Renewable and Sustainable Clean Energy Technology Managment of Biomass Waste for Fuel and Food

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Summary

Sustainable Development using waste disposal problems should reach acceptable limit of technology impact within the period of assured economic coverage. then also the obtained results of the project developed need to be more relevant that can be used in real scale evaluations bioeconomy from waste.Energy demand and the price for energy is increasing day by day everywhere as global economic problems. Renewable energy from waste is one of the alternative source which can be use parallel to conventional energy resources. Agro industrial wastes pose a major concern today due to the increase of production with time and thus needs ecological solution using principle of closed loop via reuse, recycle and renewal of the material and nutrient flows. This paper deals with tools and methods used to make the small process system design for power and gas production , and also the process optimization for waste minimization using biodrying, biomethanation and bioscrubbing integrated to autothermal gasification process developments.The overall objective of the project is to make possible an internationally oriented collaborative Brazil and India research competency in biomass waste based zero emission biofuel technology with co-products valorization. The project aim is also to study both technological feasibility and economic prospects for new zero emission waste to power .Also the power to biomethane gas was focused with the help of networking and big data of integrated digital incubator of process technology researchers. viable projects design development using google online real time team work using google online tools The system design use Bio thermal process, hydrogen and methane biofuels and internal combustion (IC) engine. For this problem an integrated system, industrial and ecological using the clean Small Integrated Process Systems (SIPS) was used.The Zero Waste,, cleaner product design and green chemistry concept was also applied to the process design using the three basic principles. The first principle is to use all components of the biological organic materials of the wastes. The second principle is to obtain more co-products from the wastes.The third principle is to close the loop via reuse, recycle and renewal of the material and nutrient flows made possible using google spreadsheet and software superpro designer v.4.9.New synergetic concepts of integrated closed loop innovative bio thermal process system have been developed in this work for the integration of renewable power methane plants in biogas plants as wel as bio electrcity power . Pyrolysis system integrated with fuel cell need more investment compared to internal exhaust engine heat recovery systems l as well as bioelectrcity , biogas , feed for animal from micro algae .Thus this integrated biosystem developed will improve the bio economy local development based on the aquatic plants to reduce significantly carbon using the solar energy available in tropical country.

Keywords: *Bioenergy, biogas, biosystem, Bioeletrcit ,biohydrogen.*

Introduction

1,The sustainable production of clean sustainable agro-energy from biomass is considered as a unifying important subject for the development of a strategy aimed at unlocking the full potential of research by several researchers in several country . This is due to:

- biomass and bioenergy production is a very promising field for integrated investigations
- Our research group shows a strong cross-sectional commitment in the exploration of sustainable solutions for the management of areas with combined agricultural and natural attitude ,studying this project problem of bioenergy of Brasil during 3 decades , of research group gpecufrn linked with ufrn and cnpq

Our research group,gpecufrn , has strong links with the local bio economy of agrobusiness ,RN , Brazil (necessity to plan, guide, and regulate the spreading of the bioenergy and sector in Brasil) with focus on agroenergy biogas ,bioethanol and biomass energy. has the following mission .

2. Boosting the research capacity of our gpecufrn research group and its ability to act as a hub for the promotion of the agro-energy sectorthrough (ber of research people with solid knowledge):fostering the "capacity building" (skills, abilities and competences):bolstering the links with stakeholders (for a most effective performance).

3. To establish an bioeconomy and Agro-Energy network study comunity ration Centre for South America , South asia , able to:generate an advanced and integrated expertise on biomass , biofuel agro-energy;enacting a strong "capacity building";develop strong links within several research groups of both nationat and inter national

Objective

Our project aims at developing a technological basis mainly with reference to biogas generation (anaerobic digestion), thermo-chemical conversion processes (gasification and pyrolysis) and algae cultivation.

Briefly, some of the main objectives are:

- Design and Analysis of small-scale, low cost biohydrogent , biomethane biogas plant for the farms of the agricultural family of small and medium level.
- Design and Analysis of small-scale, low cost pyrolysis plant from solid wstes.
- Design and Analysis , photo-bioreactor pilot plant for microalgae cultivation;
- Study the integrated pyrolysis plant with internal gas engines and fuel cell
- Develop closed loop process , flowsheet based on industrial ecology and zero waste principle

Study on bio economics models based on bioenergy from wastes

Europe model based on the Star AgroEnergy Integrated Energy Platform is considered to be basis for the project development for the the present work which is outlined in the following figure 1. Integration of the system with heat and mass flow is yet problems(25-26)

Every components inputs finds its way to be transformed, utilized or recycled to be closed loop system.

