO2 Equiv[37].

The total number of a biogas plant in Jharkhand in 2013 is 7237 numbers (Sources: Energy Statistics 2013, Central Statistics Office) having potential GMP is 69960.079 ton CO2 Equiv. with a carbon credit of US $6.99 lakh year-1. However, the potential of the production of biogas is **4099.413** Mm3(Table 1) which is suitable for 18.63 lakh 3m3 biogas units having GMP potential of 18.01 Million ton CO2 equivalent with a carbon credit of US $ 180.1 million /year. This extra revenue along with fuel and fertilizer will motivate the farmers of Jharkhand to adopt clean energy technology i.e. biogas energy. Besides this direct incentive biogas also save the households from the smoke produced from the burning of fossil fuels which causes serious health problems like lung cancer, asthma, and another respiratory disease. Biogas also increases the health and hygienic condition of the kitchen by not facing the ashes of fossil fuel.

4.4 Energy Potential of Biogas Plant in Jharkhand

Energy is an important factor in the socio-economic development of any state[51]. 75.95%(census 2011) of the total population of Jharkhand lives in the rural area and depend on biomass for energy needs it leads to the emission of greenhouse gases and smokes which creates pollution & health issues. Biogas is the most efficient, pollution-free & alternative source of energy. It can play a significant role in fulfilling the energy needs as well as livelihood development in rural areas. According to Aapkes et al (2011),[49] biogas needs in rural India amount to 0.132 m^3 for cooking and 0.836 m^3 for heating water per day. Additionally, one biogas lamp requires 0.5 m^3 biogas per day [50], hence 2 lamps will require 1 m3 biogas. Total biogas required is 1.968 m3 /household hence Jharkhand has 47.30 lakh households having an energy need of 3397.6Mm3 for cooking and lighting. Total biogas potential in Jharkhand is **4099.413** Mm3 (only with cattle manure excluding agricultural waste, municipal waste, and human waste) which can fulfill total energy needs of Jharkhand rural households and remaining 701.83Mm3 biogas can be used to electricity generation.

4.5 Biogas based Fertilizer potential in Jharkhand

Fertilizer is one of the critical inputs for increasing agricultural production. In Jharkhand, per hectare consumption of fertilizer is 100kg /Hectare which is very low concerning national use. It is also unbalanced in the proportion of 10.40:3.70:01 against the recommendation of 4:2:1. (Jharkhand economic survey 2014) The main fertilizers used are Urea, Dia-ammonium Phosphate (DAP), Muriate of Potash (MP), and Complex fertilizer. Urea is the main fertilizer used in Jharkhand. It constitutes about more than 50 percent of fertilizers used in the Kharif season and three times more than DAP whereas Urea is more important in the rabbi season because its use is more than five times to DAP. The use of DAP fertilizer is declining, probably due to high prices and less subsidy to this fertilizer (JES 2014). Total fertilizer requirement in Jharkhand is 5.27 lakh ton in 2011-12 from the (table 3) collected from Department of Agriculture and Cane Development, Govt. of Jharkhand 2011-12.it is observed that there is the general practice of farmers in rural areas to use cattle manure as fertilizer which is directly used in the field which causes methane gas production or used as dung for traditional fuel which reduces the nutrient sources of manure. Biogas technology provides an advantage over fuel and fertilizer requirements of farmers. Biogas slurry a by-product of biogas plant is used as manure to substitute the chemical fertilizer. Total potential dung available for biogas production in Jharkhand is 88.30 Lakh ton which has the potential to produce 34.62 (C) lakh ton biogas slurry. This is almost 6 times the required amount in Jharkhand and can substitute an equivalent amount of fertilizer. the effluent produced through biogas plants are Biodegradable [30] superior nutrient content and pesticides effect without the harmful effects of pesticides productive use and organic fertilizer can generate better returns for farmers further increasing crop yield [51]. Jharkhand is a place where the high potential of organic farming. The use of biogas will promote organic farming and may help in soil conservation. Chemical fertilizer used by farmers is with the flow of water moves towards the water reservoir and rivers which are reported as the cause of water pollution and biogas slurry help to overcome these issues. Biogas slurry as fertilizer is produced through the locally available resources like cattle dung and other household wastes hence their cost is respectively low and easily available than chemical fertilizer. It is replacing chemical fertilizer and save money which is an extra incentive to motivate them towards the adaptation of biogas technology. The however organized market of biogas slurry is not reported in Jharkhand but cattle dung as manure is often purchased by farmers for agricultural purposes and used as fertilizer. Hence there is a possibility of local marketing of extra slurry.

Integrated agriculture along with dairy farming and biogas technology has very much potential in Jharkhand. It may prove cost-effective and sustainable in nature. Where Biogas will fulfill the energy requirement in another way it will provide value addition by using cattle dung inefficient manner to reduce energy and bio-fertilizer cost.

Table 2: Season wise use of fertilizers in Jharkhand during the year 2013 (Unit in lakh ton)

		Kharif			Rabi		
	The requ. in Lakh ton	Supply	consumption	Requirement	Supply	consumption	Total requirement
Urea	1.60	1.24	1.28	1.00	0.65	0.64	2.60
Dap	0.80	0.44	0.40	0.45	0.16	0.12	1.25
Mop	0.20		0.02	0.14			3.40
complex	0.38	0.28	0.26	0.70	0.16	0.12	1.08
							5.27

Source: Department of Agriculture and Cane Development, Govt. of Jharkhand 2014.

