Optimization of Integrated Clean Production of Pyrogas, Biogas, Methanol, Bioelectricity, Fertilizer and Feed from Agro Wastes with Reduced Emission

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Abstract

Brazil is the leader known for its ethanol biofuel development, but also for biomass charcoal, yet lacks in clean rural biofuel and bioenergy production. This paper deals with the system design based on zero emission for sustainable projects developments based on the the alternative bioenergy production from biomass wastes using innovative process equipments design and the process optimization. The main objective is towards development of sustainable small scale not only clean energy production as well as with co-production of hot and cold thermal energies from bio wastes. Agro industrial wastes pose a major concern today due to the increase of production with time and thus needs ecological solution. For this problem, an integrated industrial ecological system using the clean Small Bioenergy-Systems (SBS) based on the Zero waste concept was studied by 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. The SBS approach has many benefits and potentials. The system design is meant for small-scale energy production using hybrid bio-fuel and internal combustion (IC) engine from wastes: It was developed using process analysis (synthesis, modeling, and design) of two stage anaerobic bio process and its integration. SuperPro Designer Process simulation software was used to make synthesis and evaluate these options and performs mass material balance.

Case study was made with the anaerobic process in several stages and recycle of reactor output are found to be very use full and increases the biomass load and also the productivity when used with staged baffled and up flow reactor to produce biofertilizer, bio-hydrogen, bio-methane ,charcoal, ethanol and bio electrical energy with recycle of water ,CO_2 and microbial biomass, which are integrated to internal Combustion engine for combined heat and power (CHP). Existing biogas technologies has potential for practical application combined with hydro pyrolysis to make methanol via low temperature methanol production, but if biohydrogen systems are to become competitive, they need more detailed integrated two stage biohydrogen and methane bio reactor to enhance the efficacy of biofuel utilization for energy needs. The results obtained from several preliminary project developments of clean SBS are reported for integrated system developments for fuel and food using process and cost simulation models. These models render the process development and optimization problem with ecological economic potential objectives to be resolved very rapidly and make it possible make successful project design with the reduction of CO_2 emission , water consumption and solid residues, sustainable bioelectric CHP with value added co-products.

Keywords: *Clean technology, Carbon Reduction, Biomass, Syngas, Biogas, Biohydrogen, Biomethanol.*

1 Introduction

The two major challenges in global energy systems are to reduce energy related greenhouse gas emissions and to maintain energy supply security. This thesis presents one solution to both problems. It proposes strategies for the transformation of current energy systems into 100% renewable, stable and almost emission free energy systems without making use of nuclear energy or carbon capture and storage. Within renewable energy systems, one is facing two difficulties: On the one hand, the fluctuating renewable sources need to be matched with the energy demand, on the other hand, a substitution for high energy density fuels in heat, cold and transport has to be found.

Therefore, this work examines bioenergy and the newly developed 'renewable power biohydrogen .methane and methanol' 'renewable Bioelectric CHP and methanol ' concerning their potential to solve these problems using clean technology developing concepts using modern computer systems and process .First, bioenergy is analyzed in the broader context of climate change, energy systems and land use in order to estimate the sustainable potential of global bioenergy and Brazilian bioethanol concepts. Second, to solve this bioenergy bottleneck, a new approach of converting renewable power into biohydrogen and methanol via hydrogen and CO_2 synthesis is developed. It can be produced basically anywhere where water, air and renewable bomass waste are available and thus decrease import dependence on fossil fuels. It can recycle water,CO_2 in the SBS system proposed in this work. Third, the necessary transformation of energy systems from waste is performed. The key elements are direct renewable power generation, renewable electro-mobility, renewable power methanol and overcoming traditional biomass technology.

Main research questions on clean SBS and climate change

One cannot neglect the fact that fossil fuels are depleting and the major cause of anthropogenic global warming. At the same time, nuclear fuels are depleting as well and contain risks and unsolved problems like waste disposal, making their use unfavorable.

