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A STUDY ON THE POTENTIAL OF BIOGAS AS A COOKING MEDIUM IN INDIA- STUDY DONE AT MICRO LEVEL

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Abstract: The present study was undertaken to know Domestic cooking scenario in rural India all well as its positive and negative effects. The study was also focused to document the potential in Biogas by studying a model village Kedia, And to know how biogas plays an important role in becoming a Model village. Also to know How the complete process which is being followed by Kedia Villagers having positive effect on farmers life as well as on environment and benefits to others? The study also identifies Potential of biogas as per cattle availability. Few part of study was undertaken in "KEDIA" Village of Jamui District in Bihar. And rest of the study was confined to Muzaffarpur district of Bihar. The data were collected from selected farmers and farm women through personal interview and focused group discussion, secondary data was also collected in this study.

Key words: Biogas, Domestic cooking, Model village, Renewable energy, Greenhouse gasses.

Introduction: The energy balance compiled by International Energy Agency (IEA 2013c) indicates a total residential consumption of 178 453 thousand tonnes of oil equivalent (KTOE) on a net calorific value basis during 2011 in India. This is 8.6% of the world's total residential consumption on a net calorific value basis during 2011. At the household level in India, two major uses of energy for basic access are lighting and cooking. [1]

India's dependence on imported fossil fuels rose to 38% in 2012.The country's energy demand continues to climb as a result of its dynamic economic growth and modernization. India is the third-largest economy on a purchasing power parity basis and has the world's second-largest population, according to World Bank data.[2]

In 2013, India was the fourth-largest consumer and net importer of crude oil and petroleum products in the world after the United States, China, and Japan. India's petroleum product demand reached nearly 3.7 million barrels per day (bbl/d). [3]

High speed diesel oil accounted for 38.83% of total consumption of all types of petroleum products in 2013-14. This was followed by Refinery (10.15%), Petrol (9.73%), **LPG (9.28%)** and Naphtha (6.50%). Consumption of Light Diesel oil continuously decreased from 2005-06(0.88 MTs) to 2013-14 (0.39 MTs)[4]

LPG forms one of the major energy sources in India. The consumption of LPG has seen a steady increase over the past five years. Most of the LPG supply comes from indigenous production and about a quarter of the supply comes from imports. 92.3% of LPG consumption in India is done so as a domestic fuel. Apart from being used for domestic purpose, 3.4% of LPG is used in commercial and industrial establishments, as a fuel during manufacturing processes. Apart from these main uses, about 2.4% of LPG is used as a vehicular fuel.[5]

[1] *TERI Energy & Environment Data Directory and Year book 2013/14*
[2] *http://www.eia.gov/todayinenergy/detail.php?id=17551, 16/11/16*
[3] *http://www.eia.gov/todayinenergy/detail.php?id=17551, 16/11/16*
[4] *Energy statistics 2015,22nd issue, Central statistics office, Ministry of statistics and programme implementation , Government of India.*
[5] *RENEWABLE ENERGY : BIOGAS,INDIA LANDSCAPE 2012, Athena Infonomics India Pvt. Ltd.*

In rural India, 86.5% of households depend on solid biomass including firewood, crop residue, cow dung, coal, lignite, and charcoal as primary fuel for cooking.[6] There is a host of issues associated with the traditional use of solid biomass for cooking, including the release of harmful indoor air pollutants that are a major cause of premature death, as well as environmental degradation as a result of deforestation and biodiversity loss.[7]And hence, definitely there is a need to provide clean and modern cooking fuel to rural India.

