We request you to join the BIOGAS FORUM - INDIA as a life member. Membership form is attached at the end.

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From the Editorial Desk

India’s biogas experience is the oldest in the world. India was a pioneer in the area of biogas. Government of India started National Biogas Development Programme (NPBD) started in 1981. In this programme more than 4.1 million biogas plants has been installed in the country. Technology has been upgraded continuously still there are various areas in which we have to create our strength to make a present Biogas and Manure Management Programme (NBMMP) a success. Recently Government of India has significantly increased the financial support for family size biogas plant and also launched two schemes mainly Biogas Fertilizer Plant (BGFP) and Biogas Power generation.

Biogas Forum aims towards developing a conducive environment which can facilitate biogas programme implementation in an efficient and sustainable manner in the country with the participation of scientist, policy makers, implementing agency, entrepreneur, field workers and beneficiaries.

I request all who are concerned with sustainable green energy implementation and reducing carbon foot print to join this movement by big coming aids and supports. In the future various activities are plan like:

- Publication of journal
- E-news letter
- Conference/workshop/training
- Preparation of policies promotion of entrepreneur and commercialization of biogas plants

Once again I request to join hands together in their endeavor your suggestion are always welcome to strengthen Biogas Forum India.

Yours own

V. K. Vijay
General Secretary
1. **About the Forum**

The forum was registered on 23rd February, 2010. The main motto of the Forum is to encourage and support the basic and applied research in the field of biogas and to provide national as well as an international platform for the scientists/researchers to communicate and discuss the results of their research Recognition of the leading lights of the day in the entire area of biogas.

**Objectives of the Biogas Forum**

1. To promote biogas technology as a source of clean energy, organic manure, improved sanitation and environmental protection in India.
2. To act as opinion maker and think tank for popularization of Biogas in the country.
3. To facilitate entrepreneurship development and marketing of Biogas systems.
4. To create economical, social and Technological viability for Biogas Technology.
5. To provide a common platform for Institutions, organizations, industries, farmers and beneficiaries to interact in the area of Biogas Technology.
6. To develop linkages amongst all stakeholders from grass root to international level engaged in Biogas.
7. To bring our periodical publications related to biogas technology.

**Activities**

1. To generate awareness, popularize and promote biogas development, its use and marketing in India based on scientifically developed biogas technology and systems, potentially to provide environmentally benign, renewable and sustainable fuel for meeting demand in domestic, agriculture, power and transport sectors;
2. To provide a vibrant platform to stakeholders, such as research institutions and laboratories, planning and development organizations, financing institutions, scientists; engineers; managers; planners; promoters; supervisors; technicians; volunteers, financiers, private entrepreneurs (individuals, organizations and industries); students, academicians, officials, etc., interested in the discipline of biogas and related subject matters through consultations, conferences, workshops, seminars, exhibitions, business meets, E-mailing etc.;
3. To act as an opinion maker and pressure group for popularizing biogas in an holistic manner to benefit farming community, local bodies and industries in recycling bio-wastes both in rural and urban area through biomethanation for producing fuel and fertilizer and simultaneously reducing, rather eliminating, emission of green-house gases;
4. To constructively work, cooperate, assist and advise the government, corporations, local bodies, industries and non-governmental organizations in promoting biogas technology and/or implementing biogas programmes/projects/schemes in the country with financial assistance from Government; public, private and international agencies;
5. To maintain relations and cooperation with national and international sister associations, societies, cooperatives and other organizations concerned with biogas and related subject matters through exchange of scientific information, publications and expertise; organizing and participating in training courses, visits, conferences, seminars, workshops etc.;
6. To undertake and facilitate preparation of plans and programmes; to arrange expertise consultancy, studies, monitoring and management reports, socio-economic and financial analyses, etc., for promoting mature and viable biogas technology in the country;
7. To improve economic benefits and acceptability of biogas by assisting organizations and individuals eligible in availing facility of carbon credits and related benefits directly or through coordination of other agencies involved in the carbon trade by preparation of project documents, monitoring and verifying outputs of the projects implemented, etc., by following internationally approved norms and terms and conditions;

8. To develop and assist organizations (for example Bureau of Indian Standards) concerned with the framing and implementation of standard specifications for feed-stocks for generation of biogas, biogas plants and systems, bio-slurry and manure, biogas appliances and accessories, biogas cleaning/upgrading systems, biogas distribution pipelines, biogas storage systems, biogas transportation systems, biogas engines and turbines, biogas vehicles and tractors etc.;

9. To serve as an information clearing house based on scientifically verifiable and statistically field tested data and bring out technically appraised and reviewed publications, reports, critical position papers, audio-visual and multimedia aids, etc., on biogas and related subject matters;

10. To arrange financial support and grants from international /multilateral, bilateral organizations, national and state governments, industries and non-governmental organizations for publications, research fellowships, training, field visits, consultations, conferences, workshops, seminars, exhibitions, business meets, awards, etc., for furthering the cause of popularizing biogas in the country; and

11. To suggest and organise strategy and mechanism for bringing a constant and regular improvement in the skill and competency of persons involved in research and development as well as promotion and extension of biogas in the country.

**Governing Body of the Forum**

1. **Dr. Atma Ram Shukla**, President, Delhi
2. **Dr. Anjan K. Kalia**, Vice President, Dharmshala, H.P.
3. **Dr. Virender Kumar Vijay**, General Secretary, New Delhi
4. **Mr. Amit Agarwal**, Treasurer, New Delhi
5. **Prof. Rajendra Prasad**, Member, New Delhi
6. **Mr. Ved Prakash Goyal**, Member, Ghaziabad, U.P.
7. **Dr. P. Venkatachalam**, Member, Coimbatore, TN
8. **Dr. S.P. Singh**, Member, Indore, M.P.
9. **Mr. Bhuvnesh Kumar Bhatt**, Member, Delhi
10. **Dr. Deepak Sharma**, Member, Udaipur, Rajasthan
11. **Dr. Sarabjit Singh Sooch**, Member, Ludhiana, Punjab
12. **Dr. Shyam Sunder Kapdi**, Member, Anand, Gujarat

2. **Various Schemes of MNRE Related to Biogas**

   a) **Implementation of National Biogas and Manure Management Programme (NBMMP)** ([http://mnre.gov.in](http://mnre.gov.in))

   **Objectives**

   i) To provide clean bio-gaseous fuel mainly for cooking purposes and also for other applications for reducing use of LPG and other conventional fuels.

   ii) To meet ‘lifeline energy needs for cooking as envisaged in ‘Integrated Energy Policy’.

   iii) To provide bio-fertilizer organic manure to reduce use of chemical fertilizers.
iv) To mitigate drudgery of rural women, reduce pressure on forests and accentuate social benefits.

v) To improve sanitation in villages by linking sanitary toilets with biogas plants.

vi) To mitigate Climate Change by preventing black carbon and methane emissions.

