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# BIOENERGY INDIA

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**In Focus**

- Future Potential of Biomass Energy in India
- On the Waste Route

# Press Release

**New Delhi, March 7, 2011**

## Grant of €200.5 million (approximately ₹ 1,200 crores) Line of Credit by KfW Development Bank, Germany for Promotion of Renewable Energy Projects in India

Indian Renewable Energy Development Agency Limited (IREDA), Government of India enterprise, New Delhi and KfW Development Bank, Germany have signed an Agreement for €200.50 million (approximately ₹1,200 crores) at New Delhi on 7th March, 2011. This agreement was signed by Mr Debashish Majumdar, Chairman & Managing Director, IREDA and Mr Uwe Ohls, Senior Vice President, KfW in the presence of Mr Christian Schlaga, Chargé d'Affaires a.i. of the Federal Republic of Germany, and Mr Prabodh Saxena, Joint Secretary, Department of Economic Affairs of Ministry of Finance, India.

The agreement consists of a credit line of €200 million and a Technical Assistance grant component of €0.5 million as accompanying measures. This is the fourth line of credit being sanctioned by KfW to IREDA. This involves a total loan period of 12 years including 4 years of moratorium.

This Line of Credit aims at promoting innovative renewable energy business models, involving new technologies/financing mechanisms/institutional arrangements across a variety of renewable energy sources – solar (both PV and thermal), wind, biomass and cogeneration, and small hydro.

BIOENERGY INDIA

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# FROM THE EDITOR

Dear Readers,

As we come to an end of another financial year, with hopes to bring new opportunities in sustainable development in bio-energy, we present 7th issue of Bioenergy India magazine with a wide range of articles focusing on the latest and the newest trends in the field of biomass.

This issue brings to you the case study of biomass energy's future potential in India, wherein we explore the possibilities and the challenges that we face today. We have highlighted the current status of bioenergy use and future potential of growth including the incentive structure and technologies available in the country. With regard to sustainability of bioenergy projects in developing countries, an analysis of the currently available methodologies for assessing the varied impacts, both positive and negative, of bioenergy production has been included in this issue.

*'On the Waste Route'* is an exclusive article focussing on Brazil's garbage disposal system and how it can prove to be of advantage in managing the garbage scientifically and generation of energy.

We continue to explore the international scenario by comparing India's Bioenergy Policy with another developing country. This time we chose to compare the South African Bioenergy Policy and analyze it from the Indian perspective, to compare the pros and cons and to understand the differences in order to keep abreast with the latest in the sector.

Biomass can play an important role in providing sustainable energy solutions in rural areas. Various technological routes and the possibility of employing steam- turbine route to set up relatively small grid connected plants at the tail end of the grid has been examined in an article presented in this issue, with particular reference to the state of Maharashtra. We also present a CDM analysis of biomass projects registered in 2010-11.

Making this magazine an effective platform for interaction would be an ideal way to further our discussion on this alternative sustainable energy source. Therefore, sharing our common concerns and updating with the latest in the field of bio energy would be our continuous endeavour. Therefore we urge you to participate in this interaction and provide us with glimpses of what more would you want to hear about. So do write to us and send in your emails, as we welcome your news, views and comments on Bioenergy India magazine.

**(K.P. Sukumaran)**

BIOENERGY India is a quarterly magazine covering technological, operational, financial and regulatory aspects of various biomass conversion technologies such as combustion, cogeneration, gasification and biomethanation. Biomass specific project perspectives, technology innovations, industry/market outlook, financial schemes, policy features, best practices and successful case studies etc are also included in the publication.

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## From our Readers

I would like to compliment the Editorial Team on this excellent initiative and the relevant and useful areas covered in the publication in a very pleasant manner. It is suggested to include articles on catalyst for conversion of biomass to liquid biofuels, bioenergy, and other green initiatives.

*A R Upadhya, Director*
*National Aerospace Laboratories*
*Bangalore*

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# In Focus

# Future Potential of Biomass Energy in India

Energy sector is the key to India's future growth. Energy from non-conventional resources like biomass would be crucial in meeting the growth targets in the power sector and overall economy. Through this article we highlight the current status of biomass energy use and future potential of growth including the incentive structure and technologies available in the country.

Biomass is a vital source of energy for household and industrial energy requirements in India. It is the most commonly used domestic fuel apart from being the energy source for several small-scale industries and fuel for independent power plants.