Key elements of a bio-based economy and bio-energy

And that nearly 85% to 95% of the "original natural resources l" are actually wasted or carelessly utilized in almost all activities? Let us consider two concrete but random examples: The Automobile IC engine and Agriculture.

1. The net energy that is available at the wheels of an automobile, to propel it in motion is about 10% to 12% of the heat energy input in the fuel, gasoline. But if we consider the energy that were required to produce and transport the same fuel till it reached the automobile fuel tank, the ultimate efficiency may not even be 2% or 3%!
2. In any form of agriculture - be it Coconut cultivation or any food crop cultivation - the actual material balance would show that the CROP value in terms of percentage with respect to the total Biomass generated would be about 7% to 10%. This means that over 90% of the biomass are either wasted or are utilized in some inefficient manner. Off-course, these days there are

attempts to use the available biomass as Compost or other relatively useful forms. But, when we consider that every gram of biomass is a potential system for alternative chemicals .

Our group study aims to come up with excellent technology with various practical project propositions to utilize, recycle, convert and create commercial values for these huge wastes in our various technologies ... without however creating greater damage to the environment and ecology and towards local bioeconomy (2-7 e 20-28)

The term bio-economy is more frequently used to refer to a broad range of activities in different productive sectors whose common goal is the sustainable use of renewable biological resources for the obtainment of a variety of end-products (such as food, feed, biofuels, bioenergy and fine-chemicals

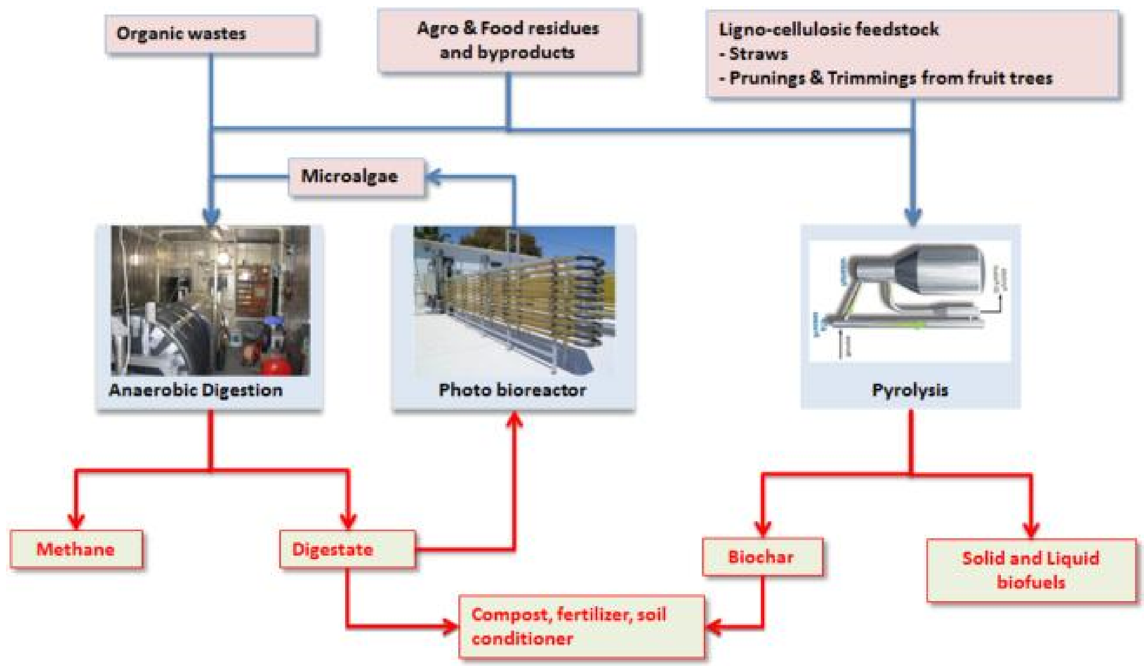

Figure 1: European Model of agroenergy,biofuel production from wastes (Ref web link 10)