**Special and Innovative Features**

Special and Innovative Features of the programme during the remaining part of 11th Plan are given below:

i) Introduction of competitive bidding on pilot basis for setting up biogas plants with the recommended Central Financial Assistance as upper limit.

ii) Large scale installation of biogas plants with possible CDM benefits subject to a suitable tie-up and restricting per plant Central Financial Assistance to the existing level of subsidy applicable during 2008-09.

iii) Taking up implementation through Biogas-Fertilizer Companies/ Entrepreneurs (BOFCOs/BOFEs), Banks, IREDA, Financial Institutions, Self-Help Groups, Cooperatives and NGOs in addition to State Government Nodal Departments/ Implementing Agencies and Khadi & Village Industries Commission (KVIC).

iv) Five percent of proposed outlay to be used for establishing innovative models for financing and implementation.

v) Repair of the old non-functional biogas plants- may be supported up to 5 percent of the outlay for the programme after, at least, five years of installation of such plants.

vi) Putting up of beneficiary- wise list of installation of biogas-fertilizer plants, on websites of the respective organizations, has been made mandatory.

vii) Focus on capacity building through various organizations.

**Release of Funds in Advance**

The Central Financial Assistance (CFA) will be released for various components of the programme to the concerned State Nodal Departments (SNDs)/ State Nodal Agencies (SNAs) and other implementing agencies @ Rs. 16,700/- per plant for NER States and Rs.10,000/ for other States at an estimated unit cost for advance release of funds per plant for the allocated target on lump-sum basis. The funds released as advance can be used for expenditure on Central Financial Assistance, turn-key job fee, administrative charges, publicity, training, etc. The Central Finance Assistance (CFA) will be released in two installments on the following pattern:

i) Advance amounting to 50% of the Central Financial Assistance (CFA) corresponding to the allocated target, after adjusting the unspent balance, if any, will be made to all States and agencies after issue of the sanction order for physical targets and on receipt of U.C. for the previous releases.

ii) The balance 50% of the CFA will be released as second installment after the receipt of Utilization Certificate of the previous releases and receipt of audited Statement of Account up to previous to previous year and based on the satisfactory progress made during the implementing year.

iii) State Nodal Departments/ Agencies and NGOs should submit the claim for settlement to the Ministry along with consolidated utilization certificate and audited Statement of Expenditure as soon as after the close of the financial year but not later than 30th June of the implementation year.
Pattern of Central Financial Assistance (CFA)

Pattern of Central Financial Assistance (CFA) for different component of National Biogas and Manure Management Programme (NBMMP) is given below:

Table-I: Pattern of Central Financial Assistance under National Biogas and Manure Management Programme November 2009 for 11th Plan

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Items for Central Financial Assistance(CFA)</th>
<th>Family type Biogas Plants under CDM</th>
<th>Family type Biogas plants under NBMMP**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 cum 2-4 cum</td>
<td>1 cum 2-4 cum</td>
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<tr>
<td>-------</td>
<td>---------------------------------</td>
<td>-----------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>A</td>
<td>Central Financial Assistance to beneficiaries of Biogas Plant (in Rs. per plant)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>NER States, Sikkim (except plain areas of Assam)</td>
<td>11,700</td>
<td>11,700</td>
</tr>
<tr>
<td>2</td>
<td>Plain areas of Assam</td>
<td>9,000</td>
<td>9,000</td>
</tr>
<tr>
<td>3</td>
<td>Jammu &amp; Kashmir, Himachal Pradesh, Uttarakhand, Niligiri of Tamil Nadu, Sadar Kusroong &amp; Kalimkpong Sub-Divisions of Darjeeling, Sunderban (W.B.) and Andaman &amp; Nicobar Islands</td>
<td>3,500</td>
<td>4,500</td>
</tr>
<tr>
<td>4</td>
<td>All Others</td>
<td>2,100</td>
<td>2,700</td>
</tr>
<tr>
<td>B</td>
<td>Turn-Key Job Fee including warranty for five years (in Rs. per plant)</td>
<td>700</td>
<td>1,500</td>
</tr>
<tr>
<td>C</td>
<td>Additional CFA for toilet linked Biogas Plants (in Rs. per plant)</td>
<td>500</td>
<td>1,000</td>
</tr>
<tr>
<td>D</td>
<td>Incentive for saving Diesel and kerosene conventional fuels by using biogas in engines/ gensets and/ or biogas based refrigerators (in Rs. per plant)</td>
<td>2,500</td>
<td>5,000</td>
</tr>
<tr>
<td>E</td>
<td>Administrative Charges- for target range of plants (in Rs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>100-3,000</td>
<td>50,000@</td>
<td>1,00,000^</td>
</tr>
<tr>
<td>2</td>
<td>3,001-7,000</td>
<td>8,90,000#</td>
<td>10,50,000^^</td>
</tr>
<tr>
<td>3</td>
<td>Above 7,001</td>
<td>14,90,000$</td>
<td>24,50,000 *</td>
</tr>
<tr>
<td>F</td>
<td>Training Courses (in Rs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Users course</td>
<td>1,000</td>
<td>2,000</td>
</tr>
<tr>
<td>2</td>
<td>Staff course</td>
<td>5,000</td>
<td>8,000</td>
</tr>
<tr>
<td>3</td>
<td>Refresher/Construction-cum maintenance course</td>
<td>19,000</td>
<td>35,000</td>
</tr>
<tr>
<td>4</td>
<td>turkey-key operator and management course for workers of companies/ entrepreneurs</td>
<td>38,500</td>
<td>67,500</td>
</tr>
<tr>
<td>G</td>
<td>Biogas Development &amp; As per existing pattern Training Centers</td>
<td>As per existing pattern</td>
<td>As per existing pattern</td>
</tr>
<tr>
<td>H</td>
<td>Communication and Publicity-for target range of plants (in Rs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Up to 1,000</td>
<td>1,00,000</td>
<td>1,00,000</td>
</tr>
<tr>
<td>2</td>
<td>1,001- 10,000</td>
<td>2,50,000</td>
<td>2,50,000</td>
</tr>
<tr>
<td>3</td>
<td>More than 10,000</td>
<td>5,00,000</td>
<td>5,00,000</td>
</tr>
<tr>
<td>I</td>
<td>Support for Repair of Non-functional Plants with the restriction of utilization of upto 5% of the outlay of the programme in that year of the concerned State UT</td>
<td>Nil</td>
<td>50% of applicable CFA category subject to sharing of 50% of the cost of repair by the beneficiary.</td>
</tr>
<tr>
<td>Family type Biogas Plants under CDM</td>
<td>Family type Biogas Plants under NBMMP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>@ Extra Rs.300 per plant in excess of 200 biogas plants.</td>
<td>** Maximum 0f 50% of the cost of the biogas plant for low cost models.</td>
<td></td>
<td></td>
</tr>
<tr>
<td># Extra Rs.150 per plant in excess of 3000 biogas plants.</td>
<td>@ Extra Rs. 350 per plant in excess of 100 biogas plants.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$ Extra Rs.100 per plant in excess of 7000 biogas plants &amp; maximum of Rs.30 lakh.</td>
<td>@ Extra Rs.300 per plant in excess of 3000 biogas plants.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Extra Rs. 250 per plant in excess of 7,000 biogas plants subject to maximum of Rs. 50.0 lakh.</td>
<td>* Extra Rs. 250 per plant in excess of 7,000 biogas plants subject to maximum of Rs. 50.0 lakh.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Implementation**

The programme will continue to be implemented by State Nodal Agencies, District Rural Development Agencies, other State Government Agencies/ Organizations/ Departments etc. However, within the State, the implementing agencies could also identify other organizations but which would function within their overall responsibility and coordination.