Further, doubling nuclear power use reduces global greenhouse gas (GHG) emissions only by 4%. Carbon capture and storage (CCS) technology reduces GHG emissions only to a certain extent, it does not reduce fossil fuel dependency, and long term CO_2 storage facilities are not yet tested. Energy efficiency and energy savings can reduce energy demand and energy related GHG emissions drastically, but in the long run, energy systems will have to be based on renewable. Therefore, future energy systems will be dominated by renewable energy sources.

The fundamental difference between today's and future energy systems is that the expected main energy sources, namely wind and solar energy, are of a fluctuating, unsteady nature. So far, fossil and nuclear energy supply has been able to meet the flexible energy demand, while fuels basically are stored energy, available for flexible use. Therefore, one main research question is how to match future energy supply with energy demand at high shares of fluctuating energy sources, i.e. how to balance and integrate wind and solar energy. Especially the transport sector is challenged and shaped by a high dependency on fossil fuels and high density energy carriers. The heat sector can use solar and geothermal energy for residential heating and warm water supply, but in some cases the base load is missing and especially process heat is still highly dependent on natural gas. Thus, another main research question is how to replace fossil fuels in heat and transport. In the power sector, many options are discussed to integrate fluctuating renewable energy sources, for example virtual power plants on the supply side, demand side management on the energy customer side and different transmission and storage options in between. No silver bullet has been found yet and all options face difficulties: Increasing power transmission capacities encounters resistance from local residents, pumped hydro storage or compressed air storage sites are not sufficient or too far away from main power generation sites. This list can be continued. Bioenergy is an attractive solution to the renewable energy integration challenge. It is renewable, but is has fossil fuel properties like high energy densities and is basically stored chemical energy. It is therefore suitable to substitute fossil fuels in transport, heat and power sectors and particularly interesting for balancing power.

In contrast, bioenergy has experienced a vigorous international discussion on its effect on climate change and sustainability. Bioenergy use has a vivid history. Since the beginning of humankind, it was the energy source number one: easy to access, easy to use, geographically well distributed. Until the first industrial revolution some 200 years ago, it was the main energy carrier and accounted for 99% of primary energy demand. During industrialization, biomass has been gradually substituted first by coal.

The conversion of biomass into valuable products such as fuel methane gas , ethanol ,methanol and protein feed have been considered to be important by research centre, the central and state government, industries and financial agents (1-6). Brazil has nearly 126.806.000 tones of total biomass wastes produced per year as it is one of the major producer of agricultural crop such as cashew, coconut,cassava, soybean , coffee and sugar cane. The use of this lignocellulosic biomass has the potential to solve the present economic crisis such as third world debt, air pollution due to burning, trash disposal, deforestation, animal feed shortage and migration from rural area (1-10).

However, the economic utilization of the biomass waste are handicapped by the technical problems due to the pre-treatments and slow bioconversion process (1-4) involved in biofuel production as well as environmental problem. Economic and ecological utilization of the biomass wastes from tropical fruits such as coconut, banana, cashew nut and cashew fruit processing is still problems as their energy valorization involve very complex system design and operation [1-3]. Brazil is the leader known for its ethanol biofuel development, and also for the biomass charcoal, but yet lacks much regarding the rural energy production. There is a need to decrease the pollutants emitted by these wastes as very huge quantities, nearly 70% (seventh percent) of total generated, are considered to be wasted in Brazil and this makes necessary to consider different alternative process, renewable energy source and co-product design from these biomass residual. This needs focus on system study of the clean biomass technology, cogeneration of energy and also the sustainable development approach for the small scale energy production from wastes (1-10). The main objective of the present work also is related to the current research study made on the system design, analysis and optimization tools and methods which made possible to the best value of the input variables and/or model parameters of the complex integrated biomass projects for the total integral utilization agro wastes .The system design for small scale energy production from wastes integrated with small enterprise related to agro wastes involve dynamic system models. This system need to attain economic and ecological viability leading to the sustainable development of rural villages with green SBS. The novel flow sheet development for maximum output energy and minimum wastes is also our main objective of the present work.

