IMPLEMENTATION OF HOUSEHOLD BIOGAS PLANT BY NGOS IN INDIA-

PRACTICAL EXPERIENCE IN IMPLEMENTATION HOUSEHOLD BIOGAS TECHNOLOGY, LESSONS LEARNED, KEY ISSUES AND FUTURE APPROACH FOR SUSTAINABLE VILLAGE DEVELOPMENT[1]

By

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EXECUTIVE SUMMARY

This paper presents the salient and brief experience of NGOs members of INSEDA in the transfer, capacity building, extension and adoption of household biogas plants in rural India for the last over two decades, with a view to solve the rural energy problems in a meaningful way as well as removing drudgery and protecting health of rural women in collecting fire wood & biomass and cooking as well as by promoting ecological farming using biogas digested organic manure, by the efficient recycling of locally available biomass waste. In the light of the global poverty in which 2 billion people are living below the poverty line as well as the inaccessibility of sustainable energy to 1/3rd of the global population, mainly living in the rural areas of the developing countries of the world, the paper also discusses some of the important lessons learnt form the implementation of NGO's biogas programme and the potential for reducing green house gases (GHGs) to the atmosphere by building household plants in India from bovine dung (dung) to its fullest potential, treating biogas unit as one of the important tools for empowering the rural people in general and rural women in particular. The paper also points that realizing this goal would require appropriate changes in funding and policy support for the successful implementations of biogas and other RET programmes in the developing countries, one of the approach suggested is to recognize the NGOs networks/associations for providing them funding support under the Clean Development Mechanism (CDM) for implementing household biogas programmes in clusters of villages, through north-south partnership, where both the groups would not only gain but would lead to developing of global data base, measurement of GHGs, as well as closer follow-up & monitoring, which will ensure sustainability of such programmes. The paper also highlights some of the key points/issues and suggests new approach and future strategies for implementation of rural energy programmes that would endeavour to address the issue of rural poverty and improve the living conditions of rural people, thus checking their migrations to urban areas in the developing countries. In the end the paper presents a simple conceptual model for promoting process oriented and community centered, sustainable energy based eco-village development, enumerating some of its important main & sub-components, for regenerating micro-agro-eco system for sustainable human development (SHD), through decentralized action, which would also check GHG emission to the atmosphere, there by creating positive environmental impact, both at micro and macro level, thus contributing to the global efforts to arrest climate change, with the possibility of North-South Cooperation.

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I. GLOBAL OVERVIEW OF POVERTY AND ENERGY UTILIZATION

1. The International community has recognised some thing has to be done for the large global population of about 2 billion people live below the poverty line, whose needs have to be addressed on priority basis, so that they are not margilised further due to globalisation of economy and unequal sharing of resorces and wealth. But the actual situation in terms of resource sharing by the developed countries would show that so far only lip service have been provided by them for solving the problems of the developed countries in a meaningful ways.

2. Approximately the same number of people i.e. (2 billion people (1/3rd of the world population) still have no access to electricity and other form of efficient and sustainable energy, majority of these people are living in remote and inaccessible regions. A very large group of people of the devloping countries have only limited quantity and lesser hours of supply of electrical power, to meet their entire energy requirements. At the same time, the growing demand of groups already being served well at the present level of consumption, would also require additional electrical power and energy for meeting cooking needs. The centralized generation of power from large power plants (connected with the large Grids) and traditional and inefficient use of domestic energy from locally available biomass has not been able to fully meet the needs of the rural masses. With the dwindling of local biomass and massive deforestation over the years the rural women-folks have to now spend more time for the collection of biomass and fuel wood to meet their energy requirement, which is contributing to their drudgery poor health and less time at their disposal for rest. At the same time loss of top soil due to erosion has been degrading the agricultural land affecting the quality and quantity of crop production for rural people to maintain themselves even at the subsitance level.

3. A closer look at the poverty status would show us that the number of poor, both in terms of total figure as well as in percentage has gone up over the years. Out of this the majority of poor live in the rural areas of the developing countries. The gap has been increasing so fast in the last five decades that there is a big divides not only between the developed countries and the developing countries; but also even between urban and rural areas within developing countries itself. This is in spite of the fact that the rural, remote and far-flung areas have abundance of resources, including the manpower and other bio- resources, e.g. domestic animals, as well as rich micro & macro flora and fauna.

4. The poor people have been living in the worst situation for centuries and have undergone vagaries of nature and witnessed disasters after disasters and depletion of their physical and biological resources. In spite of this these people have learnt to survive, as there were no other options available. But now even they have reached the limit where their future survival depends upon massive destruction of ecology and environment, which is threatening the survival of humankind it self. Therefore, the "Global Community" cannot wait any further but would have to play a pro-active role for promoting and establish non-polluting, eco-friendly and environmentally sound, people centered village development for realizing the goal of sustainable human development (SHD) on a priority basis. In such a development renewable energy would have to play a very important role.

II. FUTURE TRENDS IN DEVELOPMENT AND ENERGY UTILIZATION

5. Some of the following future trends in global developments, including the developing countries are becoming the cause of concern, as it is threatening the very survival of the humanity.

   a). Rapidly growing population, especially in the developing countries;

   b). Expanding consumption of food and energy in developing countries, home to three quarters of the world population;

   c). Unsustainable consumption patterns of the developed countries as well as in the urban centers of some of the developing countries as a result of fast growing economy in due to globalization of world trade. This is creating wider gap between the life style of urban and rural areas even with in the developing countries; and

   d). Dwindling fossil fuel resources due to wide pace of burning of fossil fuels in an unsustainable manner, which is ever increasing and causing pollution and contributing the green house gases (GHGs) to the atmosphere.

6. The population of the world in 1990 was approximately 5 billion people, which as per the UN estimates of population trends show it continuing to increase to around 8 billion by 2025, but is expected to be stabilized towards the end of the next century at somewhere between 10 and 12 billion people. Most of that increase will be in the less developed countries. Thus the future of the global energy use shows an alarming trend. The outlook for energy use throughout the world continues to show strong prospects for rising levels of consumption over the next two decades, led by growing demand for end-use energy in Asia. World energy demand in 2015 is projected to reach nearly 562 quadrillion British thermal units (Btu). The expected increment in total energy demand between 1995 and 2015- almost 200 quadrillion Btu- would match the total world energy consumption recorded in 1970, just before the energy crisis of 1973.