**Turn-Key Job Fee (TKJF)**

Turn-Key Job Fee for in-situ construction of Biogas Plants. The turn-key job fee is linked with five years warranty for trouble-free functioning of biogas plants set up on turn-key basis. It is payable to corporate bodies; registered societies identified by the State Governments and approved trained entrepreneurs. This is subject to the condition that the turnkey worker would visit the plants twice in a year at least during the warranty period. Guidelines and procedure for payment of turn-key job fee for setting up family type biogas plants were issued to all the States and agencies vide letter No.17-4/82-Biogas dated 18th December, 1982. TKJF should be paid to the TKJF worker preferably through ECS or account payee Demand Draft! Cheque only, it should be paid in five installments. The first installment to be of Rs. 700/- in the first year and second, third, fourth and fifth installment @ Rs. 200/- each per year after completing the inspection and providing satisfactory warranty services.

**Turn-Key Job Fee for Prefabricated Biogas Plants**

Turn-key job fee of Rs. 700/- only is payable for bag type digester made of rubberized nylon fabric (“flexi” model), HDPE, FRP and RCC material based prefabricated complete family type Biogas Plants as it does not involve any supervision of construction and manufacturers are supposed to provide a guarantee for five years. However these plants do involve feeding, supervision for installation and guidance for operation and maintenance. For such prefabricated plants the turn-key job fee may be provided in three installments of Rs. 300/- in the first year and two installments of Rs. 200/- each at the end of second and third year for taking care of operation and maintenance problems.

**Additional Central Financial Assistance (CFA) for Cattle Dung based Biogas Plants linked with Sanitary Toilets**

The additional Central Financial Assistance (CFA) can be used only for meeting the extra cost involved in raising the toilet level, if required, and its connection with a biogas plant. However, SNDs/SNAs should ensure that plants are set up only after assuring the requirement and preparedness of the beneficiary to use biogas from the plant attached with the toilet and the biogas
plants should be completed in all aspect. States and agencies concerned with implementation for rural sanitation programme are requested to make effective coordination with the Departments/Agencies concerned at the State and district level in identification of beneficiaries for linking of biogas plants with sanitary toilets, wherever feasible.

Additional CFA for saving of diesel, other fuels by using Biogas based Engines Gensets/ Refrigerators.

The additional incentives will be given for purchase of biogas based engines/ Gensets (100% or dual fuel) and refrigerators, plastics or rubber balloons/container for storage and transportation of biogas from the site of the plant to the site of the engine subject to the condition that the cost of such appliances be equal or more than the CFA.

**Administrative Charges**

The rate of administrative charges for SNDs/SNAs Implementing Agencies is linked with actual achievement. No administrative charges will be given for achievement of less than 100 nos. of biogas plants. The manpower required for the programme may be outsourced. The manpower engaged by SNDs/SNAs, KVIC and other Implementing Agencies should not be treated as employees of Ministry of New and Renewable Energy, Government of India.

**Biogas Development and Training Centers (BDTCs)**

Biogas Development and Training Centers (BDTcs) are supported for providing technical training and monitoring & evaluation and preparation of technical booklets guidelines material support for quality implementation of biogas programme in addition to technology development. BDTCs should submit their claims indicating training-wise details (viz: venue, periodicity, number of participants, expenditure incurred etc.) as also the number and names of manpower engaged emoluments etc.

**Support for Repair of Old Non-functional Plants**

Support is provided for repair and revival of old family type biogas plants which are at least five years old and which are in dis-use at present for want of structural repairs excluding replacement of gas pipelines, gas cock, burner, etc. The 50 percent expenditure of the repair of the old plant would be borne by the concerned beneficiary. The State Nodal Departments and Programme Implementing Agencies are required to carry out a detailed block/district-wise field assessment on the number of non-functional plants to be repaired and details of repair costs, along with expected contribution from the beneficiaries, support from the State Government and financial support needed from MNRE. SNDs/SNAs may undertake repair of non-functional biogas plants intensively in chronic districts and complete the repair work of the plant, subject to above conditions, utilizing the advance funds released by MNRE and submit the claims along with other items for adjustment and reimbursement. The expenditure towards repair of old non-functional plants is restricted to 5 percent of the outlay in accordance with the target for that year of the concerned State Agency. The repaired plants are to be got verified by BDTCs/ independent organizations.

**Implementing Organizations**

The multi-agency approach will continue to be adopted for the implementation of the National Biogas and Manure Management Programme (NBMMP). The programme will be implemented by State Governments/ Union Territories, Departmental agencies, KVIC (in all States/UTs), corporate bodies/ societies State Nodal Agencies, State Agro-Industries Corporations Scheduled Banks,
Grameen and Prathama Banks IREDA, NABARD, and other financial institutions. State Nodal Departments and Implementing Agencies should maximize their role in actual installation of biogas plants and focus only on promotion awareness raising, quality control, training, etc. A major emphasis should be laid on achievement of entire programme through Biogas-Fertilizer Companies, Entrepreneurs and Turn-Key Workers.

**Coordination Committee at the State and District Levels**

NBMP envisages multi-agency approach for setting up of biogas plants. Besides, State Government departments/nodal agencies, KVIC and a few GOs have also been involved in implementation of the programme. With a view to ensure proper monitoring, coordination and review of programme implementation, all States nodal departments and agencies should include the subject in the meeting of District Advisory Committees on Renewable Energy. The details of the meetings of the Committee held during each quarter may be included in the quarterly progress report attaching the List of important decisions and sent to MNRE headquarters.

**Payment of CFA after Commissioning of Plants**

Central Financial Assistance (CFA) is to be disbursed to the beneficiaries after completion of construction of biogas plants, including pipeline, burner, and commissioning of biogas plants preferably through ECS or account payee Demand Draft/ Cheque.

**Placing of Advance Funds at District Levels**

The State Governments/Implementing agencies, KVIC may, if necessary, place funds received in advance from MNRE at the disposal of the State/district/block programme executing agencies and concerned banks. However, the Central Financial Assistance (CFA) should be paid to beneficiaries/organization only after commissioning of the plants. Efforts should be made to minimize burden of investment made or interest on the loan amount, availed by the beneficiary organization.

**b) Development of projects on "Demonstration of Integrated Technology-Package on Medium-Size Biogas-Fertilizer Plants (BGFP) for Generation, Purification/Enrichment, Bottling and Piped Distribution of Biogas towards Harnessing’ near Total Potential of Suitable Biomass in Rural Areas. (http://mnre.gov.in)**

1. The R&D Policy Guidelines (available on website address http://mnre.gov.in) provide for taking up technology demonstration projects in the area of renewable energy with MNRE support of 50%. For demonstration of a technology package on Biogas-Fertilizer Plants an advertisement was hosted on the website of the Ministry and ‘expression of interest’ has been received from many States. So far 5 proposals have been sanctioned for implementation.

2. In pursuance of the said provisions and ‘expression of interest’ received by the Ministry, proposals are invited for Demonstration of ‘Integrated Technology-Package on Medium-size Biogas-Fertilizer Plants (BGFP) for Generation, Purification/Enrichment, Bottling and Piped distribution of Biogas towards harnessing ‘Near Total Potential of suitable Biomass in Rural Areas’ through the involvement of entrepreneurs. The MNRE support of 50% can be made available for taking up such technology projects. Balance 50% or the cost of the project is required to be invested/ mobilized by the entrepreneur/developer. However, at least 20% of the cost of the project is to be met by the entrepreneur/ user
agency in case loan is availed from banks/ financial institutions including NABARD, IREDA and KVIC. The capacity of BGFP could be 200, 400, 500, 1000m³ biogas/ day and multiples thereof depending on the availability of suitable biomass feed-materials and cattle-dung.