5. Other opportunities with biogas energy

Rural households mostly use Kerosene for the lighting which depends upon the cost and availability. Burning of kerosene imposes many health-related issues. Lighting and cooking & space heating are an important issue which can be sustainably solved with the help of biogas. It has the potential to provide sustainable livelihoods and local sources of energy in rural areas of developing countries. Commercial use of biogas energy is not frequent in Jharkhand however limited use of energy is reported in some areas in small and cottage industries. Energy is an important issue for the development of cottage and small scale industries. Biogas not only fulfills the energy requirement it also increases the extra working hours in the night for rural households which is mostly unutilized due to the unavailability of lighting facility. Biogas has the potential to use in the generation of electricity by biogas generator it can widely use in agriculture for irrigation and other household uses. However, per unit cost and efficiency are important considerations that need more research and development. Women in India, especially in rural areas, are often responsible for providing daily essentials such as food and water. Fuel is a key constrain for rural households in Jharkhand. More time women need to spend looking for fuel increases the workload of women and girls, thus leading to their exclusion from opportunities likes education and diminishment in their equal participation in development. Hence biogas is playing an important role in women empowerment.

Further Scope of the study

The study does not include the potential of agricultural waste and municipal waste for biogas production. Consumer attitude and behavior towards the adaptation of biogas energy is an important aspect of the promotion of biogas energy in Jharkhand which needs to be studied. Socioeconomic impact of biogas energy in rural households in Jharkhand and the impact of biogas energy in agriculture and cattle breeding is an important scope for further study. There is very little contribution to renewable energy especially of biogas energy in the electricity mix in Jharkhand. Further study is required towards the opportunities and challenges associated with the potential of electricity generation through biogas in Jharkhand.

Challenges of biogas energy in Jharkhand

- The raw material is sufficient to present in Jharkhand but in an unorganized way, there is a geographical variation in the availability which limits the full efficiency of the use of biogas technology. However, integration of biogas with dairy farming, piggery, poultry farming, and agriculture is very much viable and efficient for the development of the technology it will provide food security in one side whereas per unit cost reduction of biogas production in another side.
- It is observed that family partition limits the use of household biogas which can be overcome with the community-based biogas plant and cooperative means of raw material uses. Storage and transportation of biogas are possible after the treatment of biogas and removal of CO2. These technologies will help to promote and use of biogas.

- Still, Jharkhand is in the nascent stage in the production and dissemination of biogas technology. Technological innovation, investment, and management are important for the success of any technology. There is a need for sustainable use of available biomass resources in the production of clean energy, accurate resource data is very important for the planning process to frame targets and the availability of this data is crucial. While for wind and solar, efforts are already underway, for biomass state nodal agencies should take a lead in collecting the latest information about biomass resources from the district and state-level agencies.
- Combined effort and coordination of JAREDA and another Government department like agriculture and rural development and animal husbandry etc is required for the success of biogas technology in Jharkhand .better coordination and community-based participation is important for the better outcome. There is an opportunity to explore the Community based biogas plant in Jharkhand.
- Considerable human and institutional efforts and adequate funds are needed to launch, run, and learn from demonstration projects, as one can see from the Indian experience. Lack of support, either from the Government or from international donors, can thus be a barrier for further growth of renewable energy. There should also be simultaneous support for carrying out R&D and establishing an entrepreneurial base from manufacturing /assembling /service providing etc.
- Increasing penetration of renewable in the electricity mix requires proper planning and sound managerial and technical capacities at the institutional level. It is essential to enhance their technical capabilities in terms of setting up forecasting tools and skill base of the employees managing these responsibilities in the state center.

Conclusion

Biogas is an important and clean source of energy and feasible for rural households having poor economic resources. Jharkhand has a high potential of biogas energy it may cover almost 37% of the total energy requirement of total households. The use of biogas will reduce the extra pressure on petroleum oil and forest cover in Jharkhand for cooking and lighting purpose. Besides energy, it has also production potential of slurry as a by-product which can substitute two times more total required chemical fertilizer in Jharkhand which adding extra incentive to the farmers in agriculture. It will promote a high yield of agriculture with soil conservation. Global mitigation potential is another important aspect of biogas energy which will reduce the environmental pollution as well as earn the carbon credit is an important economic motivation for the adaptation of biogas technology for the rural households in Jharkhand. Biogas technology utilizes local resources like cattle dung as a raw material an integrated development model is suitable for Jharkhand where Agriculture along with cattle breeding promotion is required to increase the total potential of biogas energy. Energy is the key issue for the development of cottage and small scale industries in rural areas biogas is one of the best solutions for the energy problem in rural India. It will help in sustainable development along with better socioeconomic and environment up gradation of rural households. Community-based biogas technology has very much potential in Jharkhand .all resources are locally available only need is to proper utilization with the latest technology. Government Nongovernmental organizations and community participation are important for the success of the technology.

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