7. Two-thirds of all energy growth will occur in developing economies and economies in transition, with much of that growth concentrated in Asia. Energy growth in the developing countries of Asia is projected to average 4.2 percent per year, compared with 1.3 percent for industrialized economies. As per an estimate, the U.S. energy consumption in 1990 exceeded total consumption in the nations of developing Asia by 33 quadrillion Btu; however, by 2015, energy use in developing Asia is expected to exceed U.S. consumption by 48 quadrillion Btu.

III. CLIMATE CHANGE

8. During the last few decades, concern has been growing internationally that increasing concentrations of greenhouse gases in the atmosphere will change our climate in ways detrimental to our social and economic well being. Abundant data demonstrate that global climate has warmed during the past 150 years, and that it is caused by increases in the concentration of so-called “greenhouse gases” in the atmosphere. The most important single component of these greenhouse gas emissions is carbon dioxide (CO_2). The major sources of emissions of CO_2 are power plants, automobiles, and industry. Combustion of fossil fuels contributes around 80 percent to total worldwide anthropogenic CO_2 emissions. Different fossil fuels produce different amounts of CO_2 per unit of energy released. Coal is largely carbon, and so most of its combustion products are CO_2.

9. Another source is global deforestation. Trees remove carbon dioxide from the air as they grow. When they are cut and burned that CO_2 is released back into the atmosphere. Massive deforestation around the globe is releasing large amounts of CO_2 and decreasing the forests' ability to take CO_2 from the atmosphere.

10. The second major greenhouse gas is methane (CH_4), while it is a minor by-product of burning coal, and also comes from venting of natural gas (which is nearly pure methane) as well as the release of methane from the animal dung (manure) left in the field. Natural gas, which is methane (CH_4) produces water as well as CO_2 when it is burned, and so emits less CO_2 per unit of energy than coal.

11. When the animal manure is efficiently recycled through a biogas plant then it produces biogas having 55-65% methane (CH_4) and 35-45% carbon dioxide (CO_2) as well as an excellent organic manure from the digested dung- this biogas when burnt in efficient stoves provides clean and efficient domestic fuel for rural houses and manure for their agricultural field in the developing countries, which if systematically implemented would promote sound and sustainable ecological farming. This potential for dual benefits of the production of environmentally benign fuel and manure from the domestic farm animal is lost by either directly burning the same dung (manure) in the form of dried dung cakes or alternatively using it directly for making organic manure, apart from creating the negative environmental impact.

IV. SITUATION IN DEVELOPING COUNTRIES

12. The rural poor of the developing countries mainly depend on agricultural & allied activities and the existing natural resource base for meeting their day-to-day subsistence needs.

13. In many marginal rural areas, growing numbers of poor have no option but to use the already degraded & marginal lands for meeting their subsistence food and fuel wood production, which is resulting in to further degradation of land, water, ecology and the micro-environment.

14. However, now there is a growing awareness & acceptance of environment & ecological aspects, energy consumption and their strong linkages with food production for tackling the poverty, employment generation, improving standard of living and quality of life of rural people in a sustainable manner.

V. ENERGY IN AGRICULTURE & RURAL DEVELOPMENT

15. The backbone of agriculture in developing countries is Animate Energy- both manual and animal power. The domestic farm animals and family labour are normally not considered as costs. The majority of the operations requiring animate energy in these countries were to be assigned cash value or replaced by mechanized, even though they might be energy efficient, would perhaps increase the cost of cultivation substantially.

16. In India, the locally generated biomass play very important role in meeting the cooking fuel need of the villagers- the biomass is usually collected (in the form of harvested crop stems and crop residues) and stored by the villagers at the time of harvesting of crops for personal use and also given to landless agricultural labourers used by them for harvesting and threshing of crop in the season.

17. Thus it is clear that rural energy demand in the developing countries are at present met by the renewable natural sources which would continue to play the important role in meeting the energy needs of the rural people, therefore its efficient use has to be looked in very critically.

VI. PROMOTION AND IMPEMENTATION OF BIOGAS TECHNOLOGY IN INDIA

18. India took a big leap foreword in the promotion of renewable energy, especially the two most appropriate rural based technologies, namely, biogas and smokeless & efficient biomass stoves, but other RETs though have large potentials are yet to make any significant dent and impact in terms of reach and acceptability in Indian villages.

19. The systematic development and promotion of household (Hh) biogas technology programme is over 60 years old in India. The demonstration and limited extension phase of Hh biogas plants was first initiated in India by KVIC, using their floating steel gas holder model, in 1960. However, the implementation of Hh plants got impetus in India, only after the Ministry of Non-Conventional Sources of Energy (MNES- earlier known as DNES), Govt. of India, launched a centrally sponsored scheme, known as National Project on Biogas Development (NPBD), in 1981-82.

20. With the Multi-Model and Multi-Agency approach adopted under the NPBD, in which NGOs also played constructive role, India has achieved massive target of approximately 3 million household biogas plants, which has also ensured wider coverage throughout the country. Though it is still a drop in the ocean when considering the revised potential (in year 2000) of 20 million Hh plants, and the present rate of implementation of 150,000 units per year, it could take 75-100 years to realize this potential.

21. A few pilot and regular projects implement large size community or village level, biogas plants were launched in India for domestic (cooking & lighting) of village community, as well as for generation of village level electrical power to meet essential needs of individual and community. However, except for a few successes, by and large, the majority of such schemes was not so successful and could not sustained themselves.

22. In the above backdrop, the development and promotion of low cost, Hh biogas plants by an NGO network (now members of INSEDA) in India and the lessons learned for empowering rural people in general and women in particular is of great significance.

