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Mitigation of greenhouse gases through instillation of biogas plants in rural area: A case study in South Karnataka, India

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Abstract
Rural areas of developing countries are very dependent on biomass fuels such as firewood and dried up cattle dung for their energy consumption. This use of energy is often coupled with many problems such as deforestation, land degradation, various human health and socio economical and environmental problems as giving raise to emissions of greenhouse gases. This report assesses the use of biogas plants in developing rural areas and looks into problems and challenges as well as benefits and success factors. In general, the assessment found that the total carbon emissions saved from the setting up and use of biogas plants ever since inception can therefore be designed to be 85tCO_2. The total fuel wood use reduced by the installation and use of the BERI project is calculated as 1.46 tones /family/year. Estimating this for the total 53 households benefiting from biogas, gives a total fuel wood conservation of 24.82 tones /year. A case study of BERI Project has been made. The project was funded by Global Environment Facility and co-financed by India Canada Environment Facility (ICEF), Government of Karnataka and Government of India (Ministry of New and Renewable Energy (MNRE).

Keywords: Bio-gas, fuel wood, climate change, fossil fuels, Green house gases

1. Introduction
The energy usage in most emergent countries mainly constitutes of bio-energy, fossil fuels, fuel wood, firewood etc. Apart from that other importance of especially the least developed countries is that most of the energy burning up comes from household use as opposed to a larger part industrial usage in the developed countries (Li *et al*. 2005) [5]. The use of fuel wood and supplementary forms of biomass as a catering fuel is also directly interrelated to exposures of the harmful emissions from the smoke that these fuels generate when burned (Gautam *et al*. 2009) [4]. The make use of fire wood is also an important aspect in the declinement of forests in the world and there by an important aspect to atmosphere change (Bajgain *et al*. 2005) [2]. In India partially of all the energy usingup for cooking and this correspon ds to approximately double the energy used in the industrial sector of the cooking fuel about 87% comes mainly from fuel wood (Bhatt, Sachan, 2004) [3].
The use of biogas as an energy source has proven itself to be an important strategy in solving the problems of energy usage in rural areas of developing countries. By using locally available substances like cattle dung and other waste products to produce biogas. The biogas can be used as a clean cooking fuel without the effects of pollutants typically associated with firewood and can also be used to generate electricity or for heating (Bajgain *et al.* 2005) [2].
Biogas technology, using local resources such as cattle dung and organic wastes, provides an alternate source of energy for cooking and lighting in rural areas and manure in the form of biogas spent slurry. When organic waste is stored in the absence of air, a microbial degradation process starts producing biogas, which is a mixture of 55% to 70% methane (CH_4), which is the combustible component, 30% to 45% carbon dioxide (CO_2) and a small amount of hydrogen (H_2). Biogas is a smokeless fuel offering an excellent substitute for kerosene oil; cattle dung cake, agricultural residues, and firewood, which are used as fuel in most of the developing countries. Biogas is one of the oldest and most important renewable energy programmes implemented in India. Biogas production from biomass is considered carbon dioxide neutral and therefore does not emit additional green house gases into the atmosphere.

The calorific value of biogas is about 6 kw/h/m^3 corresponds to about half a liter of diesel (BERI, 2001) [1].
Biogas use, replacing conventional fuels like kerosene or firewood, allows for the conservation of environment. The biogas generated from small and medium sized units (up to 6m3) is generally used for cooking and lighting purposes. Thus overall, installation of community biogas units for generating cooking gas can have local environmental benefits such as conservation of village trees and forests and global environmental benefits such as biodiversity conservation and Co_2 emission mitigation. A key output of the BERI project is to reduce CO_2 emissions through the promotion of bio energy as a viable and sustainable option to meet rural energy service needs in India. This study undertakes an analysis of carbon savings achieved by the BERI project and its related activities, as of July 2010. The main objectives of the study are to reduce carbon dioxide, assessment of Co_2 mitigation from running of biogas plants (Biomass Energy for Rural India Carbon Mitigation Report, Darshini Ravindranath, 2001) [1].

