V SUMMARY AND CONCLUSION

Energy is a vital element for ensuring quality of life. India like other developing countries consumes energy in a variety of forms. The energy consumption is bound to increase over the years with the development of the country. Over the past 30 years, the energy consumption rate has grown much faster; as a result “Global Energy Crisis” has been raised to an alarming level. Excessive consumption of energy has caused the fast depletion of fossil fuels, large scale deforestation, hike in the prices of petroleum and also global environment problems-global warming. Therefore, the challenge is to increase energy generation through judicious utilization of abundant renewable energy resources. Alternative use of energy has gained greater importance, of which organic waste plays a vital role as it is most abundantly available in our country.

India is on the brink of a massive waste disposal crisis. It is ironical that when there is great need for conserving energy, a large quantum of energy is allowed to go unutilized in the form of waste as a result of human activities production and consumption. The enormous increase in the quantum of waste materials led to an increasing awareness world-wide about an urgent need to adopt efficient, scientific and safe method for the treatment, processing and disposal of wastes. Keeping in mind the resource crunch and expected coverage of maximum possible percentage of population, it is necessary to adopt methodologies based on the following parameters

- The suggested technologies may be such that resource recovery is made possible by energy recovery, recycling and reuse
- The process needs to be decentralized ‘on site’ as far as possible so as to minimize waste carriage.

Among the various technologies available for conversion of organic waste, bio-methanation appears to be the most desirable as it results in the production of methane rich gas (biogas), an alternative of conventional fuel and digested slurry, which can be used as an organic fertilizer. Bio-methanation is a universally accepted and proven technology for bioenergy generation from organic waste.
The mushroom growth of educational institutions and industries consumes enormous quantity of fossil fuels and generates enormous quantity of waste such as night soil, garbage and left over foods. These wastes should be channelized in an appropriate way to generate fuel, fertilizer and promote a clean environment. For facilitating better use of organic waste in large scale establishments, Institutional Biogas Plant is a convenient and operationally viable device.

A major portion of the population in India is widespread among many small and isolated villages. The problem of fuel wood is more menacing and unless adequate measures are taken the fuel wood supply will be critical and unmanageable. Hence an alternate efficient source of energy is the need of the hour. In the view of the fuel crisis and environmental pollution in recent years, biogas technology has attracted worldwide attention. With the commendable work of National Biogas Development Project (NBDP) considerable number of domestic biogas plants has been installed. High cost, lack of space, insufficient number of cattle and lack of man power made rural women drive back to use the ordinary chulah. The multifaceted problems faced by the rural households such as non-availability of clean energy, indoor air pollution caused by traditional chulah and insanitary surroundings due to open defecation can be mitigated through the night soil/garbage based Community Biogas Plant. The studies in this direction are meagre hence a scientific investigation is felt necessary.

These phenomena prompted the investigator to take up a micro level study in two major phases

- Resource Recovery from Institutional Biogas Plant
- Exploring the prospects gained by the women in using Community Biogas Plant

The objectives of the study are to

1. understand the trends and issues of Institutional Biogas Plant.
2. quantify the extent of availability of organic waste in an educational institution.
3. gain knowledge about design considerations, materials and labour involved, modus of operandi of an Institutional Biogas Plant

4. assess the resource recovery in terms of fuel energy, money and organic manure

5. analyse the socio-economic impact among women in using Community Biogas Plant.

6. monitor the indoor air pollution arise from the kitchen of rural households.

7. explore the strengths, weakness, opportunities and challenges.

The study comprises of survey of Institutional Biogas Plants, comprehensive study and resource recovery of an IBP in an educational institution and evaluating the impact of CBP among women beneficiaries in selected villages.

• Forty institutions in Tamil Nadu and ten institutions in Kerala who have installed Institutional Biogas Plants constructed by Nirmal Biogen Technology, pioneer in construction of biogas plants were selected based on purposive sampling method. Interview cum observation method was opted for collection of data. An interview schedule was formulated covering all the aspects to get complete details about IBP’s installed at various institutions in Tamil Nadu and Kerala.