VII. EXPERIENCE OF IMPLEMENTATION OF HOUSEHOLD BIOGAS PLANTS AND OTHER RENEWABLE ENERGY TECHNOLOGY BY INSEDA'S NGO NETWORK

23. The Integrated Sustainable Energy and Ecological Development Association (INSEDA) is the Nodal Agency for the implementation of this project. INSEDA is a national organization formed by Indian NGOs involved in the promotion of renewable energy programmes, since 1980. It is a membership organization at present having over 75 members who are operating in almost all the states of India. The member organizations had been operating as an informal network for more than 15 years before establishing INSEDA as a formal body, registered as a society on December 11, 1995, with national headquarters in Delhi. The main focus of INSEDA is the development and promotion of sustainable rural energy and renewable energy based sustainable village development (SVD) with active participation of target groups to

promote eco-friendly and environmentally sound sustainable human development (SHD). The INSEDA members/partners have deeper commitments to the promotion of low cost affordable renewal energy technologies as well as environmentally friendly ecological development, and have a fairly well developed infrastructure at the grassroots level to implement such projects/programmes. This common interest and goal binds the member NGOs together.

24. Role played and achievements in promotion & implementation of biogas and other renewable energy technologies by this NGO Network (now members of INSEDA) for over 2 decades have been divided in five major stages, as summarized below:

FIRST STAGE- (1979 TO 1981)

25. **RECOGNITION AND PROMOTION OF HOUSEHOLD BIOGAS PLANTS BY AN NGOs GROUPS**

a). **Recognition and Potential of Biogas by a group of Indian NGOs involved in agricultural and rural developmental in early1970's**:

(i) Based on consultations amongst themselves, the NGOs recognized the biogas as a viable means for solving domestic rural energy problems, which would also fit in very well with in their existing integrated agricultural and rural development programmes. While the dung (manure) from the domestic farm animals could be efficiently recycled through a biogas plant giving non-polluting & convenient cooking fuel to rural women removing their drudgery, on the other hand the biogas digested slurry would provide enriched organic manure for farming.

(ii) Based on the national census, there were 240 million bovine (cattle plus buffalo) population in the mid 1970's, it was estimated that on an average 1000 million tones of dung (manure) was being produced annually by bovines in India, which was used in the following manner:

- Out of this 300 million Tones (over 1/3rd) manure burnt each year (in the form of dried dung cakes) as fuel for the domestic (cooking) purpose in an inefficient manner in traditional stoves.
- Balance of manure was being left in heaps outside the rural houses for decomposition in an unscientific manner, creating pollution and release of methane (CH_4) and carbon dioxide (CO_2) in to the atmosphere.

(iii) Biogas Potential, based on the dung (manure) available form the bovine population alone was estimated to be 12-15 million in mid 1970's.

b). **Promotion & Transfer of Low cost Biogas Plants by the NGOs group**:

(i) In 1979, a group of NGOs after a search, decided to systematically promote an affordable fixed dome biogas plant (called Janata model) as an alternative to the existing biogas model (with floating steel gas holder, called KVIC model). The Janata model developed by an Indian biogas research center, used bricks & cement mortar and required local skills for building and was 30% cheaper than the KVIC model.

(ii) Based on the discussions amongst these group of NGOs, one national technical development NGO took the lead for its promotion and transfer this technology though, with the following three main objectives:

- Transfer of skills to rural masons on construction techniques of Janata BGPs- through brick-by-brick training at with farmers identified by grass roots NGOs.
- Transfer of knowledge to the functionaries of grassroots NGOs.
- Initiate steps to form a biogas network of these and other interested NGOs around a common programme as a strategy for- (1) long term development and extension of low cost household biogas plants in rural areas in a decentralized manner, and (2) to create impact at the national level to influence policy in favour of biogas technology.

SECOND STAGE- (1982 TO 1984)

26. **POPULARIZATION AND EXTENSION OF JBP AND DEVELOPMENT OF NEW LOW-COST FIXED DOME HOUSEHOLD BGP MODEL BY THE NGO NETWORK- LAUNCHING OF PHASE-I**

a). Development and strengthening of infrastructure facilities of grassroots development NGOs operating in different regions of India.

b). Development of Informal Network by increasing number of training programmes, information dissemination, increasing number of NGOs and organizing workshops etc.

c). Launched Phase-I programme in mid 1983, through out the country, by the network members with the financial support of an overseas funding agency:

(i) Establishing and operate Biogas Extension Centres (BECs) by each NGO member of the Network, for implementing of Phase-I programme;

(ii) Systematic transfer and extension of household biogas plants in rural areas, under the National Project of Biogas Development (NPBD) of the Ministry of Non-Conventional Energy (MNES), Govt. of India.

d). Planning and organization of different types of training programmmes for different level of NGO functionaries as well as for the End Users of biogas.

e). Trained over 5,000 masons on the systematic construction of fixed dome BGPs.

f). Participatory development and evolution of new low cost fixed dome household biogas plant of 5 different sizes (1, 2, 3, 4 & 6 m^3 capacities) by the NGO network, which was christened as Deenbandhu (meaning, friend of the poor).

THIRD STAGE- (1985 TO 1989)

27. **FIELD EVALUATION, DEMONSTRATION, PROMOTION, TRANSFER, POPULARIZATION, DISSEMINATION, TRAINING & EXTENSION OF DEENBANDHU MODEL BY NGO NETWORK**

a). Testing of comparative performance of Deenbandhu Biogas Plant (DBP) and refining and finalizing the design based on one year of field evaluation of the performance of the 5 different capacities household DBPs in 1985.

b). After the pilot project for demonstration on Deenbandhu plants and preparation of field Manual by the NGO network, the MNES (Ministry of Non-Conventional Energy Sources) Govt. of India, approved the Deenbandhu model in 1986-87, for extension under the National Project on Biogas Development (NPBD).

c). The systematic promotion, dissemination, popularization and extension of Deenbandhu biogas plant (DBP) was taken up by this NGO Network, under phase-I with the support of an overseas funding agency, from 1983 to 1989:

(i) *The NGO network built a total of 42,000 household BGPs in the Phase-I of the project implementation. The cost of constructing these biogas plants (42,000 BGPs in six years) came from the Indian resources:*

- Out of which between 30 to 50% cost for building plant came in the form subsidy provided under the NPBD (MNES), Govt. of India; where as, the balance amount (50 to 70%) was met by plant owners from their own resources and/or by taking loans from banks.
- In some states the plant owners were also provided additional subsidy by the State Governments.