2. Materials and methods

2.1 Study Area

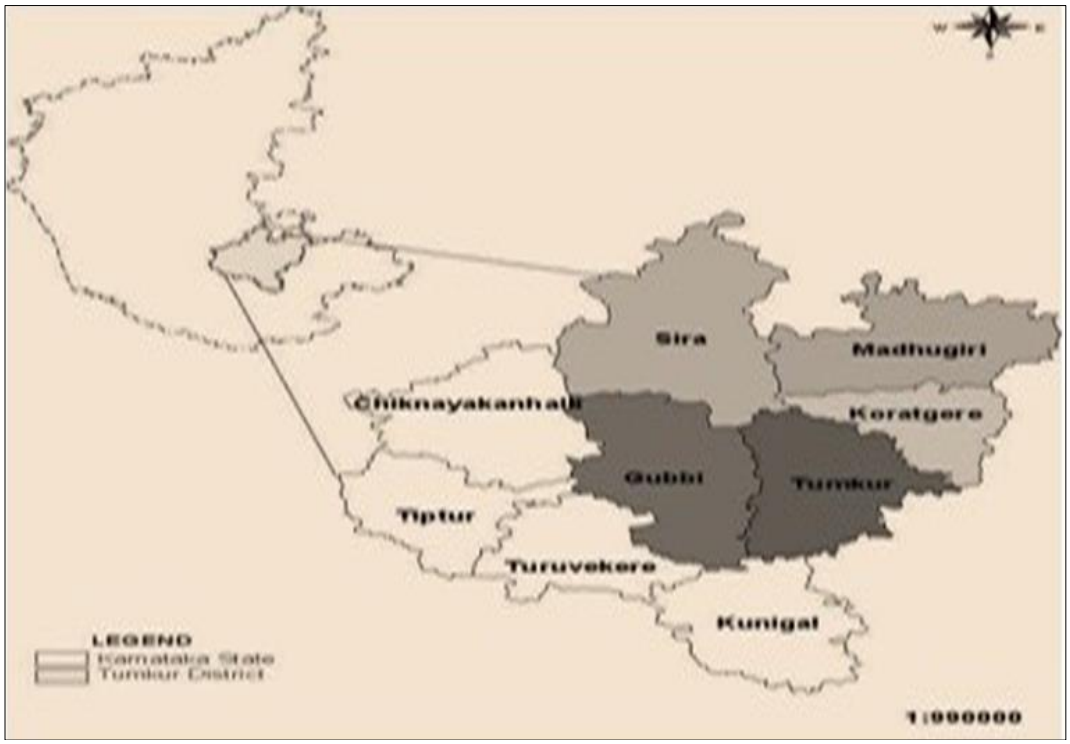

Fig 1: Showing the location map of five clusters

BERI is one of the projects supported by UNDP for achieving the millennium improvement goal of ensuring environment sustainability and thereby reducing poverty. The project is funded by Global Environment Facility (GEF) and co-financed by India-Canada Environment Facility (ICEF), Government of Karnataka and Government of India (Ministry of New and Renewable Energy (MNRE). The project sites covered five clusters in the Tumkur district of Karnataka in Southern India (figure 1). The state of Karnataka's population accounts for 448 lakhs, 5.3% of the total Indian residents. Project district covers 5.5% population of Karnataka and accounts for 5% of the state inhabitants. A significant 80.38% of the population in Tumkur district is rural. In additional approximately 80% of the population in the Tumkur district relies on agriculture and related activities such as farming. Of those, only 9% come from the urban areas of Tumkur (Census 2001).

2.2 Survey of Biogas Plants

Biogas technology provides a very good hope for carbon alleviation through the following: replace firewood for cooking, replacing kerosene for lighting and cooking, replacing Inorganic fertilizers and saving trees from reckless deforestation. A survey of all accessible biogas plants and their handling was conducted in 2013. A questionnaire was prepared and the results evaluated to enter at the carbon mitigation potential of biogas at five project sites.

2.3 Business as Usual Scenario

A preliminary appraisal of the project area in 2001 had indicated the predominance of fuel wood for the purposes of cooking. Burning fuel wood leads to high emissions of CO_2 and methane in addition to causing human health problems. In the BAU situation the total quantity of fuel wood used for cooking earlier than the installation and use of biogas units is assessed. This helps recognize the carbon abatement possible from fuel wood saving. An assessment of project literature shows the lack of sufficient quantitative baseline information on the amount of fuel wood used before the setting up of the project. Headed for overcome this constraint, a detailed survey of the 171 households that participated in the community biogas programme was conducted. Each one interviewee was requested to ascertain the average amount of firewood collected and used for the purpose of cooking on a every day/weekly/monthly basis. For households that are currently using biogas for cooking, the answers even as hypothetical were found to be comparable to the amounts indicated by households currently not using biogas. The information was collated and averaged to generate a rough baseline scenario of the

amount of fuel wood, timber used by households for cooking. Consequently, it is important to note that the information collected and used is subject to people's perceptions and as in any assessment involving people, is subject to a important error margin. On an average of 2.8 tones of firewood was projected to be used per household per year for the purpose of cooking.