2. Objectives

The four main objectives of this study were (i) to identify the strategic role of selected biofuel and bioenergy in future sustainable energy systems for Braziil and its potential in climate mitigation; and (ii) to develop new concepts for storing and integrating renewable power generation via biohydrogen and methanol (iii)to design integrated systems and stable 100% renewable energy systems with emission free energy sources, and (iv), to make possible CO_2 emission reduction and analyze the importance and develop possible tools to design clean bioenergy system relevant to Brazilian biomass feed stocks.

2.1 Selected Paths and Methods for generating energy from biomass wastes

In recent years, there has been seen considerable efforts devoted to the search for the best ways to use the potentially valuable of biomass wastes sources for energy production by four different main methods, it is possible to order them by the complexity of the processes involved[1-15] that is direct combustion of biomass; thermo chemical processing to fuel; biological conversion and combined anaerobic digestion with pyrolysis. The main products of some of these processes is power and heat which is presently studied in application of small scale fruit processing and milk dairy industry to generate heat via metane production besides the need of the generation of "cold" effect, is also necessary, the production of hot water (around 50 ºC to 60 ºC) for cleaning of the facilities and processing equipments (1) as well as the refrigeration.(24-30)

2.2 Pyrolysis: The thermo conversion for biofuel (syngas) and energy production.

Pyrolysis is the simplest and almost certainly the oldest method of processing one fuel in order to produce a better one. Conventional pyrolysis involves heating the original material (which is often pulverized or shredded then fed into a reactor vessel) in the near-absence of air, typically at 300 - 500 °C, until the volatile matter has been driven off. The residue is then the char - more commonly known as charcoal - a fuel which has about twice the energy density of the original and burns at a much higher temperatures made in almost all rural areas to make charcoal. Fast pyrolysis of plant material, such as wood, bagasse or nutshells, at temperatures of 800-900 ^{o}C are intensively studied under pilot plant scale. The slow pyrolysis data has been compared to with the yields as shown in Table 1.

Table 1: Slow Pyrolysis reactor data designed to maximize the energy recovery compared to conventional charcoal making system.

Pyrolysis Reactor	**Conventional**	**Present**
Charcoal yield,%	30	25
Bio oil yield,%	0	35
Wood gas yield	70	40

Sugar Cane Bagasse and Napier Elephant grass was studied in Brazil for the pyrolysis, had as little as 10% of the material as solid char and converts some 60% into a gas rich in hydrogen and carbon monoxide. This makes the fast hydro pyrolysis a competitor with conventional gasification methods but like the latter, it has yet to be developed as a treatment for biomass on a commercial scale. For this same we have joint research effort.

Hydro pyrolysis and The slow pyrolysis: We are able to make better reactor for small scale charcoal production with characteristic properties listed in Table 1 using conventional slow pyrolysis using ceramic kiln. Small scale wood gasification project using simple brick wall construction was successfully demonstrated in several remote rural areas, developed mainly in the decade of 80, now not employed much as it is not competitive with the power generated with IC diesel engines. Recently we are designing hydro-pyrolysis jointly with NTNU ,Norway. Thus a better quality hydrogen rich syngas can be made possible using this process.(

2.3 Anaerobic biodigestion: The bioconversion method for Bio fuel production

The gas (Marsh Gas) obtained from the natural waste decomposition process, is a mixture of Methane (CH_4) and Carbon dioxide (CO_2). This gas is commonly called as the 'Biogas'. Anaerobic digestion, like pyrolysis, occurs in the absence of air; but in this case the decomposition is caused by bacterial action. This is a valuable fuel which is in many countries produced in purpose built digesters filled with the feedstock like dung and effluents from the dairy. The input is in batches, and digestion is allowed to continue for a period of ten days to a few weeks. A well-run digester using plug flow bioreactor design operating at the farm in Brazil produce 200-400 m^3 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 m^3 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/m^3. Often the production is given per kg of volatile solid (VS), which for manure without straw is about 80% of total solids (TS). Biogas applications from animal wastes or a large centralized 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. Many such systems use engine waste heat in Europe, but mostly it is used for anaerobic digester heating. Biogas-fueled engine-driven chillers are probably not suitable for most operations that are needed for fruit processing that would like cooler temperatures than 42ºF to 44ºF for raw material and product storage, as the cooler temperatures are obtained by direct electric unit. In this work we study the slow and hydro pyrolysis for clean SBS.