(iii) *Average ratio of overseas funding to local resources generated by the NGO network, from within the country came to about 1:5 (1 overseas: 5 Indian), thus could be rated as one of the most successful programme.*

(iv) *Some of the network members took the initiative to do experiments for generation of biogas from other biomass, and others experimented with alternate building materials for the construction of Deenbandhu model.*

d). Some of the members of the NGO network were also involved in the transfer of Deenbandhu biogas plant to other developing countries.

FOURTH STAGE- (1990 TO 1995)

28. IMPLEMENTATION OF PHASE-II BIOGAS PROGRAMME BY THE NGO NETWORK

a). The phase-II programme of NGO network was taken up for further extension of biogas; as well as taking up new activities related to biogas technology. Some of the important achievements of Phase-II initiated in 1990 are given below:

(i) *Constructed over 35,000 household plants (mainly DBP model) in five years period, October 1990 to September 1995, under NPBD (MNES).*

(ii) *Implemented appropriate capacity building activities for strengthening the existing and new NGO members in the network as well as for providing post-plant maintenance services to the existing plant owners.*

(iii) *Undertook Adaptive R&D and Trial & Testing for:*

- Appropriate modifications in the existing biogas plant models and for designing & developing new low cost fixed dome biogas models.
- Scientific utilization of digested slurry from the BGPs for sustainable crop production.

(iv) *Facilitated decentralization of the network by promoting Regional Consultative Groups (RCGs) for solving regional level problems.*

(v) *Enlarged the memberships of the network with inducting new NGOs.*

b). The research & systematic experimentation on biogas slurry use, was one of the main Adaptive R&D activities under Phase-II. The analysis clearly showed that digested slurry from biogas is feasible as a replacement for inorganic fertilizer and that considerable savings on the purchase of these fertilizers could be realized using digested slurry as manure for agricultural production.

c). Transferred the fixed dome (Deenbandhu model) biogas plant was from India to other developing countries, by some of the NGO members of the network.

d). With the growth of Biogas Network of NGO, a process was started for decentralisation on regional basis as well as formalising network as an autonomous national registered organisation:

(i) *By early 1992, the network had grown to 60 members, operating 75 Biogas Extension centres (BECs); and by the end of 1993/beginning of 1994, the Network had grown to 70 members, operating 90 BECs.*

(iii) *As a outcome of strengthening of the regional networks of biogas extension NGOs one of the regional group was registered into an autonomous body, named as Sustainable Development Agency (SDA) and started receiving direct funds from MNES under NBPD.*

e). Action was initiated by the author, on behalf of the NGO Network, to design a new low cost fixed dome BGP, using bamboo (used for basket weaving by local villagers) to replace energy consuming bricks, which was the main building material used in all the existing fixed dome biogas design.

f). In the Annual Biogas Workshop held in 1992, members decided to gradually formalise this informal network as a national autonomous registered body for stability and pursuing other RET & ecological development programmes.

g). By the end of September 1995, the NGO Network had built a total of 85,000 BGPs (42,000 BGPs during Phase-I and 43,000 BGPs during Phase-II).

h). Based on decision, consultation and dialogue was held to prepare and finalize the constitution (Memorandum of Association and Rules & Regulations) of the formal national organisation of the NGO network with the following aims:

(i) *To respond to new and emerging challenges in the field of renewable energy and for the systematic promotion of new RETs, and*

(ii) *To plan and initiate action for the systematic promotion of sustainable energy based ecological & environmental development programmes.*

i). Finally, the representative of the Network met in late October 1995 in New Delhi and the name and the constitution of this new body was finalised and approved by the group in the first week of November 1995; and Integrated Sustainable Energy and Ecological Development Association (INSEDA) was registered as a National Association under the Indian Societies Act of XXI of1860, on December 11, 1995, with its registered National Office in Delhi.

FIFTH STAGE- (OCTOBER 1996 TO 2001)

29. **Initiation of Concrete Action Plan to Gradually Transform INSEDA and its Network in to Broad-based Network to Implement Integrated Sustainable Energy and Ecological & Environmental Development Programme**

d). In December 31, 1996, there were more than 50 members of INSEDA who together had built about 100,000 house-hold biogas plants in rural areas of India, since the inception of this network in early 1980, covering the entire country. In the year 2001 there were over 75 NGO members of INSEDA who have together built over 130,000 household plants under the NPBD.

e). In persuasion with the aims and objectives of INSEDA, Secretariat were either involved directly or acted as facilitator or provided technical and advisory services to its member in promoting renewable energy programmes, with special focus on low cost, household biogas technology. Some of the important achievements due to INSEDA's interventions, since the beginning of 1996 till the middle of 2001 are summarised below:

(i) Development and implementation of Deenbandhu Model BGPs using Ferro-cement technology by one of the NGO members, which is less costly than the existing Deenbandhu Model made from bricks and cement mortar and have installed over 1,000 ferro-cement DBP till the middle of 2001.

(ii) A new low cost fixed dome model made of Bamboo Reinforced Cement Mortar (BRCM) Plant was designed & developed by the author in late 1993/early 1994, and christened it as SHRAMIK BANDHU (meaning, Friend of the Labour), as about 45% cost for building it would go to labourers as wages. This design was field tested and demonstrated in collaboration with NGOs and local farmers in 1996. Further improvements were made before the design was finalized in 1996 and the author who is the designer prepared a "Comprehensive Manual on this Model". This new model is more appropriate for construction by village-folks, especially providing income to the target groups of all the members of the NGO network, i.e. rural women, landless peasant, artisans, masons, unemployed rural youth and other poor villagers who are earning their living through working as daily wage labourers in rural areas, after some training.