3. The interested SNAs, institutions/ industries/ entrepreneurs may prepare Feasibility- Detailed Project Report

4. Report (FDPR) for taking up such projects in a prescribed format attached at Enclosure-I. Specific guidelines and General guidelines to be considered for preparation of FDPRs are attached at Enclosure-II and Enclosure-III. Format for registration of consultants is given at Enclosure-IV. Specific Terms & Conditions and General Terms & Conditions are also given at Enclosure-V and VI. Ten nos. of hard copies of FDPRs along with 3 nos. of electronic copies/ CDs may be sent to Adviser (BE), Ministry of New and Renewable Energy, 14, C.G.O. Complex, Lodhi Road, New Delhi - 110 003.

5. The proposals are proposed to be evaluated by experts and considered by Technology Demonstration Appraisal Committee of the Ministry. Recommended projects are to be implemented, operated and owned by the concerned industries/entrepreneurs/ project developer.

6. In a meeting held on 9th June, 2009 with select SNAs it was recommended that at least one proposal from each of the states may be generated and submitted to this Ministry. The details of FDPR format along with enclosures are available on MNRE website under the icon of advertisement at address http://mnre.gov.in.

c) Biogas Based Distributed/ Grid Power Generation Programme

Biogas based power units can be a reliable decentralized power generation option in the country. In order to promote this route of power generation, specially in the small capacity range, based on the availability of large quantity of annual wastes and wastes from forestry, rural based industries (agro/food processing), kitchen wastes, etc; a number of projects of different capacities and applications will be taken up for refining the technical know-how, developing manpower and necessary infrastructure, establishing a proper arrangement of operation & maintenance and large scale dissemination. The projects to be taken up by any village level organization, institution, private entrepreneurs etc. in rural areas as well as areas covered under the Remote Village Electrification (RVE) programme of MNRE other than the industries and commercial establishments covered under Urban, Industrial & Commercial Applications (UICA) programmes for sale of electricity to individual/community/grid etc. on mutually agreeable terms. The implementing organizations must ensure that sufficient feed materials for biogas plants are available on sustainable basis and the beneficiary organization gives an undertaking that the plant would be maintained and operated for a minimum period of ten years.

Training & Awareness Promotion

The programme provides support for a variety of workshops, seminars, meetings, training programmers to the implementing agencies/specialized organizations/Biogas Development & Training Centers (BDTCs) for developing the required specifications and standards, discussions/deliberations on the performance of systems, setting up operation and maintenance mechanism, training of required manpower, capacity building, business meets for the prospective industries, etc. with the ultimate objective of promotion of power generation based on biogas in the country. The quantum of financial assistance to be provided by Ministry of New and Renewable Energy (MNRE) for conducting these programmers will be decided on the basis of nature &
duration of the programme, number of participants, etc. The maximum assistance, however, is limited to Rs. 100,000 per event.

**Implementation**

The programme would be implemented through nodal departments/agencies of the States/UTs, KVIC, institutions and NGOs. The implementing organizations are required to submit proposals on prescribed format. Funds for implementation will be disbursed through State nodal organizations/implementing agencies. Installation of projects should be encouraged only if specific responsibility is taken upright from the initiation of project by the institution including for operation and maintenance for the specified period as per DPR norms.

**Release of Funds**

Central Financial Assistance (CFA) for projects and service charges to State nodal organizations/implementing agencies/NGOs pattern of release of funds would be as follows:

i) 50 per cent of the eligible CFA plus service charges will be released to the State nodal department agency/ organization with the sanction order.

ii) 40 per cent of the eligible CFA will be made as second installment after the receipt of utilization certificates, based on report of supply & installations of equipments etc. on site and satisfactory progress made.

iii) The balance 10% of the eligible CFA will be made after successful commissioning of the biogas power plant as per the DPR norms, receipt of utilization certificates, audited statement of expenditure, project on completion requires inspection report submitted by MNRE/ an authorized agency of MNRE .The condition of successful commissioning of the plant would, inter-alia, imply generation of operation of 19 kWh/day/kW sanctioned capacity for 3 consecutive days.

**Central Financial Assistance**

<table>
<thead>
<tr>
<th>Power Generating Capacity</th>
<th>Biogas plant capacity</th>
<th>CFA/subsidy limited to the following ceiling or 40% of the cost of the system whichever is less.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 -20 kW</td>
<td>25 cu.m to 85 cu.m</td>
<td>Rs.40,000 per kW</td>
</tr>
<tr>
<td>&gt;20 kW to 100 kW</td>
<td>Any combination of above plants or alternate capacity /design</td>
<td>Rs.35,000 per kW</td>
</tr>
<tr>
<td>&gt;100 kW to 250 kW</td>
<td>Any combination of above plants or alternate capacity /design</td>
<td>Rs.30,000 per kW</td>
</tr>
</tbody>
</table>

- Biogas Plant Capacity : 25-3000 cum/ day
- Power Generation Capacity : 3-250 KW
- Estimated Power Generation From 25 cum Plant : 30 KWhr per day (3KW)
- Estimated Power Generation From 100 cum Plant : 120 KW hr per day (12 KW)
- Estimated No. of hours for meeting : 10 hrs
- Power Requirement from 25 cum Plant
3. Articles

Biogas Enrichment and Bottling Technology for Vehicular Use
Dr Virendra Kumar Vijay, CRDT, IIT Delhi

Introduction

In the present era of ever-increasing energy consumption and dwindling fossil fuel reserves, the importance of biomass based, decentralized fuel such as Biogas and Biomass based power generation has been greatly increased. It is a well established renewable and environment friendly fuel for rural energy needs. Biogas is ideally suited for rural applications where required animal or human excreta and agricultural waste are available in plenty. Harnessing such a resource promotes rural industries, agriculture, dairy and animal farming in a sustainable way. This will also increase employment in the rural regions and discourage migration to cities.

Biogas is an environment friendly, clean, cheap and versatile fuel. Biogas is produced by anaerobic digestion of degradable wastes such as cattle dung, vegetable wastes, sheep and poultry droppings, municipal solid waste, sewage water, land fill etc. Presently the biogas is mainly used for cooking and lighting purposes in the rural areas. The use of biogas in stationary engines used for different agricultural operations is going on. Its utilization is also feasible in automobiles, used for transportation purposes by enriching and compressing it in cylinders. Biogas can be converted in bio CNG after enrichment and bottling. It becomes just like CNG.

Potential of the Technology

So far, biogas has mostly been used as fuel for cooking and running stationary engines. However, its potential has not fully utilized, yet. There is a great enhancement in its utilization potential particularly where bigger plants are in operation e.g. institutional biogas plants in Gaushalas, dairy farms or community biogas plants in villages. Gaushalas are running generally on charity basis and most of Gaushalas are not in sound financial position. Enrichment and bottling of biogas will help to improve it.

India has a vast potential of $6.38 \times 10^{10}$ cubic meter of biogas per annum from 980 million tones of cattle dung produced. A National Project on Biogas Development (NPBD) was launched by Government of India in 1981. A total of about 36.5 lakh family biogas plants have been installed under this programme all over the country till Dec. 2004. This is about 30 % of the total 120 lakh family type biogas plants potential. More than 3380 Community Biogas Plants (CBP), Institutional Biogas Plants (IBP) and Night-soil based Biogas Plants (NBP) have been installed all over the country with most reporting satisfactory performance levels. The family biogas plants in the country are estimated to be saving 39.6 lakh tones of fuel-wood per year. Besides, about 9.2 lakh tones of enriched organic manure are being produced every year from these plants.