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Not all biomass feedstock is suitable for producing higher added value products (e.g. contaminated or very heterogeneous residues) and it should be considered that the energy sector is at least one order of magnitude larger than the chemical sector. Therefore, in addition to using biorefinery residues, direct biomass-to-energy (power or heat) value chains will have to remain. However, considering the limited added value of these value chains, the focus will be, increasingly, on lower quality and lower cost biomass feedstock, obtained from marginal land and producing parallel ecological services. On this respect, agro-energy is the renewable biological energy (that is to say a consistent part of the bioenergy stream) derived from agricultural and forestry products, by-products, residues and wastes. In the light of the striking world energy problems, agro-energy could provide a significant alternative, diversifying agricultural productions(2-7)

A multi-product system, as compared to a single and "linearized" bioenergy system, can be productively addressed partly for energy and partly for material purpose (food, feed or other bio-products). (1-10 and 25-26)

Environmental performance and sustainability issues of agro energy production.

Also serious ethical issues have been raised over the energy use of biomass, claiming that "producing feedstock for energy rather than food is a crime against humanity". Biomass can be scarce and often more expensive than its fossil competitors and there is evidence that biomass, unless produced sustainably, could result in significant negative environmental and socio-economic impacts.Large-scale biomass cultivation may, for example, lead to reduce water availability and to biodiversity loss if a process of agricultural intensification is involved. Moreover, bioenergy impact could be negative if based on biomass cultivation that leads to land use change, directly displacing natural forests or land previously used for food or feed production, in this latter case indirectly generating the need to compensate this land. In this context micro algae produciion making possible high carbon containg gas emissions can play key role regard to environment performance making posible closed recycing ,thus zero emissao cleaner production bioelectricity from wastes .(25-26)

Biomass can contribute most effectively to a positive environmental impact only if biomass are designed to yield the lowest GHG emissions down the value chain, from feedstock cultivation to the final use of energy product. Every time we are assessing the effectiveness of a specific bio-energy value chain, a relevant reduction in GHG emissions should mark the use of that new bio-energy with respect to the actual replaced fossil fuel. At the same time, the energy balance related to the whole biomass value chain should be largely positive in order to secure its energetic profitability and sustainable bioeconomic development .(2-7)

Biomass to energy conversion processes

With respect to the biomass-to-energy conversion processes, three different kind of technologies were chosen: anaerobic digestion, pyrolysis and photobioreactor for algae cultivation, respectively. In our opinion these kind of technologies are very promising in our region and, in a more general consideration, with respect to tropical semi arid areas . They can be considered complementary, because they are supplied by feedstock of different kind and quality (fresh highly-digestible or dried lingo-cellulosic biomass) and origin (dedicated cultivation, crop residues agro-wastes) but, at the same time, they can be thought to be connected one another to create an integrated platform according to the biorefinery concept. More details on this topic are under development gpecufrn Project (25-26) and on figure 1, 2 and 3 . The three chosen technologies are not in the same status of technological maturity. While anaerobic digestion plants are now well known (13-20 and 2-7)

Developing process and equipment for sustainable agroenergy project.

Our project AgroEnergy aims at design to the setting up of a biomass Facility Centre consisting of a technological platform made up of small scale pilot plant.Our group is developing a sound technological basis, with particularly reference to biogas generation A pilot, small-scale, low cost biogas plant (anaerobic reactor) in order to be able to carry out trials using different feedstocks from dedicated crops as well as from agricultural by-products or residues, and agro-food wastes, generally with a relatively high water content (>30%). The agronomic properties of the solid and liquid material remaining after the anaerobic digestion ("digestate", liquor or sludge) is being studied in terms of organic and mineral return to the soil.

• A pilot, small-scale, low cost pyrolysis plant, that is the basis of several methods that are being developed for producing fuel from biomass, which may include either dedicated crops or agricultural residues, both of prevalent ligno-cellulosic composition. The "biochar" obtained as a residue from biomass both of prevalent ligno -cellulosic composition.

• Pre-treatment procedures on several kinds of feedstock , using akali ,organo solve , steam ,quite reluctant to microbial degradation should be selected , experimented coupled with anaerobic digestion and biogas generation, to promote biomass utilisation and improve the system efficiency. and also integrated micro algae production

• Characterization of wastes from urban , rural places and by-products obtained from the energy plants, identifying their possible use and value, preferably in crop fertilization or soil amendment.