When we talk about worlds wide environmental issues Global warming is the big one. Greenhouse gas emission-The harmful effects of presence of greenhouse gasses in atmosphere are global warming, climate change, ozone depletion, sea level rise, adverse effect on biodiversity etc. One way or another these adverse impacts are all directly or indirectly related to the presence of greenhouse gas in the atmosphere.[8] The presence of four major greenhouse gasses ,namely water vapor(H2O),carbon dioxide(CO2),methane(CH4), and nitrous oxide(N2O) in earth's atmosphere keeps the average temperature of 15°C, where as without the greenhouse effect the average temperature would be a frosty 18°C. Out of these four CO2 is about 76% and methane is about 16%. Fossil fuel use is the primary source of CO_2 emission and Methane (CH_4) emissions is due to Agricultural activities, waste management, energy use, and biomass and burning all.[9]India is among top 5 countries in greenhouse gas emission. [10]

But does current scenario of domestic cooking in India and the environment demands for increase in LPG consumption only? What will happen if all rural households will start using LPG? Why there is a need to look for other alternatives for clean cooking fuel as alternate to LPG. What is Biogas? How Biogas have potential to give good living hood to rural India? What is Potential of biogas digesters installation?

Domestic cooking Scenario in India

In rural India, 86.5% of households depend on solid biomass including firewood, crop residue, cow dung, coal, lignite, and charcoal as primary fuel for cooking (Table 1. below). 12.1% of the rural households depend on modern fuels including kerosene and Liquefied Petroleum Gas (LPG)/ Petroleum and Natural Gas (PNG) as primary fuel for cooking and the rest depend on other fuel sources including biogas for the purpose of cooking.[11]

Aside from those without electricity, India also has the largest population in the world relying on the traditional use of solid biomass for cooking: an estimated 840 million people – more than the populations of the United States and the European Union combined. There is a host of issues associated with the traditional use of solid biomass for cooking, including the release of harmful indoor air pollutants that are a major cause of premature death, as well as environmental degradation as a result of deforestation and biodiversity loss.[12]

Using biomass is inconvenient as procuring the fuel takes up time requires effort and its use poses severe ill effects on health. In fact, 400 million people in India (of which 90% are women) are exposed to the negative health impacts associated with indoor air pollution from use of biomass, resulting in respiratory, pulmonary and vision problems.[13]

[6] *TERI Energy & Environment Data Directory and Year book 2013/14.*

[7] *Outlook for India's energy consumption,2015.*

[8] *https://saferenvironment.wordpress.com/2008/10/31/global-warming-greenhouse-gases-and-their-harmful-effects-%E2%80%93-urgent-reduction-of-these-are-essential-to-save-our-environment/ ,30/11/2016*

[9] *https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data, 30/11/2016*

[10] *Energy dependency and energy security: the role of energy efficiency and renewable energy sources, Ilhan ozturk, faculty of economics and administrative sciences, cag university, 33800, mersin, turkey.*

[11] *TERI Energy & Environment Data Directory and Year book 2013/14.*

[12] *Outlook for India's energy consumption,2015.*

[13] *User Guide for India's 2047 Energy Calculator Cooking Sector, www.indiaenergy.com accessed-16-nov-16.*

Census of India 2011-

Source of energy for domestic cooking in India		
Energy source	**Rural House Hold%**	**Urban House Hold%**
Firewood	62.5	20.1
Crop residue, Cow dung, coal, lignite, charcoal	24.0	6.1
Kerosene	0.7	7.5
LPG/PNG	11.4	65
Any other	1.1	0.8

Table1.

All India per household per month consumption of energy						
Energy sources	**Rural**			**Urban**		
	Quantity(kg)	No. of sample HHs responding	Value (rs`)need to update	Quantity	No. of sample HHs responding	Value (rs.`)
LPG (excl. conveyance, in **kg)**	8.69	20 354	259.39	12.37	30 396	363.76

Table2. **Source**[14]

[14] TERI Energy & Environment Data Directory and Year book 2013/14.