There are number of Gaushalas, dairies, village communities having large number of cattle which have potential of installing biogas enrichment and bottling system. In urban areas, large quantity of biogas can be produced in sewage treatment plants using anaerobic digestion. Okhala Sewage Treatment Plant, New Delhi is an example where more than 10,000 cubic meter of biogas is produced every day. Due to rising cost of petroleum products and environmental concerns it has become imperative to make use of local resources as an alternate to petroleum fuels. There for it is world wide trend to explore and make use of biogas as an alternate fuel in vehicles.
**Biogas Composition, Properties and Utilization as CNG**

Biogas comprises of 60-65% methane, 35-40 % carbon dioxide, 0.5-1.0 % hydrogen sulfide and rests of water vapour. It is almost 20% lighter than air. Biogas, like Liquefied Petroleum Gas (LPG) cannot be converted to liquid state under normal temperature. Removing carbon dioxide and compressing it into cylinders makes it easily usable for transport applications, say three wheelers, cars, pick up vans etc and also for stationary applications at various long distances. Already, CNG technology has become easily available and therefore, bio-methane (enriched biogas) which is nearly same as CNG, can be used for all applications for which CNG are used.

**Biogas Enrichment Process**

A variety of processes are available for enrichment i.e. removing CO₂, H₂S and water vapour. Commonly CO₂ removal processes also remove H₂S. One of the easiest and cheapest methods involves the use of pressurized water as an absorbent liquid. In this method, the biogas is pressurized and fed to the bottom of a scrubber column where water is sprayed from the top. In counter-currently operated absorption process, the carbon dioxide and hydrogen sulfide present in the biogas is absorbed in down going water and methane goes up and collected in vessel. However, water requirement in this process is high but it is the simplest method of removing impurities from biogas.

**Concept of Alternative Bio-CNG**

Biogas contains a large proportion (about 40 % by volume) of carbon dioxide, a heavier and non combustible gas and some fraction of hydrogen sulphide. Hence it is needed to enrich biogas by removing these undesirable gases to save compression energy and space in bottle and corroding effect, which can be done by scrubbing. The scrubbing system is found to enrich methane about 95 % or more depending upon biogas inlet and water injection pressure. Biogas can be used for all applications designed for natural gas, assuming sufficient purification.

**Scope of the Technique**

Enriched biogas is made moisture free by passing it through filters after that it is compressed up to 200 bar pressure using a three stage gas compressor. Compressed gas is stored in high pressure steel cylinders as used for CNG. There is large potential of this technology in buses, tractors, cars, auto rickshaws, irrigation pump sets and in rural industries. This will help to meet our energy demand for rural masses thus reduces burden of petroleum demand, moves towards energy security and will improve economic status by creating employment generation in rural area.

**Estimate for 1000 m³ Biogas Bottling Plant**

**Biogas Plant:**
- Waste Required : ~20 Tons Cattle Dung
- Water requirement in Biogas Plant : ~ 20 Tons
- Biogas Production : 1000 NM³/Day
- Cost : Rs. 60 Lakhs

**Biogas Purification & Bottling System:**
- Raw Biogas Quantity : 1000 NM³/Day
- Purified Gas Quantity : ~ 375 Kg
**Purified Gas Composition**

- CH₄: 95 %, H₂S: < 25 ppm, Moisture: < 20 ppm

**Cost**
- Rs. 55 Lakhs (excluding the cost of cylinders for gas storage)

**Slurry Management System:**

**Slurry Production**
- ~ 6 Tons (50 % solid)

**Cost**
- Rs. 20 Lakhs

**Other Cost:**
- Land preparation, Civil work, High pressure gas storage cylinders Taxes, Logistic etc. ~ Rs. 15 Lakhs

**Total Initial Cost of Project**
- Rs.1.5 Crores

**Revenue:**

- **Purified Gas**
  - (Rs. 30/kg) * (375 kg) = Rs. 11250/day
- **Slurry**
  - (Rs. 2/Kg) * (6000 Kg) = Rs. 12000/day
- **Total Revenue**
  - Rs. 23250/day
- **Annual Revenue**
  - (Rs. 23250/day) * (350 day) = Rs. 81.375 Lakhs
- **Cost of Dung**
  - (Rs. 250/ton) * (20 tons) = Rs. 5000/day
- **Annual cost of dung**
  - (Rs. 5000/day) * (365) = Rs. 18.25 Lakhs

- **Cost of Water & Electricity**
  - Rs. 15 Lakhs (Annual)
- **Manpower Cost**
  - Rs. 6 Lakhs (Annual)
- **Annual Maintenance cost**
  - Rs. 8 Lakhs
- **Total Recurring cost**
  - Rs. 47.25 Lakhs
- **Annual Profit**
  - Rs.34.125 Lakhs

**In BGFP project there is a provision of 50% subsidy**

- **Beneficiary Expenditure**
  - Rs. 75 Lakhs
- **Annual Profit**
  - Rs. 34.125 Lakhs
- **Payback Period**
  - 2.19 years
Biogas Plant

Biogas Enrichment Unit

Biogas High Pressure Cylinder and Compressor

Biogas Run Car

Enriched Biogas Operated Three Wheeler Luggage Carrier
Biogas Problems
(Courtesy http://crat.africa-web.org/Biogas/BIOGAS%20PROBLEMS)

Biogas is really no more dangerous than other fuels such as wood, gasoline, or bottled gas. But just as these fuels have their ways of being dangerous, so does biogas. Face it; anything that can cook meals and fuel an engine can also burn people.

It is very important that if a digester is built underground, that it is built in a place that never floods. If an above ground digester is built in an area that sometimes floods, make sure that the openings into the digester are above the high water mark. If a digester is built in an area that does have floods, safety measures should be taken in advance so that the gas can escape in case the digester and/or the gas storage tank are flooded. Failure to do so could result in dangerous, uncontrolled release of biogas and if the digester is a plastic bag, it could float up and away. An upside-down "T" pipe should be placed at the highest vertical point in the gas pipe line above the gas outlet from the digester. A vertical pipe and a gate valve should be joined to the stem of the upside-down "T" pipe. The gate valve can then be opened to release the biogas if a flood threatens to cover either the digester or the gas storage tank.

The following is a list of safety measures that should be read with great care before a biogas system is built:

1) Regularly check the whole system for leaks.
2) Provide ventilation around all gas lines.
3) Always maintain a positive pressure in the system.
4) The engine room floor must be at or above ground level to avoid the buildup of heavier-than-air gases.
5) The engine room roof must be vented at its highest point to allow lighter-than-air gases to escape. This is also true for greenhouses that have biogas digesters, engines, or burners in them.
6) The engine exhaust pipe must be extended so that the dangerous and deadly exhaust gases are released outside the building.
7) Metal digesters and gas storage tanks must have wires to lead lightning to the ground.
8) Gas lines must drain water into condensation traps.
9) No smoking or open flames should be allowed near biogas digesters and gas storage tanks, especially when checking for gas leaks.