2.4 Project Scenario

The project was initiated in March 2001. In Project installation of 45 community biogas units in 24 village settlements with a total power of 4,000 m^3/ day for cooking gas and bio- fertilizer manufacture. Since initiation, a total of 53 community biogas units have been installed in 31 village settlements covering 171 households. Every biogas unit was meant for three households. The energy derivative from the biogas units was considered to be sufficient to meet a majority of cooking needs of an average five households. On conducting a detailed survey of all 51 biogas units in the scheme, it was observed that over the years about 70% of the biogas units are being used.

2.5 Capacity building

On the whole, capacity building by the project area has led to improvements within the groups benefitting from the project. For instance, Self Help Groups have been set up by the women with the help of local Non governmental organizations like BAIF Institute for Rural Development - Karnataka (BIRD-K) among others.

2.6 Assessing carbon savings from community Biogas units

The total fuel wood usage substituted through the installation of community biogas units is assessed. A business as usual scenario was developed to establish past trends in fuel wood use per family unit. Once this is recognized, a BERI project scenario will be ascertained there by signaling the net carbon reductions achieved by the BERI project through the preamble of biogas for cooking.

3. Results and Discussion

Table 1: Total biogas units installed, biogas units currently in use, quantity of wood saved and Reduced co_2 / yr in the project: Source: House Hold Survey (2013)

aluk /Cluster	Bio- gas units installed house holds	Biogas units currently in use	No. of animals /house (average)	No. of people served (average)	Fertilizers produced /day (in kg) x1 yr is, equivalent (Biogas presently in use)	Qty of wood used without bio-gas Units /House (kg/day)	Qty of wood used with biogas units /House (kg/day)	Qty of wood saved (kg /day)	Total qty of wood saved in tones /yr	Each Biogas plant mitigate 5t of co_2 equivalent /year (BERI 2001) x Total. No. of Biogas units Currently in use.
Tumkur	7	5	3	5	7300	8	4	4	7.3	25
Gubbi	13	6	3	5	8660	8	4	4	8.76	30
Sira	8	1	2	5	1460	8	4	4	1.46	5.0
Koratagere	13	2	3	5	2920	8	4	4	2.92	10
Madhugiri	12	3	2	5	4380	8	4	4	4.38	15
Total	**53**	**15**	13	25	24,720	40	20	20	24.82	85 tco_2/yr

As indicated in table 1, about 28% of community biogas plants are currently in use. Many households have since discontinued use due to problems such as: unsatisfactory co-ordination among the households sharing the community biogas unit, deficient supply of dung, ground interrelated conflicts and occurrence of readily available liquid petroleum gas. As a result any investigation of the total carbon mitigated from the project must factor the potential carbon mitigated from initial use of the biogas units. At present 15 biogas units in function serve 45 households, with each unit catering to more or less 3 households. Project area surrounded by these households, a questionnaire was used to find out the total firewood used in comparison to the BAU scenario. Each aspirant was requested to ascertain the average amount of fuel wood collected and used for the purpose of cooking on an each day/weekly/monthly base since the setting up and use of the biogas units. The interviewed households indicated that approximately 50% of cooking needs were met by the use of biogas on a daily basis (Table 1). Therefore a biogas unit were saved total of 1.46 tones of firewood also mitigate 5t/co_2 per household annually due to the introduction of biogas for cooking. In general, the assessment found that the total carbon emissions saved from the setting up and use of biogas plants ever since inception can therefore be calculated to be 85tCO_2. The mitigation potential could be higher if all 53 community biogas plants installed were operational. The total fuel wood use reduced by the installation and use of the BERI project is calculated as 1.46 tones /household/year. Estimating this for the total 53 households benefiting from biogas, gives a total fuel wood conservation of 24.82/ tones/year.

4. Conclusion

Climate change alleviation involves reductions in the concentrations of greenhouse gases (GHGs) also by reducing the sources. Mitigating climate change has seen increased efforts in developing latest technologies and mechanisms even as carefully managing the existing ones, so as to minimize impacts on the atmosphere. The most accepted means of mitigating climate change worldwide are through, a decentralized bio-energy technology package, to remove barriers to large-scale adoption and commercialization of this bio-energy knowledge package. Encouragement of bio-energy as a precious and sustainable option to meet the rural energy in India. All these will contribute to the reduction in GHG's emissions. Improvement and use of eco friendly energy resources such as bio energy, biogas, the reduction of waste, energy conservation, altering utilization patterns and the use of carbon sinks

5. Acknowledgement
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