2.4 Integrated Biosystem design for cleaner bio energy production.

Approach: Composting for bioferilizer and anaerobic digestion for biogas or both

Aiming at sustainable development, the organic waste as a source of nutrients and energy has to be reused. Nowadays, composting and anaerobic digestion (AD) are seen as the most favored options to deal with organic solid waste (10,23). Both treatment options reduce the environmental burden and enable the generation of a nutrient rich fertilizer. Furthermore, in the case of AD, energy in form of biogas is produced. Now a days, energy is scarce and their production out of biodegradable waste is willingly seen. Thus, AD is attaining more relevance in solid waste management (SWM) sector. In the past, this approach was rarely considered as a feasible and sustainable solution for the (SWM) in developing countries. But

Information about the state-of-the-art of these digesters as well as the study on the system for the minimization of the water use is scarce. (1-14)

Bioenergy from agro waste: The gas (Marsh Gas) obtained from the natural waste decomposition process is a mixture of Methane (CH_4) and Carbon dioxide (CO_2) and is commonly called as the 'Biogas'. Anaerobic digestion, like pyrolysis, occurs in the absence of air; but in this case the decomposition is caused by bacterial action. This is a valuable fuel which is in many countries produced in purpose built digesters filled with the feedstock like dung and effluents from the dairy, septic tank sewage sludge. (1-3;10-14, 16)

Brazilian and Indian small system biogas technology: In the recent past the planning, construction, operation or management of low-tech biogas plants has not always been done appropriately, thus many projects failed (6,24). The selection of the following technologies is based on extensive research, means on literature review and e-mail correspondence and has to be seen as scientific founded system analysis. The following technologies are studied for further evaluation and system syntheses based on process engineering principle(27).

Brazilian project for small system for energy generation using biogas: This technology is currently working based on the energy conservation strategy and efficient energy use. In a confinement of 100 cows, a biodigester was designed to produce a volume of 118 m^3 of biogas and a generating group of from 8-15kVA and this to assist with electric energy the demand of the fruit processing installation and water pump. The total demand of the biogas working with this equipment is estimated to be 85.3 m^3 of biogas, which can be supplied with rest by the biodigester. This volume of the biogas is enough one to generate mechanical energy using internal combustion engine adopted with the gasoline Otto engine to run biogas and this to assist with electric energy to the demand of the fruit processing installation and the pump for the chilling. The system design of cogeneration of energy and heat is realized after the flow sheeting of several major components: Animal Production Facilities; Manure/Effluent Handling System; Digester Tank Heating & Mixing System Biogas Cleaning & Handling System; Biogas Storage; Energy using biogas engine;. The heat pump selected for this work is a novel system design based on the innovative and well optimized design. This is made possible recently by the research group in UNICAMP/Brazil which can run using R22 heat transfer refrigerant fluid. The use of ethanol and water mixture as heat transfer agent for heat pump to produce hot water, chilling and ice making together with IC engine has been also well studied by this group. We apply this UNICAMP/Brazil process to our integrated biowaste energy project. (24,26,27)

3 Materials and methods

Process Flow Sheet development: A conceptual design of the bioconversion process was constructed using current laboratory and technical data. (1-3, 26-27,10-15) The flow sheet development was done using Superpro process simulator and other subsystems

Material Balance and Process Yield: The general flexibility of abstract simulation model was used for material, energy balance and production costs calculation of conversion of particular substance and raw material to final product via certain steps (n) and (n-1) intermediate substances. Theoretical conversion factor, the efficient of the conversion, the processing cost of the conversion, the valorization of byproducts and extra cost involved are the parameters used. These process models were initially implemented with electronic spreadsheet and latter on SuperPRO 4.9, Inteligen.Inc,U.S.A. process simulator under window graphical operating system for microcomputer (26).