• Development of reactor Assessment of microalgae cultivation, in order to evaluate the potential of obtaining not only biofuels (ethanol, biodiesel, biogas) but also other kind of bio-material (fine-chemicals, pharmaceuticals, etc.).

Small scale "pilot plants" of biomass processing based on european model of the context of Star AgroEnergy Project(Ref web link 10)

- An Anaerobic Digester Plant -

The plant will be able to treat contextually mixtures from different matrices. The total solid content of the material to be treated can be higher than 20%. In particular the plant project will be able to treat, diversos feedstocks : slurry from animal wastes organic fraction of municipal solid waste, industrial wastes and sewage sludge as well as dedicated biomass. The plant will be furnished at least with the following items: shredder, electronic balance equipped with an alphanumeric display, loading hopper, feeding pump for the automatic reactor loading, control system with load cells, pump for the automatic unloading of the reactor, unloading tank, bioreactor of methane production line foto fermentor , air compressor, control board.(2-7)

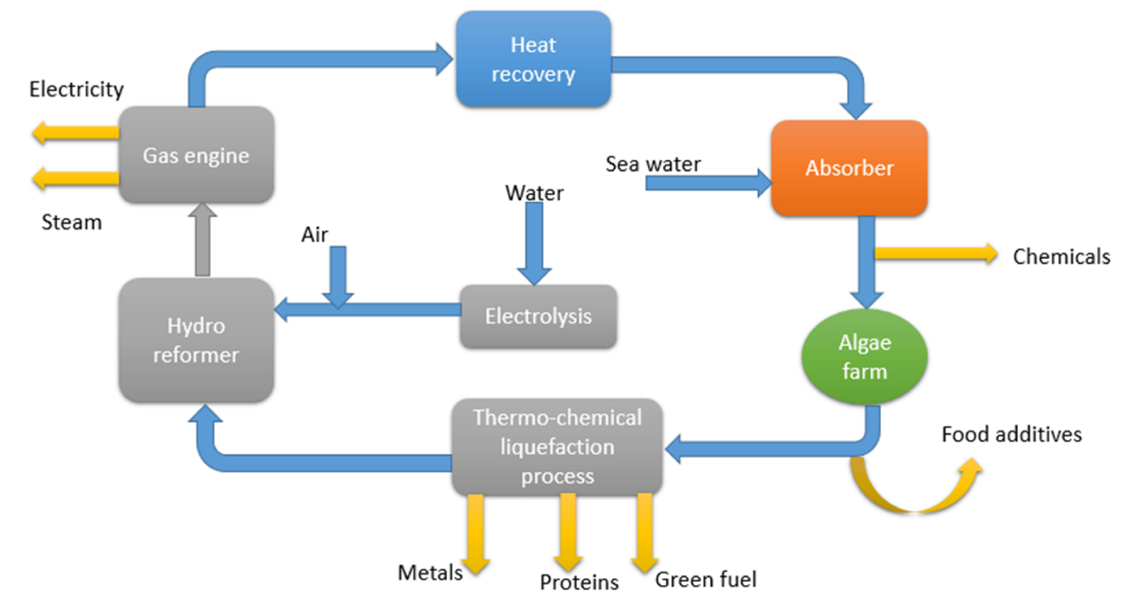
Power to biogas upgrading into biomethane using IC engine exhaust heat recovery

Practical bioreactors for anaerobic biodigestion :Continuous or in batches, and the digestion is allowed to continue in the reactor called biodigester few weeks. A well-run digester as shown in Figure 1 using plug flow on connectional in bioreactor design will produce 200-400 m3 of biogas with a methane content of 50% to 75% for each dry tone of input. The biogas-production will normally be in the range of 0.3 - 0.45 m3 of biogas (60%methane) per kg of solid (total solid, TS) for a well functioning process with a typical retention time of 20-30 days at 32°C. The lower heating value of this gas is about 6.6 kWh/m3. Often is given the production per kg of volatile solid (VS), which for manure without straw is about 80% of total .solids (TS). Biogas applications from animal wastes manure processing system are constrained by limited energy needs, storage complications, difficulties in exporting the energy, high capital requirements, and complexities in operation and maintenance. (Nijaguna., .2002;Hall, 1992) Despite the many constraints on economic application of biogas, many factors favor continued development and expansion of this technology in Brazil related to the several tropical fruit production chain. These include: ☐ Reduction of odors; ☐☐ Improvement of fertilizer quality; ☐ Improvement of financial returns as the cost rises for the electricity and fuel that biogas use can offset. (2-7)