Problems

India's import dependence on oil rose to 81% in 2015-16 from 78.5% in the previous year. Just last year, Prime Minister Narendra Modi had set a target of bringing this down to 67% by 2022. [15]

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Using biomass is inconvenient as procuring the fuel takes up time requires effort and its use poses severe ill effects on health. In fact, 400 million people in India (of which 90% are women) are exposed to the negative health impacts associated with indoor air pollution from use of biomass, resulting in respiratory, pulmonary and vision problems.[17]

Greenhouse gas emission- A number of human activities, processes and consumptions produce waste gasses or greenhouse gasses that are harmful to environment.[18] The top five countries with the highest energy related CO2 emissions in addition to China, include USA, India, Russia and Japan, which in total represented 58% of global emissions in 2011). The largest increase has taken place in China and India. To be environmentally benign, Energy services must be provided with low environmental impacts and low greenhouse gas (GHG) emissions.[19]

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[15] *http://economictimes.indiatimes.com/industry/energy/oil-gas/indias-dependence-on-crude-oil-imports-on-rise-as-consumption-increases/articleshow/51934359.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst , 25 nov 2016*

[16] *Outlook for India's energy consumption,2015.*

[17] *User Guide for India's 2047 Energy Calculator Cooking Sector, www.indiaenergy.com accessed-16-nov-16.*

[18] *https://saferenvironment.wordpress.com/2008/10/31/global-warming-greenhouse-gases-and-their-harmful-effects-%E2%80%93-urgent-reduction-of-these-are-essential-to-save-our-environment/ ,30/11/2016*

[19] *Energy dependency and energy security: the role of energy efficiency and renewable energy sources, Ilhan ozturk, faculty of economics and administrative sciences, cag university, 33800, mersin, turkey.*

What if all Biomass Users start using LPG?

Total Rural House holds	Current LPG Users	No. of households using LPG[20]	Average LPG /House Hold India[21]	Current consumption.	Biomass Users
16.8cr	11.4%	1.9152cr	8.69	166430880Kg	14.364cr
					% Increase
Assuming all Rural HH using LPG.(Keeping rest figures constant.)		16.8cr		1459920000Kg	**877.193%**

[20] *Census of India 2011*
[21] *TERI energy & environment data directory and yearbook 2013/14*

If all biomass users start using LPG then LPG consumptions will increase by **877. 193%.** This may increase India's import dependency on oil.

To achieve sustainable development, energy dependent countries must pay attention to energy security and environment, energy efficiency, and renewable energy sources issues for not facing with energy shortages, negative effects on economic growth and climate changes.[22]

Biogas is a solution

Biogas is an all-rounder among renewable energies. It can be converted to electricity and heat or be used as a fuel and natural gas equivalent.

Biogas burns more cleanly than coal, and emits less carbon dioxide per unit of energy. Biogas production kills two birds with one stone: it reduces waste and produces energy. Therefore, biogas is a perfect energy source including many benefits![23]

Biogas seems a promising avenue for India (based on ample agricultural residues) and there have been long-standing efforts to promote it, but less than 1% of households use biogas as their primary cooking fuel. [24]

Biogas technology in brief-

According to Sustainable biogas production: A handbook for organic farmers,2013 Biogas is a combustible mix of gases produced by the natural fermentation of wet biomass under the exclusion of oxygen (anaerobic digestion/ fermentation). The main combustible component methane makes up about 50 to 75 volume per cent (Vol.-%). Other molecules present in biogas include carbon dioxide, sulphide, oxygen and water vapour . Biogas formation occurs naturally in wetlands when organic matter is decomposed by anaerobic microbes to so-called "swamp gas".[25]

Methane, which burns with a clear blue flame without smoke, is non-toxic and produce more heat than kerosene, wood, charcoal, cow-dung chips etc.[26] The gas is used for cooking, lighting and to run electric motors, irrigation pumps, refrigerator and compressors. Common use of biogas as energy source in the context of developing countries are for cooking and lighting, while other uses are limited.

[22] *Energy dependency and energy security: the role of energy efficiency and renewable energy sources, Ilhan ozturk, faculty of economics and administrative sciences, cag university, 33800, mersin, turkey.*

[23] *Major stake holders of development, deployment and promotion of biogas technology: a study on muzaffarpur district of bihar, india. Raj kumar, Global Journal Of Multidisciplinary Studies ,Volume-5, Issue-10, September 2016.*

[24] *Outlook for India's energy consumption,2015*

[25] *Florian Gerlach, Beatrice Grieb, Uli Zerger (FiBL), 2013, "Sustainable biogas production: A handbook for organic farmers".*