Costs Estimation: This project model and program had been developed to evaluate rapidly the research and the preliminary biofuel project using limited number of data that was obtained from laboratory research, allowing user to have estimates about the economics of manufacturing in different scale of production. In our earlier work, we described the method of development of this model (1).

4 Results

The Bioconversion system: This system is used for milk and fruit processing industry for the conservation using the heat for pasteurization the cashew apple juice. The main equipments used are anaerobic biodigester, the combustion furnace, the heat recovery system using heat exchangers are used for food conservations.

The thermo conversion system: This case study made involves the hydro and slow pyrolysis system, making the charcoal, the heat is recovered from exit flue gas, where as the second case study involves combined pyroysis to make charcoal as well as gasification to produce syngas. Sngases were used for the internal combustion heat engine for combined power and energy recovery (4-9) for pyrolysis to make charcoal (9-13).

The Cogeneration small energy system: The main assumptions made in the model are related to the inferred value of the solids properties and the use of transfer coefficients for thermal and kinetics constants. The values of these constants assumed are validated by the simulation results comparing it to the real process published results. In the following Figure 1, the complex process scheme of the final case study made based on the design for environment using computer software. In this work, we designed the flow sheet for the processing the waste and also the whole heat recovery system based on the biomass fuel heating in regard to recirculation of the hot water (26-30).

4.1 Optimum Configuration of integrated Bionergy Energy system design

Obviously there are many path ways and combination permutations that are available for the combined use of the thermo conversion using pyrolysis and gasification or the bioconversion route. Before we started the detailed case studies, we made with an energy audit of the animal and agro industrial wastes feed stocks both in the production and processing units regarding energy demand and supply. After the detailed study material balance of all the solid liquid flows using super pro design simulation software tool which has tools to make environmental emission report , then we realized a tally of all of the energy uses supplied using biomass. The entire integrated system requirement of the hydopyrolysis combined heat power (CHP)is first analyzed and the process design was achieved from the result obtained by the process simulations and optimizations and the result of several techno economical parameters (24).

The integrated system design approach used in this made possible using combined integrated bioconvesrion and thermo conversion process determine whether the economics of selling electricity, fuel, the ice, the liquid fertilizer justifies the higher incremental capital cost of the engine-generator, the associated higher maintenance costs, and increased processing costs. The best optimized system has co-products together with the heat recovery using heat pump coupled to the low cost gasoline engine adopted to the biogas. and bio hydrogen Thus this making the system designed sustainable for rural people food processing and animal production chain and environment too. Thus the system is made both economical and environmentally clean using several simulation runs to optimize the system configurations after making the simulation of the process given in the figure below. Our project is an integration of our two stage solid biodigetor technology and slow pyrolysis process .This later one was adopted from the original conceptual design of BEST Energies Inc., which has been recently developed,, modified latter via NREL USA hyro pyrolysis for enhance hydrogen production. This hydropyrolysis technology consumes biomass waste streams while producing hydrogen rich syngas and carbon-rich end products called biochar . The syngas is composed of combustible gases including hydrogen, carbon monoxide, methane, and lower molecular weight hydrocarbons, as well as nitrogen and carbon dioxide. This gas is cleaned by a series of unit operations before being recycled back to the plant or exported. A portion of the gas generated is combusted and used as a heat source on the pyrolysis kiln itself. An additional portion of the gas is combusted and used to dry the incoming feed material for pyrolysis. The excess syngas gas represents the net energy output and can be utilized as a fuel for an engine, an industrial boiler. The biohydrogen obtained is mixed with the hydrogen rich syngas as a feedstock for down stream processes which refine the syngas into a liquid fuel methanol using low temperature .