(iii) INSEDA in collaboration with Foundation for Alternate Energy-FAE (Slovakia) and financial support from INFORSE International Secretariat/ Forum for Energy Development (FED), Denmark, prepared Material for Distant Education in Renewable Energy Technology (in short known as DIERET) and launched an International programme on DIERET through the Internet. The pilot phase of implementation of DIERET was launched jointly by FAE and INSEDA through the INTERNET in April/May 2000, which had good response. The first group of trainees completed their programmes by the August 2000. The INSEDA and FAE are now looking for Funding Agencies/Sponsors to launch DIERET for the benefit of NGOs in the developing countries on regular basis.

VIII. LESSONS LEARNED FROM IMPLEMENTION OF LOW COST DECENTRALIZED RENEWABLE ENERGY PROGRAMME IN RURAL AREAS OF INDIA

30. Some of the lessons learned, based on the experience of INSEDA members in the promotion of renewable energy technologies (RETs) for two decades in rural India, which are key to the success in implementation of any RETs are summarized below:

a). RETs are new & aliens to rural people, as they are developed outside the rural environment, therefore be first viewed with skepticism by the villagers.

b). Any new RE technology selected for promotion should be fully matured before it is transferred, demonstration, and promoted for rural applications.

c). In the initial stages of demonstration of RETs in rural areas of developing countries, failure of even one unit could create negative impact in villages, within a radius of 20-30 KMs and its short-comings would be spread like a wild fire. Therefore it is always important to first demonstrate the new RETs involving the local field agencies or NGOs who have implemented other successful developmental programmes as well as established their credibility with the local people/communities.

d). Once the people are convinced about the benefits of technology, which should also be affordable then it can succeed very well. This requires a longer gestation period, either for a new technology or for the field application of a new technological concept, for acceptance and internalization by the local people in rural areas.

e). As opposed to purely marketing approach for promotion of RE Technologies (RETs), the best strategy to follow in rural areas would be- “Extension-cum-Semi-commercial Approach”, treating Renewable Energy Technology (RET) as the ‘Means’ for ‘empowering’ the ‘local people’ and the ‘community’, rather than treating (RET) as an ‘End’ in itself. This new strategy, in the long run, will automatically help in developing a ‘sustainable RET market’.

f). Instead of treating rural areas solely as market place for RETs, the RE implementation programmes should be used for ‘creating employment’ for villagers, especially for unemployed rural youth by promoting ‘skills development training’ and over all ‘capacity building’ of ‘village community’; as well as for ‘strengthening village economy’ by starting village level, tiny ‘ancillaries units’, which could be easily managed by the local people.

g). The RE promotion should be integrated with other developmental programmes so that it could promote ‘sustainable human development’, linked with quantitative as well as qualitative growth of the local people, leading to their empowerment, and in the process would also become a marketable commodity to sustain its own growth.

IX. IMPORTANT CONSIDERATIONS FOR THE SUCCESS OF PEOPLE ORIENTED RENEWABLE ENERGY BASED RURAL DEVELOPMENT PROGRAMME

31. Based on the analysis of the experiences of promotion of various renewable energy technologies, some of the important issues are presented below, which would help in the planning and initiating appropriate decentralised rural energy programmes, especially for implementing people’s centered, electric power generation, focusing on empowering target groups & communities in developing countries:

a). The implementation organization should recognize the richness of the socio-cultural diversity of the local population, which needs to be respected and preserved while promoting RETs; as well as RET based developmental programme. This could only be done by following a process-oriented approach, comprising demonstration, awareness, education, capacity building through training, technical literacy and skills development in renewable energy.

b). The process-oriented approach, even though slow in the beginning but essential, and would play the crucial role in acceptance, adoption, assimilation, absorption and internalization of sustainable energy options for a better future of the local people/ communities, treating them as one of the main partners and stakeholders.

c). Critical awareness of the local people about the pros and cons of the RET based programmes as well as the implications of such programmes to them is a must.

d). Local people (the target group/community) should be treated as the primary stakeholders in any decentralized projects meant for their benefits, rather than treating them only as beneficiaries of the project.

e). Programme should create employment and self-employment for local people.

f). The technology as well as the technological solutions should be de-mystified so that people can operate, manage, maintain, service and repair it locally and their spare parts should be easily available.

g). Capacity building of the different actors involved is the key to the success of the RET programmes for rural applications.

h). Promoting and strengthen the decentralized structures (End Users Cooperatives and MLPIs- Micro Level People's Institutions) for installation, generation, operation, service, repair & maintenance and management of electrical power & energy services in a decentralized manner, especially for rural & far-flung areas of the developing countries.

i). Integrating energy programme with the other developmental programmes of the villages, which could also give the local people revenue for re-paying the operating cost of the energy system as well as opens up the best possibilities for utilization of the surplus energy generated, with the local economic growth.

j). The RE promotion should integrate with the other community development programmes, to meet the most important non-economic needs of the individuals rural families and the village communities as a whole, and in the process it should also promote Sustainable Human Development (SHD).

k). Removing drudgery of women in fetching of water for domestic purposes, collection of fire wood and health problems associated with these activities,

l). Saving in time for the women which could be used by them for resting and relaxing (from cooking, domestic chores and other related activities),

32. One of the best way to implement renewable energy activities in rural areas is to integrate it with the eco-food production for regenerating the micro-agro-eco system, by promoting sustainable energy based eco-village systems as a strategy for long-term development as well as conservation & preservation of rural environment.

33. Flexible funding of RE programmes for development of human resources in rural areas and linking them with entrepreneurship development programme and creation of a large number of bare foot managers, and barefoot technicians for installation, repair and maintenance.

34. Appropriate trainings of rural people in skill development, repair & maintenance, rural entrepreneur development for implementation of RET programme, should be taken-up on massive scale, for decentralized implementation, maintenance and repairs etc. Such programme should be aimed at providing sustainable income to women, rural unemployed youths, landless peasants, local artisans and masons. This should be backed by adequate supply of gadgets/ appliances/ equipments etc. with the RET Resource Centres established with the NGOs operating at the grass roots levels, on self-supporting.

X. COMMUNITY ORIENTED SUSTAINABLE ENERGY BASED ECO-VILLAGE DEVELOPMENT (EVD)

35. Based on the 4-5 years of consultation and suggestions with its members, INSEDA secretariat has prepared ad fine-tuned a simple conceptual model for implementing pilot demonstration project to tackle the rural energy and ecological degradation problems in a decentralised manner, for re-generating micro-level agro-eco-system, with active people's participation while empowering people, which would also generate local employment and self-employment and re-generate rural economy, treating village as the viable micro-agro-eco-system.