[26] *Amrit B.Karki, " Biotechnology-Vol.-X- Biogas as renewable energy from organic waste".*

The experience of the People's Republic of China could be used as a bench mark. It is reported that around 100 million rural people of China now benefit from biogas digesters, which turn livestock manure into clean cooking fuel and organic fertilizer (biogas digesters produce 410 million tons of organic fertilizers in each year) and cut carbon dioxide emissions by up to 61 million tons a year.[27]

Potential in Biogas and its role in making a Model Village

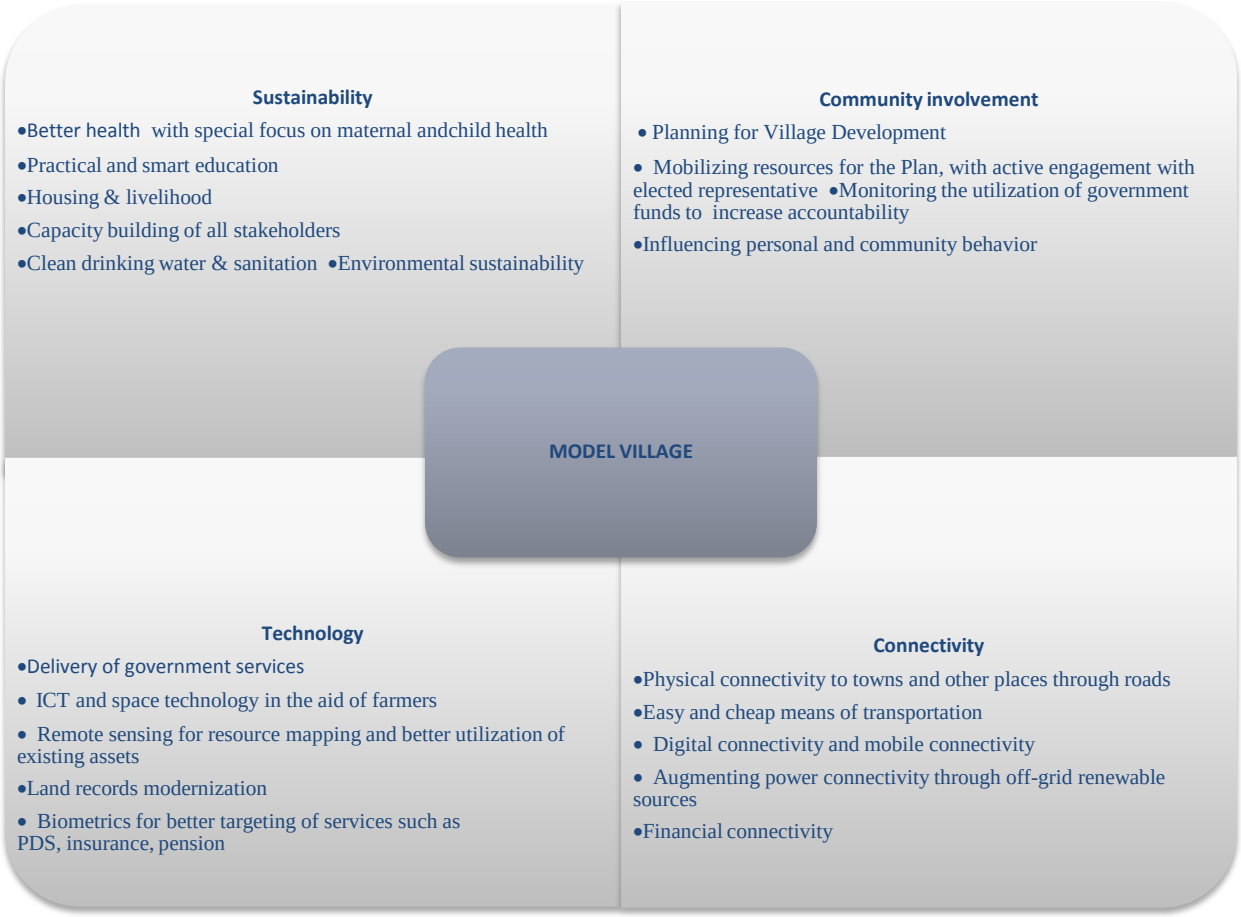
Before knowing, How Biogas is an important determinant in becoming a model village? We must know that what makes a village, A model village..?