Methane, the flammable part of biogas, is a lesser danger to life than many other fuels. However, in the making and using of an invisible fuel, dangerous situations can arise unexpectedly and swiftly--such as when a gas pipe is accidentally cut. On the other hand, precaution can be exaggerated. When cars first appeared on the roads, a man waving a red flag came first. Remember the ABC's: Always Be Careful (Fry, 1974).

Health Hazards

Health hazards are associated with the handling of night soil and with the use of sludge from untreated human excrete as fertilizer.

In general, published data indicate that a digestion time of 14 days at 35 C is effective in killing (99.9 per cent die-off rate) the enteric bacterial pathogens and the enteric group of viruses. However, the die-off rate for roundworm (Ascaris lumbricoides) and hookworm (Ancylostoma) is only 90 per cent, which is still high. In this context, biogas production would provide a public health benefit beyond that of any other treatment in managing the rural health environment of developing countries.
Bioconversion of organic domestic and farm residues has become attractive as its technology has been successfully tested through experience on both small- and large-scale projects. Feeding upon renewable resources and non-polluting in process technology, biogas generation serves a triple function: waste removal, management of the environment, and energy production.

### Table: Considerations Relating to Bottlenecks in Biogas Generation

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Bottlenecks</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>Availability and ease of transportation of raw materials and processed residual products</td>
<td>Use of algae and hydroponic plants offsets high transportation costs of materials not readily at hand. Easily dried residual products facilitate transportation.</td>
</tr>
<tr>
<td></td>
<td>Site selection</td>
<td>Nature of subsoil, water table, and availability of solar radiation, prevailing climatic conditions, and strength of village population needs to be considered.</td>
</tr>
<tr>
<td></td>
<td>Financial constraints: Digester design; high Transportation costs of digester materials; installation and maintenance costs; increasing labour costs in distribution of biogas products</td>
<td>Use of cheap construction materials, emphasizing low capital and maintenance costs and simplicity of operation; provision of subsidies and loans that are not burdensome.</td>
</tr>
<tr>
<td></td>
<td>Necessity to own or have access to relatively large number of cattle</td>
<td>Well-planned rural community development, ownership and biogas distribution schemes necessary.</td>
</tr>
<tr>
<td></td>
<td>Social constraints and psychological prejudice against the use of raw materials</td>
<td>Development of publicity programmes to counteract constraints compounded by illiteracy; provision of incentives for development of small-scale integrated biogas systems.</td>
</tr>
<tr>
<td>Technical</td>
<td>Improper preparation of influent solids leading to blockage and scum formation</td>
<td>Proper milling and other treatment measures (pre-soaking, adjustment of C/N ratio); removal of inert particles: sand and rocks.</td>
</tr>
<tr>
<td></td>
<td>Temperature fluctuations</td>
<td>Careful regulation of temperature through use of low-cost insulating materials (sawdust, bagasses, grass, cotton waste, wheat straw); incorporation of auxiliary solar heating system.</td>
</tr>
<tr>
<td></td>
<td>Maintenance of pH for optimal growth of Methanogenic bacteria C/N ratio</td>
<td>Appropriate choice of raw material, regulation of C/N ratio and dilution rate. Appropriate mixing of N-rich and N-poor substrates with cellulosic substrates.</td>
</tr>
<tr>
<td></td>
<td>Dilution ratio of influent solids content</td>
<td>Appropriate treatment of raw materials to avoid stratification and scum formation.</td>
</tr>
<tr>
<td></td>
<td>Retention time of slurry</td>
<td>Dependent upon dilution ratio, loading rate,</td>
</tr>
<tr>
<td>Topic</td>
<td>Action/prevention</td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Loading rate</td>
<td>Dependent upon digester size, dilution ratio, digestion temperature.</td>
<td></td>
</tr>
<tr>
<td>Seeding of an appropriate bacterial</td>
<td>Development of specific and potent cultures.</td>
<td></td>
</tr>
<tr>
<td>Population for biogas generation</td>
<td>Construction from cheap materials (glass fiber, clay, jute-fiber reinforced plastic) and/or regular cleaning and layering with protective materials (e.g., lubricating oil).</td>
<td></td>
</tr>
<tr>
<td>Corrosion of gas holder</td>
<td>Establishment of &quot;no leak&quot; conditions, use of external protective coating materials (PVC, creosotes)</td>
<td></td>
</tr>
<tr>
<td>Pin-hole leakages (digester tank, holder,</td>
<td>Establishment of &quot;no leak&quot; conditions, use of external protective coating materials (PVC, creosotes)</td>
<td></td>
</tr>
<tr>
<td>inlet, outlet)</td>
<td>Establishment of &quot;no leak&quot; conditions, use of external protective coating materials (PVC, creosotes)</td>
<td></td>
</tr>
<tr>
<td>Occurrence of CO₂ reducing calorific value</td>
<td>Reduction in CO₂ content through passage in lime-water</td>
<td></td>
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<tr>
<td>of biogas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occurrence of water condensate in gas</td>
<td>Appropriate drainage system using condensate traps</td>
<td></td>
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<tr>
<td>supply system (blockage, rusting)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occurrence of H₂S leading to corrosion</td>
<td>On a village scale, H₂S removed by passing over ferric oxide or iron filings</td>
<td></td>
</tr>
<tr>
<td>Improper combustion</td>
<td>Designing of air-gas mixing appliances necessary</td>
<td></td>
</tr>
<tr>
<td>Maintenance of gas supply at constant</td>
<td>Regulation of uniform distribution and use of gas; removal of water condensate from piping systems; appropriate choice of gas holder in terms of weight and capacity</td>
<td></td>
</tr>
<tr>
<td>pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residue utilization</td>
<td>Risks to health and plant crops resulting from residual accumulation of toxic materials and encysted pathogens</td>
<td>Avoid use of chemical industry effluents; more research on type, nature, and die-off rates of persisting organisms; minimize long transportation period of un-dried effluent</td>
</tr>
<tr>
<td>Health</td>
<td>Hazards to human health in transporting night soil and other wastes (gray-water)</td>
<td>Linkage of latrine run-offs into biogas reactors promotes non-manual operations and general aesthetics</td>
</tr>
<tr>
<td>Safety</td>
<td>Improper handling and storage of methane</td>
<td>Appropriate measures necessary for plant operation, handling, and storage of biogas through provision of extension and servicing facilities</td>
</tr>
</tbody>
</table>

Rural communities using the integrated system are appropriate examples of recycled societies that benefit from low-capital investments on a decentralized basis and such communities are attuned to the environment. The technology thus seeded and spawned is, in essence, a populist technology based on "Nature's income and not on Nature's capital."

Several thousand biogas plants have been constructed in developing countries. A screening of the literature indicates that the experience of pioneering individuals and organizations has been the guiding principle rather than a defined scientific approach. Several basic chemical, microbiological, engineering, and social problems have to be tackled to ensure the large-scale adoption of biogas plants, with the concomitant assurances of economic success and cultural acceptance. Various experiences suggest that efficiency in operation needs to be developed, and some important factors
are: reduction in the use of steel in current gas plant designs; optimum design of plants, efficient burners, heating of digesters with solar radiation, coupling of biogas systems with other non-conventional energy sources, design of large-scale community plants, optimum utilization of digested slurry, microbiological conversion of CO₂ to CH₄, improvement of the efficiency of digestion of dung and other cellulosic material through enzyme action and other pre-digestion methods, and anaerobic digestion of urban wastes some of the summarize of research and development tasks that need to be undertaken as follows.

**In Basic Research**

a. Studies on the choice, culture, and management of the micro-organisms involved in the generation of methane.