A Pyrolysis Plant -

The plant will be able to use ligno-cellulosic biomasses such as pellet, chopped material or wood chips; the material to be used must be made of elements having homogenous size and volume, not lower than 1 cm3. The minimum biomass flow rate must be 10 kg/h, the moisture content of the feedstock supplied to the pyrolysis pilot plant must not exceed 20% and the ashes content 15%. The project is based Petrobras technology Energy ,Brasil and gasifier project GEK ,USA.The plant was made for an outdoor use and it will be equipped with at least the following items: Loading System, Pyrolysis Reactor, Syngas Combustion Boiler,Internal combustion Engine, Unloading System, Heat Recovery System, Emergency Heat Sink, Control Board.(2-7 e 27 -28)

Figure 2: Computer Aided Hybrid Bio Hydrogen and Biogas Study For Fuel cell and IC Engine: Closed loop circular bio economy (Adopted from original Dr. Rajesh .S.K, NTNU,Norway)



Evaluation of integrated biosystem is very essential for demonstration of renewable power from pyrogas ,syngas and biogas . The renewable sustainable production is under preliminary project development stage further detailed project engineering and viability economical viabilty study are needed.The biotechnologies studied have potential for practical application.Decentralized clean power and gases from agro wastes on this project work can be applied to rural energy sector in Brazil,Africa and India as agro bio wastes are more abundant in these countries.Several computational models with appropriate implementing environments and several software tool was used .Several computational models with appropriate implementing environments and several software tool was used successfully for the integrated system design, process analysis and optimization of the complex system component design. But the system elements had been successfully integrated to make possible the dynamic study of the flow of the material, energy and cost to produce energy from wastes in an economic way using the closed loop clean technology of waste to power and also power to gas based on industrial ecology principle.(25-26)

The design involves operation of semi continuous small power plant stand alone or integrated combined heat, power and fuel gas productions .Our integrated biodrying torrefaction , autothermal gasifier , biodigestor ,bio scrubbers shaas shown to be promising technology of SBS technologies that significantly can improve the economics of gasification of biomass waste feedstocks streams into valuable of many energy products.(1-5) as given in the following figure 1 and 2 using expensive fuel cell , low investment internal gas engine power generation demand in rural area frm 20 to 250 KW

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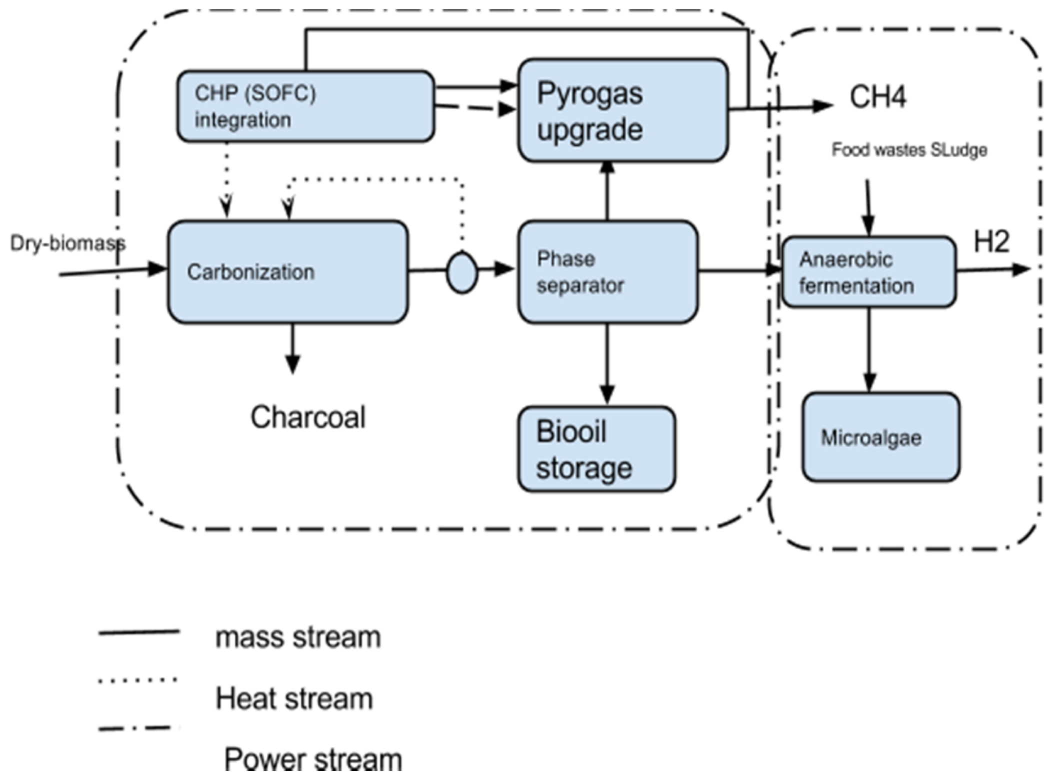