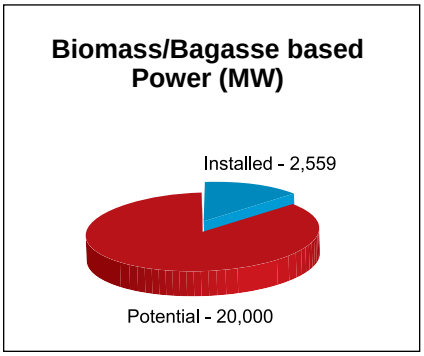
On a global scale, biomass supplies more than 1% of the electricity demand, i.e. some 257 TWh per year (IEA, 2009). Based on up-to-date combustion technologies, biomass and waste also supply approximately 4.5 EJ (105 Mtoe) of direct heat to the industrial and residential sectors, and 2 to 3 EJ (47 to 70 Mtoe) of heat from combined heat and power (CHP) plants (IEA, 2008). These estimates do not include traditional biomass combustion mostly used in developing countries.

The current availability of biomass in India is estimated at about 500 million metric tones per year. MNRE has estimated biomass availability at about 120 – 150 million metric tons per annum covering agricultural and forestry residues corresponding to a potential of about 18,000 MW. In addition to this, about 5,000 MW additional power could be generated through bagasse based cogeneration in the country's 550 sugar mills[1].

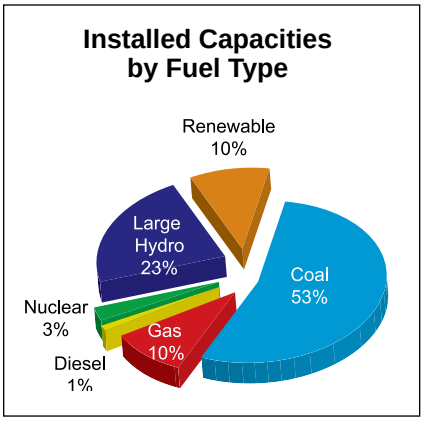
## Current Status

In the last six decades, India's energy use has increased 16 times and the installed electricity capacity by 84 times. In 2008, India's energy use was the fifth highest in the world. Still, India as a country suffers from significant electricity deficit and faces 15% shortfall during peak hours.

As of December 2010, the total installed capacity of biomass based power in India was 2,559 MW (MNRE, December




*Source: MNRE, December 31, 2010*




*Source: CEA, July 2010*

31, 2010). As per an estimate, in 2009 the total financial investment in clean energy in India was at ₹135 billion[2]. Apart from this, Indian Renewable Energy Development Agency (IREDA) and other public sector agencies are also actively funding renewable energy projects.

## Future Potential

India is poised to become world leader in power generation for biomass in the near future. India has a potential to generate an additional 20 GW of electricity from biomass residues. In order to realize the potential effectively, various fiscal incentives are being provided by the Government. Below is the description of key incentives like capital subsidy, renewable energy certificates and Clean Development Mechanism (CDM) which can be utilized effectively to make the project economically attractive.

The government provides a one time capital subsidy based on the installed capacity of the project. The entire capital subsidy amount is released directly to the lead bank / lending financial institution for the purpose of offsetting the loan amount after successful commissioning of project. In case the project is set up by the promoters through their own resources, the CFA would be released directly to promoters after successful commissioning of the project.

## Other Incentives

### Renewable energy certificates or preferential tariffs

State Electricity Regulatory Commissions have determined preferential tariffs and Renewable Purchase Standards (RPS) at the state levels. Various states have undertaken the Renewable Purchase Obligations in the range of 0.8% – 13% of the total electricity supplied in the State. State regulatory commissions have also announced the preferential tariffs for purchasing power from biomass/ cogen sources.

The power producers are also eligible to get Renewable Energy Certificates (RECs) in case they choose to opt for the base tariff announced by states. RECs can be traded and can generate revenues anywhere in between 1.5-4.5 ₹/kWh depending on the market conditions.

### Clean Development Mechanism

CDM offers additional revenues in terms of CER (Certified Emission Reductions) revenues to mitigate the technological risk and enhance the financial viability of the project. 167 biomass based projects are registered from India under CDM as on 31st December 2010. Various projects eligible for carbon credits include biomass power generation, heat generation; biomass/bagasse based cogeneration, efficient cookstoves in households and replacement of non-renewable biomass by renewable biomass.