Key elements of a model village[28] -

A 21st century model village in India needs to incorporate certain key themes which would be essential for its success. The figure below highlights these broad thematic focus areas, and also mentions the important elements under each such theme.

[27] *IIED, China's domestic biogas sector must adjust to changing conditions, January 2014*

[28] *http://unnat.iitd.ac.in/pdf/model_village.pdf , 26 November 2016*



Now To know is really Biogas have capability to make a village a Model village or in other word to know role of Biogas in becoming a model village, Selection of a model village KEDIA, Jamui District was made for study on the basis of an online article in Times of India- **Bihar's Kedia village an iconic success story in the Eco-Agri Revolution**[29]The success of this eco-agricultural model village Kedia was brought to life at the World Environment Day event through a film screening and a street play, followed by a panel discussion allowing the urban audience to thoroughly investigate this alternative way of farming.

"In little over 20 months, farmers in Kedia have constructed more than 282 vermi composting units, where they convert 'waste' into nutrient-rich, organic fertilizers. The pits also receive slurry from the biogas plants that have been installed alongside, providing a safer, healthier alternative to the burning of biomass as cooking fuel. More installation of biogas digesters are in progress.

Farmers have also built many 'pucca' cattle sheds, to capture both cow dung and urine 'at source'. While the dung goes into the biogas plants, the cattle urine is used for many purposes, including the preparation of products like 'Amritpani', one of the several plant nutrition and pest management solutions made with cattle urine. The farmers have also built

[29]*http://timesofindia.indiatimes.com/city/patna/Bihars-Kedia-village-an-iconic-success-story-in-the-Eco-Agri-Revolution/articleshow/52606587.cms , 26 November 2016, Article by Pranava Kumar Chaudhary| Jun 5, 2016, 07.26 PM IST*

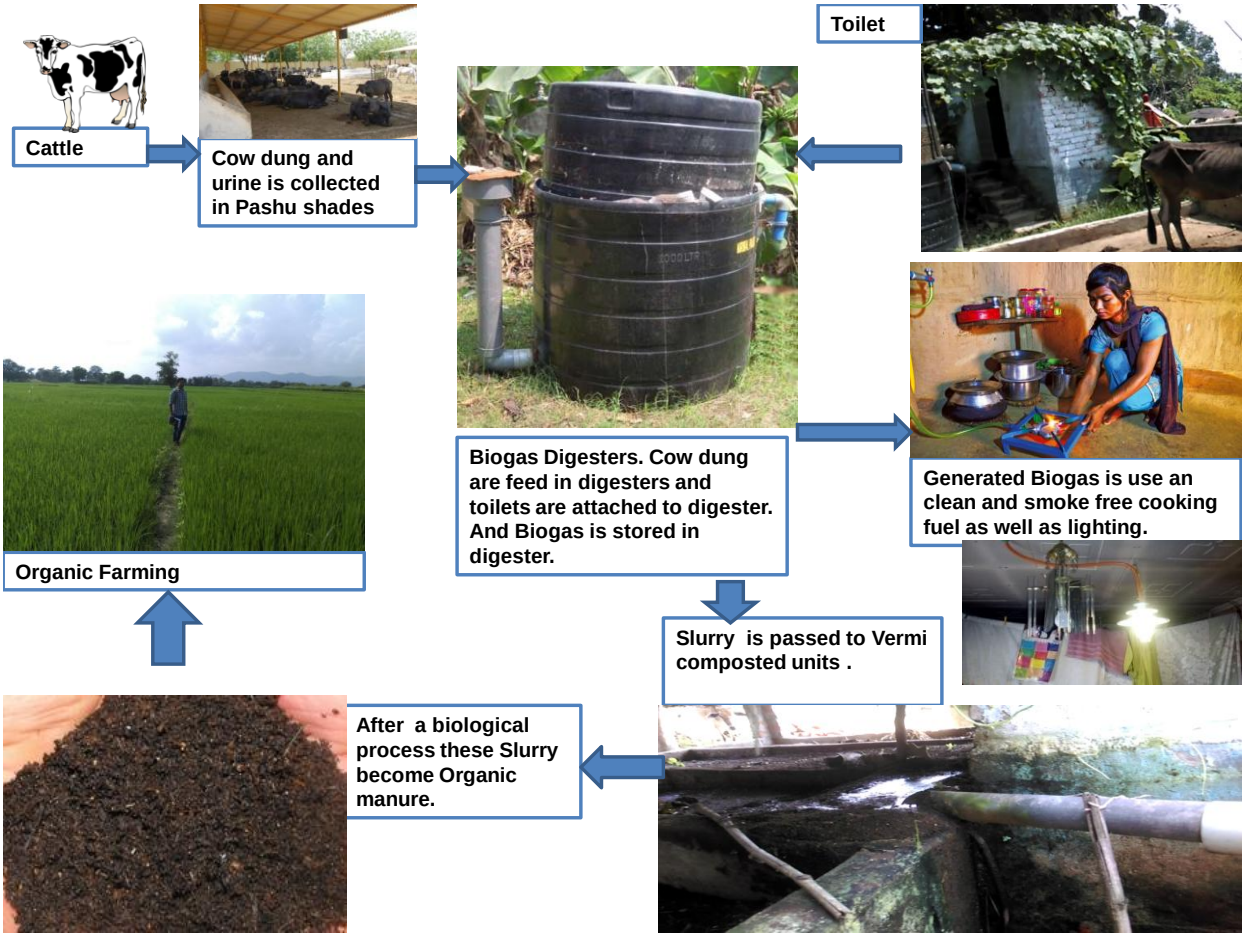
ecological toilets that provide safe, clean sanitation while making it possible to convert human excreta into ecological fertiliser.