**In Applied Research**

a. Studies on improving biogas reactor design and economics focusing on: alternative construction materials in stead of steel and cement; seeding devices; gas purification methods; auxiliary heating systems; insulator materials; development of appropriate appliances for efficient biogas utilization (e.g. burners, lamps, mini tractors, etc.).
b. Studies for determining and increasing the traditionally acknowledged fertilizer value of sludge.
c. Studies on quicker de-watering of sludge.
d. Studies on deployment of methane to strengthening small-scale industries, e.g., brick-making, welding, etc.

**In Social Research**

a. Effective deployment of the written, spoken, and printed word in overcoming the social constraints to the use of biogas by rural populations.
b. Programmes designed to illustrate the benefits accruing to rural household and community hygiene and health.
c. Programmes designed to illustrate the need for proper management of rural natural resources and for boosting rural crop yields in counteracting food and feed unavailability and insufficiency.
d. On-site training of extension and technical personnel for field-work geared to the construction, operation, maintenance, and servicing of biogas generating systems.
e. Involvement and training of rural administrative and technical personnel in regional, national, and international activities focusing on the potentials and benefits of integrated biogas systems.

Table shows a number of the benefits of biogas utilization, set against the related drawbacks of presently used alternatives.

<table>
<thead>
<tr>
<th>Present Problems</th>
<th>Benefits of Biogas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depletion of forests for firewood and causation of ecological imbalance and climatic changes</td>
<td>Positive impact on deforestation; relieves a portion of the labor force from having to collect wood and transport coal; helps conserve local energy resources</td>
</tr>
<tr>
<td>Burning of dung cakes: source of environmental pollution; decreases inorganic nutrients; night soil transportation a hazard to health</td>
<td>Inexpensive solution to problem of rural fuel shortage; improvements in the living and health standards of rural and village communities; provides employment opportunities in spin-off small-scale industries</td>
</tr>
<tr>
<td>Untreated manure, organic wastes, and residues lost as valuable fertilizer</td>
<td>Residual sludge is applied as top-dressing; good soil conditioner; inorganic residue useful for land reclamation</td>
</tr>
<tr>
<td>Untreated refuse and organic wastes a direct threat to health</td>
<td>Effective destruction of intestinal pathogens and parasites; end-products non-polluting, cheap; odours non-offensive</td>
</tr>
<tr>
<td>Initial high cost resulting from installation, maintenance, storage, and distribution costs of end-products</td>
<td>System pays for itself</td>
</tr>
<tr>
<td>Social constraints and psychological prejudice to use of human waste materials</td>
<td>Income-generator and apt example of self-reliance and self-sufficiency</td>
</tr>
</tbody>
</table>
Conversion Kit of Diesel Engine into 100% Biogas Engine  
Prof. (Dr.) G.P. Govil, Director, Ideal Institute of Technology, Ghaziabad

Introduction

Biogas production technology from various types of raw materials is well established and biogas plants of various sizes, and designs suited to different raw materials are already operating in large numbers throughout the country through the sustained efforts of MNRE, KVIC and various NGO’s. This first priority in utilization of biogas should, of course, be in providing a clean fuel for domestic cooking. However, to facilitate large scale utilization of biogas, it is essential to have a suitable energy conversion device i.e. an engine to enable efficient conversion of biogas energy into required mechanical/ electrical forms. In fact, even in the urban sector, such a conversion is becoming inevitable in context with large dairy clusters, poultry and other animal farms, sewage treatment plants and even in large hotels, hostels, food processing industries etc. where large amount of organic waste is produced and needs to be recycled in an eco-friendly manner.

Presently biogas is being used at a limited scale in dual-fuel engines which partially (to the extent of 30-40%) utilize the diesel fuel. Hence there is a strong need to have a 100% biogas operated engines. Small, stationary type diesel engines in the power range 5-20 hp are being universally used in rural areas for water pumping, gen-sets as well as for variety of agro-industrial processing applications. Bulk of these engines is D.I, vertical, single cylinder, engines operating at 1000-1500 rpm. There is a need to develop a simple kit to convert this spectrum of existing diesel engines into biogas/ producer gas engines.

Technical basis for Development

A diesel engine operates on the principle of compression ignition of the diesel fuel. It has relatively higher compression ratio (around 15-22) and a heterogeneous mode of combustion. This mode of ignition is suited only for less volatile liquid fuels with low self-ignition temperatures. It also uses a fuel injection system which injects the liquid fuel into the engine cylinder at very high pressure towards the end of compression stroke. For gaseous fuels, it is essential to use the spark ignition (S.I.) mode, premix combustion, in which case the air and fuel are homogeneously mixed in an appropriate ratio and then inducted into the engine cylinder. Towards the end of compression, a spark is applied to initiate the ignition of the compressed charge. These engines also need throttling of air-fuel mixture to control the power output.

Normal Spark Ignition Engines which use gasoline fuel are restricted in compression ratio (8-10) because of knocking condition. However, in the case of biogas which contains methane as the fuel element, the self ignition temperature is quite high and much higher compression ratios can be used, which leads to improved efficiency. The conversion of a diesel engine into an equivalent spark ignition engine requires the following modifications/ retrofitting;

i) Removal of the fuel injection system (fuel pump and the injector)
ii) Incorporation of a suitable spark plug in place of the injector by appropriate modification in the injector hole.
iii) Modification in the engine intake system incorporating suitable mechanism for air-fuel mixing and control i.e. a gas carburetor system.
iv) Retrofitting with cam shaft/ crank shaft a specially designed ignition system.
v) Modification in the combustion chamber/ compression ratio etc.
The overall arrangement of the conversion kit is shown in figure 1.

![Fig1. Schematic Diagram for Conversion to Biogas Engine from Diesel Engine](image)

**Ignition system-Special Requirements**

Both battery as well as magneto energized ignition systems has been widely used in high speed automotive as well as stationary application spark ignition petrol engines.

Since the diesel engine being converted is a relatively slow speed, high compression ratio engine and the fuel is a dilute gaseous fuel. It requires extra high intensity spark; keeping the simplicity and the rural situation in mind, it would be desirable to use a magneto-ignition rather than battery-ignition. However, starting of slow speed, hand-cranked engines with magneto-ignition is extremely difficult as under these conditions, the best available magneto also produces very feeble spark. An innovative strategy of mounting the magneto on the crank shaft rather than the cam shaft, thus doubling the magneto rpm (of course, it results in providing one redundant spark towards the end of exhaust stroke.). Further, an advanced CDI system has been adopted to provide extra-high spark intensity.

**Derating of the Engine**

Whenever a diesel engine is converted for use of a gaseous fuel, particularly a dilute gaseous fuel such as biogas which contains only 55-60% combustible constituents viz. methane and the rest is CO₂, there occurs necessarily reduction in the maximum power output of the engine. This is called derating. The main reason for this derating is as follows.

The engine in diesel mode takes in only air during the intake stroke while in the converted mode, it has to take in air and gaseous fuel. As a result, substantial part of the cylinder is occupied by the gaseous fuel reducing the air availability per cycle which controls the maximum fuel that can be burnt per cycle, in accordance with the required air fuel ratio. Further, because of difference in calorific values of diesel (about 43 MJ/Kg) and biogas (about 20 MJ/ Kg), the energy available in the charge per cycle is reduced. To some extent, reduction also occurs because of decrease in efficiency due to comparatively slower combustion of biogas. Even though, the air fuel ratio required for biogas is much lesser (around 6:1) as compared with diesel (around 20:1), which is an
advantage for power output per cycle for biogas engine on the whole, it is usual to have the engine power derated to 50-55% of the original output as a result of this conversion.