36. The conceptual model is named as- "Sustainable Energy based Eco-Village Development (EVD) Model", which focuses on Human Centred Development (HCD). It is recognized that the success of this model would depend upon the participatory planning and implementation, as well as the capacity building and active participation of the target community, therefore the NGOs involved in the implementation would have strong base and credibility in the selected villages.

37. The above-mentioned community oriented Eco-Village development model (ECO-VIDEM) could be defined as the sustainable development of a micro-agro-ecological system within a defined boundary of a given village, which is based on the principle of community centered, Sustainable Human Development (SHD) with active people participation. The INSEDA members who have shown interest in promoting the ECO-VIDEM also believe in maintaining socio-cultural diversity as well as protecting the local bio-diversity of the proposed target area.

38. It is proposed to implement a few of this conceptual model (i.e., EVD MODEL) which would also act as demonstration-cum-training unit for NGOs and other developmental organizations, interested in promoting environmentally sound and eco-friendly sustainable human development with people's participation, as well as generation of employment and unemployment.

39. The page-16 of this paper shows a schematic diagram depicting a simple conceptual design of Sustainable Energy based Eco-Village Development (EVD) Model for facilitating and promoting environment-friendly Sustainable Human Development.

40. **<u>Major Sectors and the Sub- Sectors of EVD Model</u>**

a). Community oriented Sustainable Energy based Eco-Village Development (EVD) would broadly encompass the following Major Sectors and Sub-Sectors:

(i) Awareness and motivation of People for initiating appropriate Eco-Village Developmental (EVD) programmes;

(ii) Development of basic infrastructure (community center, building and repairs of roads inside the village, drinking water etc.) and establishment of pre-school education centres (as the entry point programmes) within the village adopted for eco-development;

(iii) Human Potential Development- HPD (using a process oriented participatory approach for HPD).

d). Organization of Rural People and Strengthening Micro Level People's Institutions (MLPI), e.g. Mahila Mandals (MMs), Self-Help Groups (SHGs), Thrift & Credit Groups/Societies (T&CG/C), End User's Groups (EUGs) etc.

e). Starting functional education and literacy programmes for the different groups living within the boundary of the proposed Eco-Village selected for Eco-ViDeM;

f). Promotion of Ecological Agriculture (EA) in the selected villages;

i). Establishing of Decentralized Village or Community level Electrical Power Generation {preferably based bioenergy (locally available Biomass, e.g. biogas and/or gasifire small scale battery of units) and other RE based (Solar Photovoltaic), Micro hydro etc.}, depending on the needs and potential;

j). Promotion of village level eco-friendly forestry and development of community pasture land;

q). Employment and self-employment generation, as well as development of local enterprises based on RETs, for example, running of village level small-scale power operated enterprises and agro-based industries (oil expelling, chaff-cutting, grinding of flour, grinding and mixing of animal feeds etc.),

l). Promotion of viable micro credit system to make finances available to target populations for taking up small economic activities on reasonable interest;

m). Promotion and establishing of Agro-based Industries;

o). Development of marketing infrastructure and networks for selling of ecologically grown, processed and agro-industrial product;

41. Establishment of Resource Centres by NGOs and other field agencies for undertaking appropriate capacity building programmes of the target groups, develop entrepreneurs, establish production-cum-consumers cooperatives and for the effective promotion, implementation, maintenance, management and utilization of physical structure with in the eco-village.

42. The Table-1 & Table–2 respectively on page-17 & 18 give calculations for methane (CH_4) abetment (in terms of carbon dioxide-CO_2) to the atmosphere by installing household biogas plants Indian villages, based on available potential of dung from domestic farm animals, preferably using cluster approach for implementation, thus reducing overall 'Global Warming' and promoting positive environmental impact. The Table-1 gives the quantity of methane (CH_4) abated (per day, annually and the useful working life of the plant) in terms of equivalent carbon dioxide (CO_2) for 5 different sizes (1, 2, 3, 4 & 6 M^3 capacities BGPs) household biogas plants in India, as well as the present cost of abatement in the Carbon Market. The Table-2 gives the total abatement of carbon dioxide (CO_2) equivalent of methane (CH_4) emission from building the different number (1,000 to 100,000 household biogas plants of 2 M^3 capacities in India, as well as their total value in the Carbon Market.

XI. SUMMARY AND CONCLUDING STATEMENT

43. Experience of NGOs in the promotions of appropriate renewable energy technologies (RETs) in the rural areas for over two decades have shown that there are several problems yet provides challenging opportunities for the implementation of RETs in villages. These problems need to be studied and analyzed properly in the context of the given socio-cultural realities, and the local people/communities are adequately motivated and prepared, before the introduction of any new RET otherwise there would be good chances of its failure, as these technologies are new & aliens to rural

people. It would require a process oriented approach and longer gestation period, for a new technology or a new technological concept, for the acceptance and internalization by the rural people. Once the villagers are convinced about their benefits viz. a viz. their existing local technology, and if they can also afford then the new RETs can be accepted and adopted very well.

44. From the calculations in table 1 & 2, it can be seen that by installing average size of 2 M^3 capacity household biogas, which would utilize 750 million kg of dung per day from domestic farm animals, at present being dumped in heaps or in open pits for making organic manure, and was responsible for releasing methane (CH_4) emission in the atmosphere would be abated Therefore, by installing all the potential 20 million household plant of 2 M^3 average capacity, rural India would be able to abate 660 million tones (@ 66 million tones per year of with average plant working days of 330 per year) of carbon dioxide equivalent of methane emission in their "Useful Working Life" of 10 year of these plants. In addition to preventing release of green house gas to the atmosphere and thus creating positive environmental impact, these household BGPs would also become instrumental in promoting ecological agriculture, using enriched organic manure from the BGPs, in rural India. Thus there is a strong case for North-South collaboration in the implementation of household plant in rural India.