• A comprehensive study has been planned to review an IBP installed in an educational institution where the investigator is employed to assess the various parameters of the unit. The details were gathered from the authorities, agency involved in the construction and personnel appointed for the operation and maintenance.

• In order to ensure availability of the organic waste (the feed stock material for the Institutional Biogas Plant) a yearlong investigation was carried out to assess the generation of wastes. The recovery of resources such as fuel, organic manure, money and environmental benefits were quantified by using various methods.
• An evaluatory study was carried out in two villages namely Komarapalayam and Kolinjanur to find out the impact of Community Biogas Plant among women beneficiaries. The findings of the study are summarized below

Trends and Issues of Institutional Biogas Plants

• The most pressing problems such as energy crisis and waste disposal made the administrators to install Institutional Biogas Plant in their campus. Achieving National Millennium goal in energy efficiency made all of them to venture into this project. All of them unanimously expressed the safe disposal of night soil; high cost and sudden hike in price of LPG were the major issues in deciding the installation.

• Prior to the installation of IBP, organic wastes were not utilized properly and made the premises unhealthy. But with the advent of the installation of IBP, these wastes found a proper place through recycling methods and generated most precious fuel-biogas. It was inferred that on an average 79 to 90 per cent of night soil was generated in educational institutions and negligible amount of garbage and leftover foods. The capacity of the plant was based upon the number of inmates residing in their premises. The textile industry occupies a major portion of the industries in and around Coimbatore and Erode. On an average the labourers working in these industries varied from 268 to 1780 members and the wastes generated in the textile industries were directly proportional to the number of inmates. In Kerala, majority of the hospitals had installed Institutional Biogas Plants. The organic waste generated in hospitals and religious centre greatly depends upon the inmates. The average generation of organic wastes per day in Educational institution, Textile Industries, Hospitals and Religious centre when analysed statistically did not vary significantly among the institutions.

• Prior to the installation of IBP, the authorities had adopted various disposal methods and faced many problems. Clearance of septic tank, over flowing of the tank and getting man power to clean it were the problems faced in disposing night soil. Dumping the garbage and leftover foods, throwing them in uncovered common dust bin and in the drainage created unhygienic surroundings.
• The retention time of the IBP’s differed with regard to feed stock materials. Thirty two per cent of the institutions had shorter retention time of 30-40 days and 14 per cent of the institutions had longer retention time of 60-70 days. This may be attributed to insufficient of feed stock materials.

• The main aim of installing IBP in the institutions was to recover fuel energy. They were spending huge amount for purchase of Liquefied Petroleum Gas for quantity cookery. The introduction of IBP paved way for them to minimize the usage of cylinders and considerable number of commercial LPG cylinders could be saved. The saving of LPG cylinders is directly proportional to the capacity of the plant in that as higher the capacity, more number of commercial cylinders is saved. Jack fruit and rubber tree woods were used as fuel wood in the canteen of the hospitals in Kerala. After the installation of IBP in hospitals, the amount spent ₹1950-2800 towards fuel wood per month had been recovered.

• It was found that saving of commercial LPG cylinders was more in hospitals and industries compared to educational institutions and it was significant at one per cent level when analyzed statistically.

• The capacity, design structure and materials needed for construction, identifying suitable agency for entrusting the work were the major issues in majority of the institutions. Deciding an ideal location for constructing the IBP had created a controversial opinion among the members expressed by 84 per cent of the institutions. Any novel venture for its wider acceptance requires awareness among the end users of its product. Hence they made several efforts to create awareness.

• The administrators expressed that erecting IBP was an ideal technology in solving energy crisis. They recovered the capital amount invested in IBP within 2 to 3 years. Hence they propose the fellow institutions to emulate this idea and come forward in large numbers to adopt ‘Waste to Energy’ concept for saving fossil fuels for future generation.

**Description of an Institutional Biogas Plant**

• Adequacy of site, Identifying the construction agency, ensuring the availability of feed stock materials, design and capacity of the IBP, capital
outlay were the pre requisites considered for installation of Institutional Biogas Plant. The 35cu.m capacity IBP constructed in the campus consists of digester, inlet tank, outlet tank and other accessories such as gas outlet pipe, gate valve, hose pipe, moisture trap, bends, joints and stop cock. The construction of the biogas plant took 38 days with well-trained masons and labourers.