CDM process is complex, but has achieved success in the past by improving the financial viability of the

**Fiscal incentives for Biomass Power Generation**

| Item | Description |
|---|---|
| Accelerated Depreciation | 80% depreciation in the first year can be claimed for the following equipment required for co-generation systems:<br>1. Back pressure, pass-out, controlled extraction, extraction-cum-condensing turbine for co-generation with pressure boilers<br>2. Vapour absorption refrigeration systems<br>3. Organic rankine cycle power systems<br>4. Low inlet pressures small steam turbines |
| Income Tax Holiday | Ten years tax holiday |
| Customs Duty | Concessional customs and excise duty exemption for machinery and components for initial setting up of projects |

**Central Financial Assistance for Biomass Power Projects & Cogeneration**

| | Special category states (NE region, Sikkim, J&K, HP & Uttarakhand) | Other states |
|---|---|---|
| **Project type** | **Capital subsidy** | **Capital subsidy** |
| Biomass power projects | ₹25 lakh X (C MW)^0.646 | ₹20 lakh X (C MW)^0.646 |
| Bagasse cogeneration by private sugar mills | ₹18 lakh X (C MW)^0.646 | ₹15 lakh X (C MW)^0.646 |
| Cogeneration by cooperative/public sector sugar mills<br>40 bar & above<br>60 bar & above<br>80 bar & above | <br><br>₹40 lakh * per MW of surplus power<br>₹50 lakh * per MW of surplus power<br>₹60 lakh * per MW of surplus power<br>(maximum ₹8.0 crore per project) | |

projects. At the moment, markets for CERs post 2012 are uncertain and it is crucial to get the projects registered with UNFCCC by 31st December 2012, in order to be eligible to participate in the EU emission trading scheme.

Newer mechanisms under the CDM, like Program of Activity (PoA) have also achieved success and a PoA for biomass based projects from India has already been registered under CDM, "Promotion of Biomass Based Heat Generation Systems in India".

## Biomass energy technologies and applications

Power generation and CHP based on biomass, as well as biomass co-firing in coal-fired power plants is rapidly growing in India and state-of-the-art plants are characterized by high-performance steam parameters and efficiency. The capacity of biomass power and CHP plants varies considerably.

- Biomass-fired power plants and CHP plants have capacities ranging from a few MWe up to 35 MWe. Small and medium-size CHP plants are usually sourced with locally available biomass.
- Large CHP plants and coal/biomass co-firing power plants require biomass sourcing from a wide region and/or imported wood or forestry residues. Biomass CHP plants are mature technologies while biomass integrated gasification combined cycles (BIGCC), which offer higher technical and economic performance, are currently in the process of entering the market, following the industrial demonstration phase.
- Biogas anaerobic digestors are usually associated to gas-fired engines for heat and power generation with electrical capacity from tens of kWe up to a few MWe.

*Biomass based boiler with feeding system*

*Gas storage system for biogas projects*

*For more information on PoAs, please refer to the latest PoA Guidebook prepared by South Pole Carbon: https://www.southpolecarbon.com/_downloads/PoA_Guidebook_SouthPole.pdf*

## Combustion

Combustion is the most commonly used technology for generation of power/heat using biomass. It is fairly well established and uses conventional boilers and turbines with slight modifications depending on the feedstock.

***Salient features of direct biomass combustion***

- Generation of electricity through heat and steam
- Relatively established and proven technologies
- Economically viable for sizes between 5 MWe to 35 MWe

*Transportation of sugarcane to sugar mills*

Biomass based energy generation has significant potential to contribute to India's growing energy needs. Technology has also significantly advanced and is being made available locally along with a host of financial incentives and policy measures being put into place to accelerate the investment in this sector.

- Biomass combustion power plant is attractive to:
  - Industrial factory owners
  - Plantation/mill owners
  - Feedstock utilized are sugar cane (bagasse), rice husk, wood/ paper (wood waste), corn (corn waste), palm oil (empty fruit bunches, shells) and cassava (roots, stems)
- Able to supply both electricity and heat (steam) for factory use
- Excess electricity can be supplied to the grid
- Main challenges
  - Securing the long-term supply of biomass fuel source at stable prices
  - Optimum selling price of electricity, if connected to the grid to sell electricity.

**Gasification**

Biomass gasification is a process of converting biomass to a combustible gas in a reactor, known as gasifier, under controlled conditions. The combustible gas, known as producer gas has a calorific value of 4.5 - 5.0 MJ/cubic metre is then cooled and cleaned prior to combustion in internal combustion engines for power generation purposes. Thus it uses gasifiers in conjunction with gas engines to produce electricity. It can operate at small-scale (10-25 kW) as well as medium-scale (up to 2 MW). As a result, it presents an interesting opportunity to many small-scale and medium-scale entrepreneurs and businesses.