45. Any technology programme launched in the developing countries must be critically analyzed in respect to the socio-cultural and the socio-technical aspects, treating technology only as a means and not the end in itself, so that the needs of such un-served areas or regions could be met effectively, using a developmental approach, which is the only way to empower the local people.

46. For this purpose a new and alternate strategy, focusing on people centered development, which will have to recognize the rural people as the primary stakeholders in their own development. Such a strategy will have to integrate rural poverty alleviation programme and increased food production with the focus on appropriate agro-ecological and renewable energy development based on sound environmental principles and approach.

47. The promotion of sustainable energy based Eco Village Development (EVD) Model conceptualized by INSEDA, as elaborated in this paper could be considered as a guide and starting point for a long-term strategy for implementation people-centered, "Micro Environment at the Village Level", for promoting Sustainable Human Development (SHD). This model could gradually evolve and fine-tuned to develop a more comprehensive "Eco-Village System" for each Agro-Ecological Zone for "replication", based on practical experience gained during the implementation by grass-roots development agencies.

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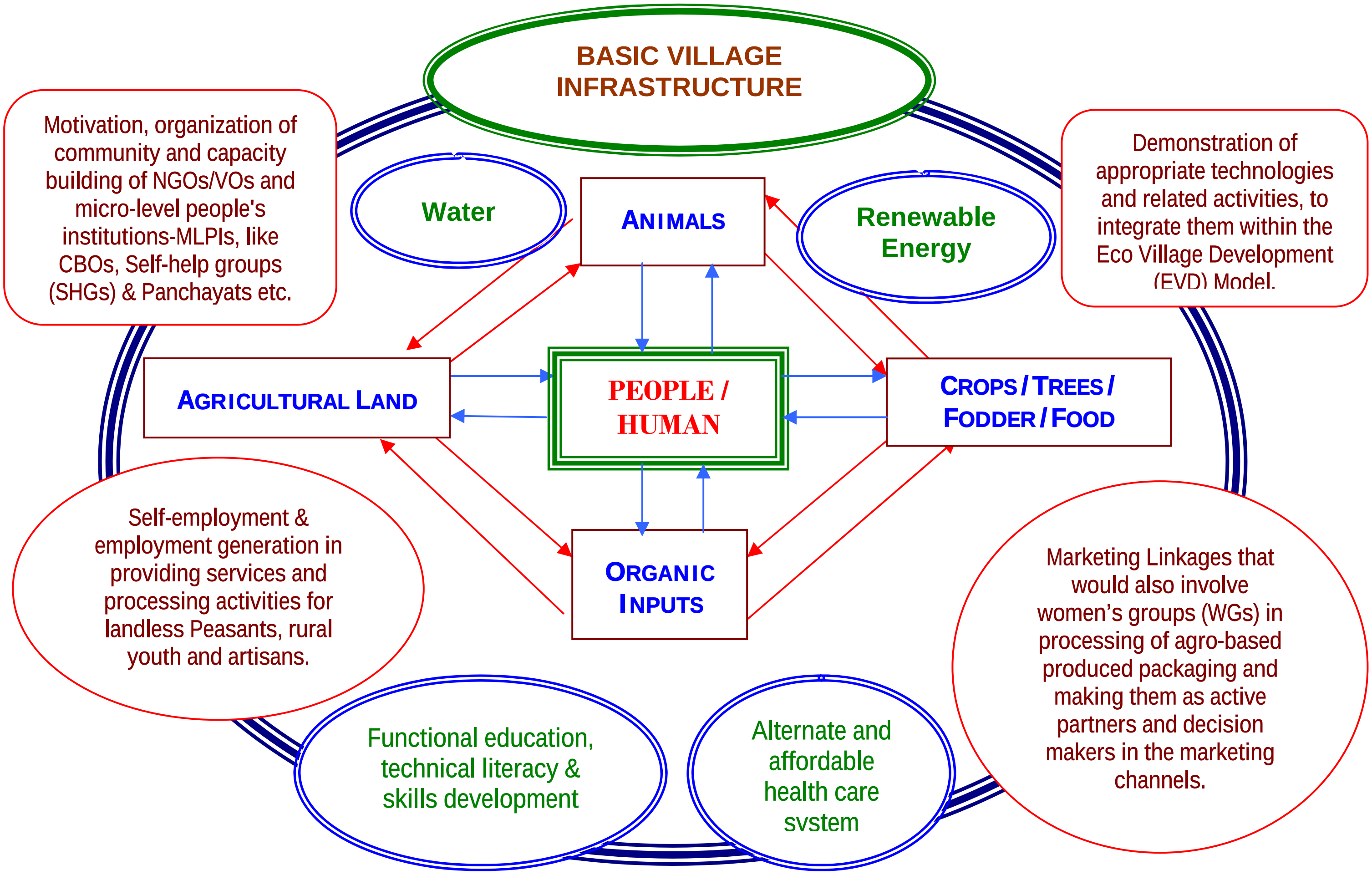
SIMPLE CONCEPTUAL DESIGN OF ECO-VILLAGE DEVELOPMENT (EVD) MODEL TO PROMOTE COMMUNITY ORIENTED SHD



The above-mentioned sustainable energy based Eco Village Development (EVD) Model conceptualized could be considered as one of the most appropriate models at present, for promoting Sustainable Human Development (SHD) within the Indian villages, as a long-term strategy by grassroots NGOs involved in promoting PEOPLE-CENTERED rural development. This conceptual EVD MODEL is developed based on the last 4 to 5 years of intensive interaction, discussions and dialogue with members as well as feedback received from them, to realize the common/shared VISION and GOALS of INSEDA and its Member NGOs. This conceptual model would provide ample flexibility and scope to INSEDA members/partner NGOs for incorporating new and innovative approaches based on local needs, for promoting better "Micro Environment at the Village Level", using it only as a guide and starting point for promoting people centered development. This model is expected to get gradually evolved and fine-tuned in to a more comprehensive "Eco-Village System" for each Agro-Ecological Zone for "replication", based on practical experience gained during the implementation by grass-roots NGOs members in collaboration and partnership with INSEDA.