- The continuous feeding of waste materials such as night soil, garbage and leftover foods ensures successful running of the biogas plant till now. The gas released was taken from the plant through the pipeline and connected to the steam boiler (380 litres capacity) in the kitchen. The digested slurry which comes out from the plant was used to irrigate coconut and mango trees in the campus.

- The total cost spent for construction of IBP was ₹4,62,248. Fifty per cent was spent for purchase of materials, 26 per cent for labour charges, 16 percent as overhead charges, nine per cent as profit for the contractor and one percent as miscellaneous expenses.

**Resource Recovery of Fuel, Money and Organic manure**

**Fuel Energy:** The average gas production from organic wastes per day was calculated. It was inferred that production of gas per day increases with the generation of night soil, garbage and left over foods. It shows that if organic wastes were treated properly through biogas plant, it gives a clean fuel as well as hygienic surroundings.

- The fuel equivalent calculation indicated that if biogas is used for cooking it replaces on an average 8.83kg of LPG; 12.65 litres of kerosene; 8.51 litres of furnace oil; 95.84 kwh of electricity in a day.

**Organic manure**

- The institution has 3.5 acres of land planted with mango and coconut trees. The Biogas Spent Slurry was used to irrigate those trees. The sample of BSS was tested in the Tamil Nadu Agricultural University, Coimbatore to find out the NPK content. The result when compared with recommended nutrient content values reveals that BSS has fairly rich source of manure. A sum of
₹7437/year spent for the purchase of chemical fertilizer and farm yard manure was saved through the use of spent slurry.

**Economic viability of the 35cu.m IBP**

- Economic viability of the biogas plant was arrived based on investment, revenues and expenses. The profit was found out from the amount recovered from revenues (i.e from fuel and manure) after deducting the expenses. It was found out that the institution had realized a profit of ₹91,000/- and they recovered the construction cost within 4 years. The payback period calculated for the IBP constructing at present was found to be 4.7 years. This might be due to the hike in the price of materials and labour cost.

**Environmental benefits**

- The disposal of garbage and leftover foods as feed stock materials into the inlet tank and diverting night soil directly from the septic tank to the digester makes the surrounding healthy and hygienic. The scientific analysis revealed that there is a significant reduction in the Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD) through anaerobic fermentation. Thus toxic substances are removed and it provides safe slurry.

**Profile of the Rural Households**

The second phase of the study brings forth the impact of Community Biogas Plant in the selected villages.

- The socio-economic profile includes social, educational and economic status of the households in selected villages. The joint family system exists in the olden timings was disintegrating even in the rural areas and 85 per cent adopt nuclear family system. It was evident that 68 per cent belonged to medium size families with 4-6 members and one third of them were of small families. Large families were negligible. More than 50 per cent of the head of the families were literate. Even with the commendable efforts of the mass literacy programme, 53 per cent of the homemakers remained illiterate.

- Daily wage earning for their livelihood was still prominent in the rural areas as 36 per cent of head of families and 43 per cent of homemakers were working as coolies. As agriculture was one of the predominant occupations in
surrounding area of the villages, 30 per cent of head of the families and 32 per cent of homemakers were agricultural labourers. Fifty seven per cent of the households irrespective of the occupational category were earning less than ₹ 5000/- per month. A few households were high middle income families earning ₹ 7000-9000/- per month.

**Fuel Management Practices**

- Majority of the homemakers collected the firewood from the nearby hilly areas. Nearly 60 per cent of rural households purchased firewood in the nearby markets. Ten per cent of them used firewood along with kerosene and 20 per cent used firewood besides using biogas. Out of the 312 families surveyed only 15 households were using LPG for their cooking requirements. Fifty two per cent of the families purchased 50-60 kg of firewood by spending a sum of ₹350-420 per month and 36 per cent purchased 40-50 kg for ₹280-350 per month.

- The homemakers narrated several problems in using firewood. More than 80 per cent of them mentioned walking long distances to collect firewood, dangers of poisonous snakes and insects in the forest area, spending a lot of time, insufficient storage space, not available at reasonable cost, taking more time to clean the utensils, smoke emission and eye strain as their major problems.