**Conversion Kit**

The conversion kit mainly consists of the following sub assemblies/ components:

i) Ignition system assembly
ii) Gas carburetor assembly
iii) Gas control valve assembly
iv) HT coil
v) Spark plug
vi) Connecting cables.

Fig. 2. Shows various components and sub-assemblies of the conversion kit mounted on engine

**Performance of Biogas Generator**

In the course of past three years, Biogas generators have been installed at a number of user situations such as in goshalas, sulabh shochalaya complexes, a number of testing and demonstration sites of the all India coordinated project on Renewable Energy Sources of ICAR as well as in some institutions and NGOs and have run at different sites for more than 300 hours without any trouble. The initial difficulties experienced during starting have also been eliminated and users have been satisfied with the field performance of these engines.

On an average, derating to the extent of 50-55% of power output in diesel mode has been achieved. With manual control, the engine runs stably. It is able to maintain the speed variation within 10% from no-load to full-load condition. This speed variation does not cause any tangible deterioration in performance in actual applications. Even with higher compression ratios as used in diesel engines (16-18) no knocking has been observed with the present design of the kits. The typical performance of converted biogas engine in terms of specific fuel consumption for various engine outputs is shown in fig.3 and the comparative performance of converted biogas engine and the original diesel engine is shown in fig 4. The derating effect is also indicated. On the basis of these assessments, it is concluded that the conversion kits are quite satisfactory for field applications.
COMPARATIVE PERFORMANCE OF DIESEL ENGINE AND CONVERTED BIO-GAS ENGINE
(ORIGINAL DIESEL ENGINE – 5 KW KIRLOSKAR ENGINE)

SPECIFIC BIOGAS FUEL CONSUMPTION PERFORMANCE OF CONVERTED BIOGAS ENGINE
(ORIGINAL DIESEL ENGINE 5 KW ‘KIRLOSKAR’ ENGINE)

FIG. 3 ENGINE POWER OUTPUT (kW)

FIG. 4 BRAKE POWER OUTPUT (kW)
Cost Estimates & Availability of Kit

The cost of conversion kit including the installation charges at the site come to Rs.20,000 to 250,000/- per installation. With the present cost, the expenditure of conversion is recouped by the user during 6-9 months by way of savings achieved by eliminating the use of diesel fuel. Kit is available at following address:

Siya Instruments
1-ba-6 Gaytri Nagar
Hiren Magri, Sec 5
Udaipur, Rajasthan
09811345179/09414156154/ 0294/2491903

4. Biogas Related Programmes Held/ Future Programme

Training Programmes organized by BDTC IIT Delhi

Recognizing the need and importance of biogas in India the Ministry of New and Renewable Energy, Government of India has taken a step towards commercialization of biogas in an entrepreneurial mode.

In this direction, two training programmes of three days on “Biogas Purification and Bottling Technology and Electricity Generation” were organized in the Month of January, 2010 (21-23) and again in the Month of February, 2010 (24-26). The first 3 days training programme during 21-23 January, 2010 was organized by BDTC IIT Delhi for KV IC officials for human resource development in India in this technology. The third training programme will be organized in coming days.

And the second training was organized for officials of KV IC and Haryana for human resource development in India in this technology. Training programmes covered various aspects of biogas enrichment & bottling technology and its utilization in vehicles such as:-

1. Overview on the training programme on “Biogas Purification and Bottling Technology and Electricity Generation”
2. Biogas enrichment and bottling technology and its prospects
3. Biomethanation: a promising option for solid waste management
4. Conversion kit for engines to run on 100% biogas
5. Electricity generation from bioenergy
6. CG experience & biogas in rural areas
7. Possible applications of biogas slurry
8. IREDA’s role in promoting and financing biogas
9. BGFP programme
10. Management of biogas slurry
11. High rate biomethanation plants
12. Financing aspects of BGFP projects
13. Production of multiple bio-fuels using non-edible oil seed collections a viable village enterprise
14. Biogas scenario in India and enrichment and bottling for application in vehicles for rural energy security
## Seminars/ Conferences (International/National)

<table>
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<tr>
<th>Date</th>
<th>Title</th>
<th>Contact</th>
</tr>
</thead>
</table>
Contact name: Derek Walters |
Contact name: Ms. Yang, Kyoto Japan |
Contact name: Mr. Rajneesh Khattar |
5. **Membership Form of Biogas Forum**

**MEMBERSHIP FORM**

All prospective members of BiGFIN are required to duly fill up this registration form and **return** by post to **Dr. Virendra Kumar Vijay, General Secretary – BiGFIN, Centre for Rural Development and Technology, Indian Institute of Technology Delhi, IIT Campus, Hauz Khas, New Delhi – 110016** alongwith the Demand Draft in favour of “**Biogas Forum – India**” payable at New Delhi or online transfer the amount in account number 0346101060870, Canara Bank, SDA, branch Delhi.

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<tr>
<th>PERSONAL DETAILS</th>
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<tbody>
<tr>
<td>Name (Full):</td>
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<td>Title:</td>
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<td>Member Sex:</td>
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<tr>
<td>Mailing Address with Pin Code:</td>
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<td>Telephone/Mob. No.:</td>
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<tr>
<td>Date of Birth:</td>
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<td>Nationality:</td>
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<td>Telephone/Mob. No.:</td>
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<tr>
<td>Brief about Research/Field Activities related to Biogas:</td>
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<tr>
<td>Organization Name:</td>
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<tr>
<td>Nature of the Organization: (Please tick in appropriate box)</td>
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<tr>
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<tr>
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<td>□ Autonomous</td>
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<td>□ Students</td>
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<td>□ Any Other</td>
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<th>Telephone/Mob. No.:</th>
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</table>
Fax Number: 
Email Address: 
Specialization: 

Brief Activities of the Organization related to Biogas:

PAYMENT DETAILS

Membership Type: (Please tick in appropriate box)
☐ Corporate Membership
☐ Life Membership (Academic/Scientific or Field Worker)
☐ Annual Membership
☐ Student Membership

Tick (✓) whichever is applicable and also mention DD/Bank Transfer Number
☐ DD  □ Bank Transfer:
☐ Cash
☐ Bank Number: Date: Amount:

Amount in Words:

Drawing Bank:

UNDERTAKING TO BE SIGNED BY THE APPLICANT

I hereby certify that all Information supplied in this application for membership is true and correct and abide by the rules and regulations of the Biogas Forum – India (BiGFIN).

Date: _________________________ Applicant’s Signature: __________________________
Place: _____________________________________________________________________

IMPORTANT: The Governing Body of the BIOGAS FORUM – INDIA has a right to accept or reject the membership proposal.

--For Office Use Only--
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<th>Membership Type</th>
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<tr>
<td>1</td>
<td>Corporate Membership</td>
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<td>(Rs. 50,000/- For 10 years)</td>
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<td>2</td>
<td>Life Membership</td>
<td>Rs. 1,500/- (For Academic/Scientific Person)</td>
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<td>Rs. 1,000/- (Turnkey/Field Workers)</td>
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<td>Annual Membership</td>
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<td>4</td>
<td>Student Membership</td>
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