The design involves operation of semi continuous small power plant stand alone or integrated combined heat, Cold and power applications **.**Our integrated Pyrolysis reactor and biodigestor holds a portfolio of SBS technologies that significantly can improve the economics of pyrolysis and thermo and bio gasification of biomass streams into valuable products.(23-30)

Biohydrogen and Small Bio Refinary proposed flowsheet. The flow sheet was proposed after studying various patents. At the present time, dark fermentation and water-gas-shift are the only methods that have feasible reactor dimensions for practical applications [Ginkel,2001]. Secondly, biohydrogen production by dark fermentation is most interesting option for the conversion of organic wastes because of its analogies to AD (anaerobic digestion). Two stage reactor comprising dark fermentation and water gas shift photo-bioreactors were considered The size of the bioreactor for various process were given below in a Table 2.

Table 2 Comparative cost analysis of energy production

Levelised Cost	**Two stage hydrogen fuel cell (PEM)**	**Biogas fuelled SOFC**	**Biofuelled IC biogas-engine**
Cost for biofuel production US $/kWh	0.087	0.08	0.08
Cost for Gas cleaning US $/kWh	0.0076	0.0076	0.0016
Cost for Fuel cell and its Components :US US$/kWh	0.119	0.129	0.045
Total cost : US$/kWh	0.217	0.22	0.1591

Incase of biohydrogen, biohydrogen produced from the two stage bioreactor , the first hydrogen production and then latter to methane production and then the gas obtained was sent after separating CO_2 The theoretical energetic value of biogas with 60% methane content is 5.56-6.64 kWh/m3; in general the value can be taken 6.5kWh/m3.If this energetic gas is used in CHP-motor, then the conversion process efficiency must be taken into account. The overall process efficiency can be taken as 30% and the energetic value of biogas in terms of electrical energy is 1.95 kWh/m3.The combined electrical power production of 150 kW electricity by three sources biohydrogen, conventional biogas and char coal will have energy generation cost of 0.2 US $/kWh. Thus it is again good proposition to develop district level power production center and along with steam requirement can be managed by heat recovery from the hybrid fuel cell. The heat required for the reforming is 24 kW is recovered form the hot spent gas heat recovery management. The hot gas CO_2 separated from the hybrid fuel cell is circulated indirectly to reduce the char coal to CO for IC engine. The biofuel requirement for the each fuel cell and char required were tabulated below. The biohydrogen flow rate required for the PEM cell estimated to be 0.97 m3/hr with two stage tank size of 200 m^3 and 12 m^3. The new biohydrogen reactor has benefit in terms reduction in residence time and reduced size in tank by half. The char required for the IC engine estimated to be 250 kg/hr (11-16),

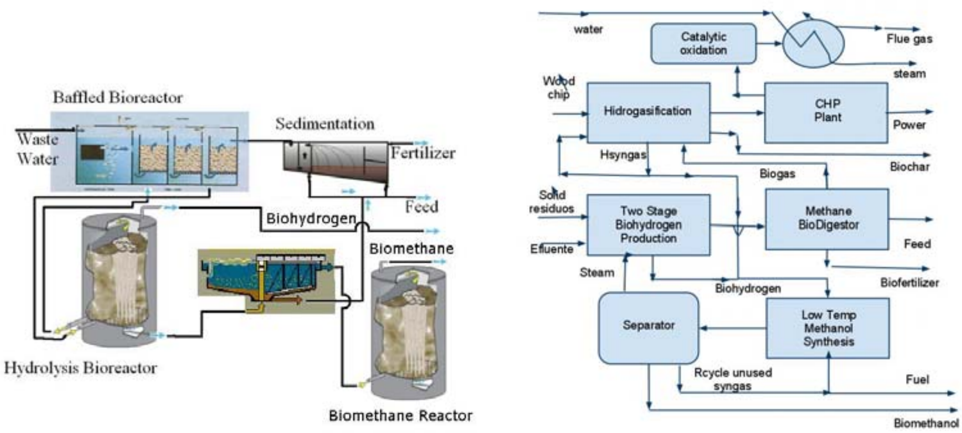

Figure 01: Proposed two stage bioreactor of clean bioenergy production

5 Summary and outlook

New, renewable power Biohydrgen and biomethanol concepts enable stable renewable power supply and the use of wind, solar, hydro for long-distance transport and process heat A key element for the integration of renewable energy into existing supply structures is the ‘renewable power methanol and small CHP concept, which has been developed in this work