The visit to Kedia

The demographic data was collected from "Living Soil farmers committee" office in Kedia, which is a self help group of Kedia farmers. Which says, Kedia having around 125 households with 282 vermi composed units and 20 biogas digesters. Main occupation of villagers is farming. Organic farming and other initiatives by "Living Soil farmers committee" makes kedia a model village. "Greenpeace" a NGO helped the committee in creating awareness, getting technology, as well as funding up to some extent.

To know the complete process, one of the farmers 'Mr. Sunil kumar Amit' was interviewed, in which he showed the physicals units, demonstrated the practical working and explained its uses. The whole session was digitally recorded.

The Process-



The Process itself shows that by Domestic biogas unit a household can satisfy Sustainability which is of the key elements of a model village and if other villages also opt for this, then the village will soon be a model village.

Methodology

In the methodology of data collection the 20 only available farmers, with biogas installed in their house where interviewed in first stage.And the findings explored the benefits of Biogas installation as follows- A rural house hold can get following benefits by installing a biogas digester:-

•Better health with special focus on maternal and child health
•Housing & livelihood
•Clean sanitation
•Environmental sustainability
•Money making by manure production and reducing expenditures on farming.
•Organic farming will insure better price of their agricultural products.

At the 2nd stage of data collection, 20 households with live stock and vermi composed unit at their place but biogas digester is not installed were randomly selected and interviewed.

The finding of which gave answer of following questions:-

1. Do they know about Biogas technology?
2. Are they interested in installing biogas digester?
3. If yes then why they are not installing?

The finding says everyone among them is aware about biogas digester technology as well as benefits. And also all of them were willing to install it but the problem was money and subsidy reimbursements process. Farmers do not have amount of 38k (approx) at once to invest. Also the farmers who have already installed biogas digesters are still waiting for subsidy and fade up of the lengthy reimbursement process.

In study, it is found that People of Kedia are working towards organic farming, and in the process of achieving that, they were also taking steps towards becoming a Model Village, in which biogas plays an important role.