**Impact of introduction of CBP**

- The Community Biogas Plants were constructed in the two villages under the rural reconstruction programme by Bannari Amman Rural Foundation in order to remove the drudgery of rural women and to bring a clean environment. But out of the 312 households only 62 households realized the importance of biogas for cooking and still 250 women confined to the traditional fuels due to various reasons.

**Resource Recovery in Households**

- On an average fuel wood ranging from 32 kg to 54 kg/month and a sum of ₹111-378 per month as resources were saved. The fuel consumption and amount spent for fuel before and after introduction of Community Biogas Plant
was statistically analysed using ‘F’ test and indicated that there was significant reduction at one per cent level in the fuel consumption and amount spent for fuel.

- The women beneficiaries were highly conscious of many problems in their fuel management practices. The homemakers faced several drudgery in using conventional fuels such as walking for long distances; spending a lot of time in collection; difficulty in lighting the fire and smoky kitchen, so 62 households welcomed the idea of introduction of CBP.

- Out of 250 women who are not using CBP, ninety per cent of the homemakers mentioned that the community kitchen was located far away from their households; so they feel discomfort in carrying the vessels to the area. Eighty two per cent of the families were addict to the taste of foods prepared using firewood as fuel. The night soil based biogas plant made a psychological dent among the women. By equipping them with the adequate knowledge about the process of biomethanisation, their attitude might change towards positive side.

- The chi square analysis revealed that age and occupation of the homemakers did not have any significant impact on biogas technology. The educational level and income of the homemakers had a significant impact at one percent level in adopting the community biogas technology and providing importance of educating the rural women either through formal or non formal centres.

**Awareness Programmes for Rural Women**

- As a culminating factor, to make the women realize the outcomes of having CBP in their villages such as availability of cost free fuel, smoke free environment, hygienic surrounding and nutrient rich organic manure, an awareness programme was planned and executed. Individual counseling, group discussion, distribution of leaflet, placing posters in the prominent places were the methods adopted.
Future Strategies

Bringing structural changes in the attitudes of the public in respect of environmental changes and also the advance effects on environmental degradation is the need of the hour. In order to fulfill this goal the following strategies are recommended.


2. The State and Central Government should recognize the institutions using New and Renewable energy sources in their premises by providing subsidy and incentives.

3. The environmental scientists, engineers, social activists, project developers, nodal bodies and other key stakeholders should work out various strategies for protection of environment from pollution taking a note of the reasons for environmental destruction.

4. The Universities and Colleges can act as a catalyst by educating the youth the concept of waste recycling and energy utilization by incorporating into the curriculum and instigate them to participate actively in National and Community Social Service Scheme.

5. Information on appropriate technology must be made available to potential users through mass awareness programmes. Use of folk art and folk media are good medium for effective dissemination to reach the unreached – village community.

6. The goal of the transfer of technology programme aims at improving the quality of life among the rural communities. The current massive awakening among rural women through ‘Self Help Group’ programme is highly encouraging. Hence they should take active part in identifying the fuel needs of the people and frame appropriate courses of action to fulfill their aspirations and desires.

7. Data base with reference to the potential availability of newer and renewable sources of energy, and the extent of its use, technological intervention, and success and failures and the future course of action should be maintained.
Conclusion

We, in India are bestowed with vast natural resources as well as rich biological heritage. The day when fossil fuels get exhausted one needs to turn onto the perennial sources of energy - the radiating sun, the blowing wind, the surging tide and other sources of biomass, especially the misplaced resource ‘Waste’ is not far off. Continuous, conscientise and co-operative efforts on a large scale by Governments, Universities and Voluntary agencies will pave way towards achieving self-sufficiency in energy.

The world famous Tamil poet ‘Thiruvalluvar’ had rightly pointed out the features of a prosperous country 3000 years ago in the following words:

-இயக்கத்தை வாயில் கடையை வாய்வு; அரங்கை
-சாலையில் கேவும் கேபா.

The meaning of this couplet is that the country will be prosperous if all the uncared resources are efficiently utilized to raise the people’s quality of living.