Figure.3 : Power to gas from waste to power and power to gas closed loop clean technology of biomethane from wastes (Adopted from origional work Rajesh .S.K,NTNU,Norway)

New, renewable power from waste and waste heat to gas production project concepts enable stable renewable power supply and as methane gas can store the excess energy of wind, solar, hydro for long-distance transport , thus more flexible circular economy as illustrared from the figure2 and figure 4

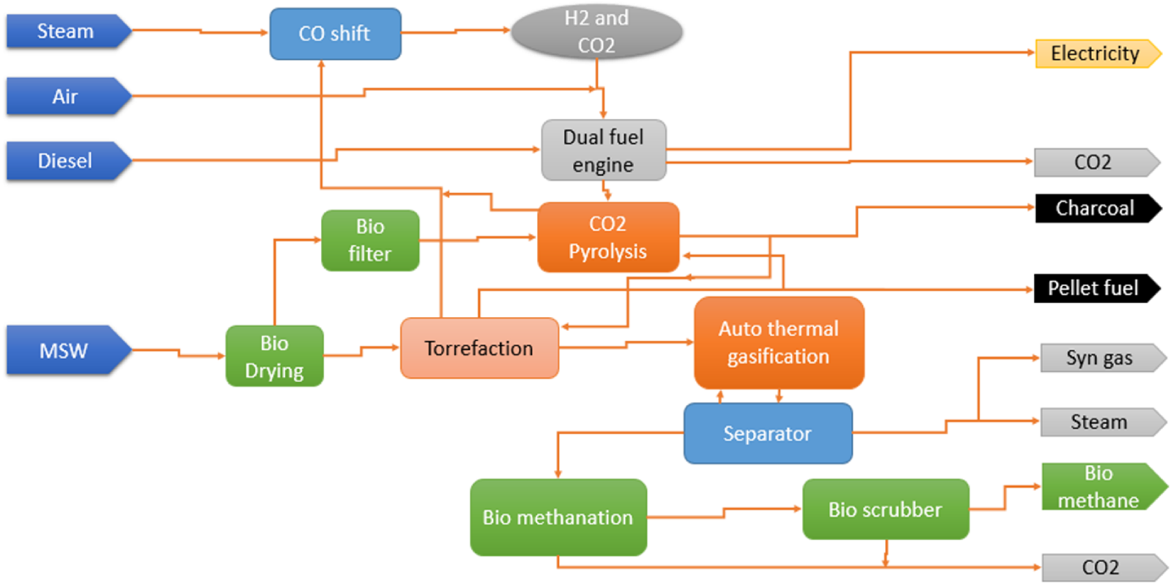

Figure.4: Integrated bio refinery system for food, feed and Bio energy under developments.

Conclusion

However integrated bio refinery system of agro bio elecricity production are too complex to be used in rual India and Brazil , as it require more skilled people to run the process thus not appropriate for developing country .. The process model and system tools based on europe model has made possible not only to calculate performance values related to bio economy for a particular configuration process or product the fuel, but also foresee sensitivity analyses to suggest possible future direction. New synergetic concepts of integrated closed loop innovative bio thermal process system have been developed in this work for the integration of renewable power methane plants in biogas plants as wel as bio electrcity power . Pyrolysis system integrated with fuel cell need more investment compared to internal exhuast engine heat recoved systems Also from waste c02 , microalgae production and biogas production process are under development for decentralize rural bioelectrcity , biogas , feed for animal from micro algae may be soon made possible to improve the bio economy local aquatic plants to reduce significantly carbon using the tropical solar energy available in tropical country.

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