Potential of Biogas-

The potential (India) is about 12 million family type biogas plants based on estimated availability of cattle dung in the country.[30]

Domestic Biogas digester Potential -

Domestic Biogas digester Potential	Potential units on the basis of cattle population.	Live stock Cattle	**Live stock buffalos**	Total bovines (cattle +buffalo)	Potential units if considering total bovines(**cattle+ Buffalos)** population.	Muzaffarpur house holds with cattle	Current Achievement	No. of house holds with buffalos
India	12339300[31] units	190904000	1,08702000.	299606000	12339300[32]		4848000[33] as on Feb 2016	
Bihar	733000[34]	12231523	7567233	19798756	733000	5568111	129523[35] as on (March 2013)	3554058
Muzaffarpur	**20602(i)**	343789	278127	621916	**23024(ii)**	159252		140775

Live stock Bihar.[36]

Live stock data Muzaffarpur[37]

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[30] *http://mnre.gov.in/file-manager/UserFiles/faq_biogas.htm : 01/09/2016*
[31] *http://mnre.gov.in/file-manager/akshay-urja/march-june-2013/EN/48-51r.pdf , 14/04/16*
[32] *http://mnre.gov.in/file-manager/akshay-urja/march-june-2013/EN/48-51r.pdf , 14/04/16*
[33] *http://mnre.gov.in/mission-and-vision-2/achievements/ , 14/04/16*
[34] *http://mnre.gov.in/file-manager/akshay-urja/march-june-2013/EN/48-51r.pdf , 14/04/16*
[35] *http://mnre.gov.in/file-manager/akshay-urja/march-june-2013/EN/48-51r.pdf , 14/04/16*
[36] *19th Livestock Census-2012 All India Report, Ministry Of Agriculture Department Of Animal Husbandry, Dairying And Fisheries*
[37] *http://dahd.nic.in/sites/default/files/Volume%20I.pdf ; 29/08/2016*

i)If considered that MNRE potential estimation for biogas digesters is only on the basis of Cattle dung then on the basis of population cattle population, potential of muzaffarpur district will be:-

(Bihar Biogas Digester potential / Bihar Cattle population) x **Muzaffarpur Cattle population.i.e. (733000/12231523)x 343789 =20602(decimal not considered)**

(ii)If considered that MNRE potential estimation for biogas digesters is on the basis of Cattle and buffalos dung together then on the basis of Bovines population, potential of muzaffarpur district will be:-

(Bihar Biogas Digester potential / Bihar Bovines population) x **Muzaffarpur Bovines population.**

i.e (733000/19798756) x 621916 = 23024(decimal not considered)

(iii) As the data shows there are 159252 households owning cattle and 140775 owning buffalos then for biogas digester potential the total universe will be **159252 households.**

Conclusion

The current energy scenario of India relies on import up to a large extent which is not good for any nation's economy. Also Government of India wants to decrease the reliability on oil imports. LPG is one of the major petroleum products Increase in consumption of LPG may increase Oil Import. 92.3% LPG consumption is for domestic use .So, by managing domestic cooking fuel, LPG consumption can be reduced in future.

In current Domestic cooking scenario as more than 80% of rural households still rely on Biomass for domestic cooking. This is definitely not good for their family health as well as environment.

Government is trying to provide LPG as clean cooking to rural HH. But achievement of which will increase LPG consumption and hence may increase Oil Import dependency.

Biogas has potential to become a perfect alternative of clean cooking fuel. And also Biogas digester installation can help a village becoming a model village. Other Villages can also become like Kedia the model village, and in this biogas installation will plays a vital role.

Use of Biogas will also reduce greenhouse gas emission as CO2 will be less emitted with decrease in burning biomass directly and also will result decrease in methane emission as agricultural waste could be use as feedstock in biogas digesters and methane will be used as clean cooking fuel.

India is having huge potential for biogas digester installation. But Only 39 % has been achieved till Feb 2016, when we see figures for Bihar then achievement is only 17%. So, Government should more focus on Biogas promotion. As it is a unique solution for many problems like Increase in OIL Imports, Rural Households Health, greenhouse gasses emissions, and is a clean renewable energy source.

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