TABLE- 1

ABATEMENT OF METHANE EMISSION- CH_4 (IN TERMS OF CARBON DIOXIDE- CO_2) FROM DIFFERENT CAPACITIES INDIAN HOUSEHOLD BIOGAS PLANTS

S N	Rated Capacity (in terms of daily biogas production in 24 Hours) of Standard Indian HH BGPs	Daily Requirement of Fresh Dung (Manure)	Daily Feeding of manure Slurry in BGP	Av. Daily Production of biogas (Taking Annual Average)		Daily Qty. of Abatement of Methane (CH_4)	Daily Qty. of Abatement of CO_2 equivalent of Methane (CH_4)	Annual Quantity of Abatement of Carbon dioxide (CO_2) equivalent of Methane (CH_4) Emission	Total Abatement of CO_2 equivalent of CH_4 emission during the 10-Year Useful Working Life of Indian HH BGP		Cash Value (US Dollars) of abatement of CH_4 emission in terms of CO_2 equivalent during the 10 year Useful Working Life of Indian HH BGP
	M^3	Kg	Liter	M^3	Liters	Kg of Methane (CH_4)- @ 0.0108 kg/kg	Kg of Carbon dioxide (CO_2) @ 0.2 kg/kg	Kg	Kg	MT (Metric Tones)	@ US$ 8.00/Tone of CO_2 equivalent of CH_4 abated
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
						(c) x 0.0108	(c) X 0.2	(h) X 330 days/year	(i) X 10 years	(j)/1,000	(k)x 8 USD
1.	1 M^3	25	50	1	1,000	0.27	5	1650	16500	16.5	132
2.	2 M^3	50	100	2	2,000	0.54	10	3300	33000	33	264
3.	3 M^3	75	150	3	3,000	0.81	15	4950	49500	49.5	396
4.	4 M^3	100	200	4	4,000	1.08	20	6600	66000	66	528
5.	6 M^3	150	300	6	6,000	1.62	30	9900	99000	99	792

TABLE- 2

COST OF ABATEMENT OF CARBON DIOXIDE (CO_2) EQUIVALENT OF METHANE (CH_4) EMISSION FROM BOVINE MANURE (DUNG) BY BUILDING DIFFERENT NUMBERS OF 2 M^3 CAPACITY HOUSEHOLD BIOGAS PLANT IN INDIA

(DURING THE 10-YEAR USEFUL WORKING LIFE OF THE BIOGAS PLANT)

S N	2 M^3 (CUBIC METER) CAPACITY, STANDARD MODEL OF INDIAN HOUSEHOLD BIOGAS PLANT (IHH BGP)										
	Proposed Number of IHH BGP Constructed Annually in India	Daily Requirement of Fresh Dung (Manure)	Daily Feeding of Manure Slurry in BGP	Av. Daily Production of biogas (Taking Annual Average)		Daily Qty. of Abatement of Methane (CH_4) Emission	Daily Qty. of Abatement of the CO_2 equivalent of Methane (CH_4) Emission	Annual Qty. of Abatement of Carbon Dioxide (CO_2) equivalent of Methane (CH_4) Emission	Total Abatement of CO_2 equivalent of CH_4 Emission during the 10-Year Useful Working Life of Indian Hh BGP		Value (US Dollars) of Abatement of CO_2 equivalent of CH_4 Emission during the 10-Year Useful Working Life of Indian Hh BGP
	No.	**Kg**	**Liter**	**M^3**	**Liters**	**(CH_4)- @ 0.0108 kg/kg**	**KG OF CARBON DIOXIDE (CO_2) @ O.2 kg/kg**	**Kg**	**Kg**	**MT (Metric Tons)**	**Amount (Value in terms of Cash) in US$ (@ US$ 8.00/Tone of CO_2)**
(a)	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**	**(l)**
		(b) X 50	**(b) X 100**	**(b) X 2**	**(b) X 2,000**	**(c) x 0.0108**	**(c) X 0.2**	**(h) X 330 days/year**	**(i) X 10 years**	**(j)/1,000**	**(k)x 8 USD**
1.	1,000	50,000	100,000	2,000	2,000,000	540	10,000	3,300,000	33,000,000	33,000	264,000
2.	2,000	100,000	200,000	4,000	4,000,000	1,080	20,000	6,600,000	66,000,000	66,000	528,000
3.	3,000	150,000	300,000	6,000	6,000,000	1,620	30,000	9,900,000	99,000,000	99,000	528,000
4.	4,000	200,000	400,000	8,000	8,000,000	2,160	40,000	13,200,000	132,000,000	132,000	1,056,000
5.	5,000	250,000	500,000	10,000	10,000,000	2,700	50,000	16,500,000	165,000,000	165,000	1,320,000
6.	7,500	375,000	750,000	15,000	15,000,000	4,050	75,000	24,750,000	247,500,000	247,500	1,980,000
7.	10,000	500,000	1,000,000	20,000	20,000,000	5,400	100,000	33,000,000	330,000,000	330,000	2,640,000
8.	15,000	750,000	1,500,000	30,000	30,000,000	8,100	150,000	49,500,000	495,000,000	495,000	3,960,000
9.	20,000	1,000,000	2,000,000	40,000	40,000,000	10,800	200,000	66,000,000	132,000,000	132,000	1,056,000
10.	25,000	1,250,000	2,500,000	50,000	50,000,000	13,500	250,000	82,500,000	825,000,000	825,000	6,600,000
11.	30,000	1,500,000	3,000,000	60,000	60,000,000	16,200	300,000	99,000,000	990,000,000	990,000	7,920,000
12.	40,000	2,000,000	4,000,000	80,000	80,000,000	21,600	400,000	132,000,000	1,320,000,000	1,320,000	10,560,000
13	50,000	2,500,000	5,000,000	100,000	100,000,000	27,000	500,000	165,000,000	1,650,000,000	1,650,000	13,200,000
14	75,000	3,750,000	7,500,000	150,000	150,000,000	40,500	750,000	247,500,000	2,475,000,000	2,475,000	19,800,000
15	100,000	5,000,000	10,000,000	200,000	200,000,000	54,000	1,000,000	330,000,000	3,300,000,000	3,300,000	26,400,000