Carbon neutral methanol and power can be produced by using renewable power, water and CO_2 from the atmosphere or other CO neutral sources like industry and biomass. The main conversion steps are hydrogen production by bio processes using agrowastes. New synergetic concepts have been developed in this work for the integration of renewable power methane plants in biogas plants, biomass gasification plants, coal power plants and natural gas sites, CO_2 intensive industry, landfills and sewage plants. Using concentrated CO_2 from fossil fuels, biomass, waste or industry processes is more efficient than extracting CO_2 from the atmosphere. Nevertheless, atmospheric CO_2 recovery offers the advantages of standalone concepts, avoiding long distance CO_2 transportation (1-3).

Renewable power methanol and energy network integration are key elements of 100% renewable energy supply structures' Energy network integration is another key element of sustainable energy structures.

Bioenergy can accelerate or slow down climate change. On one side, exploring the full sustainable bioenergy potential in combination with low emission bioenergy pathways, The most suitable parameter for evaluating GHG reduction potentials of bioenergy is the new developed absolute parameter linking GHG reduction to the chemical energy content of raw biomass. Parameters do not reflect the amount of biomass or area used for generating one energy unit to substitute one fossil energy unit. Area# specific GHG reduction indicators have the drawback that hectare yields and heating values of energy crops differ widely, and these indicators can hardly cover the other main biomass source: residues and waste (24-25).

Bioenergy and renewable power and methanol are important elements of future sustainable energy supply. Eventually, the most important strategic function of biomass in the future is the supply of carbon for industry purposes like chemical products (biomaterials) at the time fossil fuels are gone. Energy supply is not bound to carbon and can be derived by other means, especially by renewable power as direct power and as natural gas substitute in form of renewable power methane. This work contributed to the further understanding of possible future sustainable energy systems and solutions for the integration of (fluctuating) renewable energy and sustainable bioenergy.(26-30;11-12)

Simulation, integration and demonstration of renewable power methane, biohydrgen and biomethanol concepts .The renewable power methanol (RPM) concepts developed in this work require further research. In the synthesis of methanol using CO_2 and hydrogen; optimum catalyst and process parameters (pressures, temperatures, operation times) are to be identified. The potential of renewable fuel for transportation from surplus power is to be explored. Further development of system modeling and stimulation of system transformation Climate change mitigation imposes an ample industrial transformation into a pos fossil economy. Biohydrogen technologies are still in their infancy. Existing technologies are potential for practical application, but if biohydrogen systems are to become commercially competitive they must be able to synthesize H_2 at rates that are sufficient to power fuel cells of sufficient size to do practical work. Further research and development aimed at increasing rates of synthesis and final yields of H_2 as co products are essential to make biohydrogen and biogas more competitive with IC engines opertaed with biogas fuel system (11-12).

Computer aided design for biofuelled fuel cells with exiting biogas engines were compared. The Levelised energy cost to produce 1 kWh Biogas fuelled engine was compared. The integration of combined heat and power with hybrid engine reduces the cost of electricity production as well as reduction in the emission. The several process and cost parameters about the viability of this biosystem to make biohydogen and biogas were obtained and this system has shown to me more promising to rural sustainable energy production and local rural developments (20-30).

System design work for decentralized clean bio energy production for agro industrial system is under study to be implemented in Brazil. Several computational models with appropriate implementing environments and several software tool for the system design, analysis and optimization of the complex system design. But the system elements had been successfully integrated to make possible the dynamic study of the flux of the material, energy and cost to make energy from wastes in an economic way.

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