***Feedstock for gasifier***

A wide range of biomass in the form of wood or agro residue can be used in the gasifier. Any biomass that has a density of more than 250-300 kg per cubic meter can be used for gasification.

Agricultural residues - coconut shell, husk, fronds, corn cobs, corn stalks, mulberry stalks, briquetted biomass of saw dust, coffee husk, groundnut husk, rice husk etc.

This renewable power source provides the benefit of distributed power production such that small communities and remote villages could get access to affordable electricity.

While gasification is a fairly old technology, the use of biomass gasifiers for power production has gained prominence only in the recent past. Currently, India's installed capacity for biomass gasification for power production is only around 128 MW (MNRE, December 31, 2010) but this is expected to change soon due to advancement in technology and various programs by the Government.

***Salient features of Gasification technology for Biomass***

- Power generation using derived producer gas obtained through heating of biomass in limited oxygen condition
- Stoichiometric (normal) combustion has air-to-fuel ratio of 6:1 while sub-stoichiometric (gasification) has air-to-fuel ratio of 1.5:1
- Composition of Syngas: $H_2$ (20%), $CO_2$ (12%), $CH_4$ (3%), CO (20%), balance $N_2$
- Small sized biomass gasifiers are suitable for remote electrification using wood chips/blocks and are also ideal for small factories, mills for electricity, process heat
- Main challenges
  - Small sized biomass needs to be briquetted
  - Maintenance in remote region can be difficult and expensive
  - Technology is still evolving.

### Cogeneration in Sugar Mills

In a sugar mill, bagasse, which is a by-product, can be used for production of electricity and steam through a cogeneration plant. Cogeneration plants are used to produce two forms of useful energy simultaneously i.e. electric power and steam, with the surplus electric power being fed into the grid.

Bagasse has traditionally been used in the sugar mills for heat and power generation in separate or inefficient low pressure systems. However, the situation has improved considerably over past few years with the installation of high-pressure efficient cogeneration systems. While many of the private sugar mills and few co-operative mills have converted to the efficient cogeneration system, there is still enough potential in this sector and several mills are still relying on old technology. There is an overall potential to generate 5,000 MW of power from the bagasse available from Indian sugar mills. Bagasse based cogeneration technology is well established and locally available in India.

### Tail end biomass power and rural electrification

Off-grid application of biomass energy has a potential to make significant contribution towards rural electrification and decentralized energy generation. This has advantages of production at consumption points and does away with land and environment related concerns and problems. This would also result in reduction of transmission losses by 5%-7%[3] and would also improve the power availability in remote areas. Tail-end power generation involves installation of 1-2 MW small power units utilizing the biomass gasification route.

This concept is being formulated to set up 200 MW biomass gasifier projects of 2 MW capacities at the tail-end of the grid by 2022[4].

Biomass-based CHP or power generation is widely used in regions that have ample fuel wood resources, forestry or agricultural residues. A business plan including the cost of the biomass resource collection and logistics is needed to ensure that CHP or power generation from solid biomass is economically viable.

Various other technologies and options are available but are in limited use as of now.

- Biomass liquefaction via pyrolysis
  - Power generation by combustion of pyrolysis oil
  - A process similar to gasification
  - Heating of hydrocarbons in zero oxygen condition
  - Condenses the vapors to obtain bio-oil (pyrolysis oil)
  - Bio-oil is easy to transport, store and handle
  - Can be combusted in boiler for heat or electricity generation
- Organic plant based oil (i.e. crude palm oil - CPO)
  - Generation of electricity using CPO.

## Challenges

Biomass-based CHP or power generation is widely used in regions that have ample fuel wood resources, forestry or agricultural residues. A business plan including the cost of the biomass resource collection and

logistics is needed to ensure that CHP or power generation from solid biomass is eco nomically viable.

Although barriers like information and technical barriers, regulatory barriers and financial uncertainties have been addressed to a great extent, however, barriers still exist, which may slow down the growth of biomass energy sector.

- Biomass use in CHP plants may compete with other, non-energy uses of agricultural residues such as straw, or with wood processing industry (i.e. pulp and paper) in the case of forestry residues.
- Increasing competition between different markets increases the price of biomass
- Although biomass availability is high, collection and sourcing is still a problem
- Large-scale use of biomass for power generation or co-firing may raise sustainability issues and limit the potential of biomass CHP and co-firing technologies

## Conclusion

Biomass based energy generation has significant potential to contribute to India's growing energy needs. Technology has significantly advanced and is being made available locally along with financial incentives and policy measures being put into place to accelerate the investment in this sector. However, challenges like availability of biomass at economical prices and competition between different markets still needs to be addressed.

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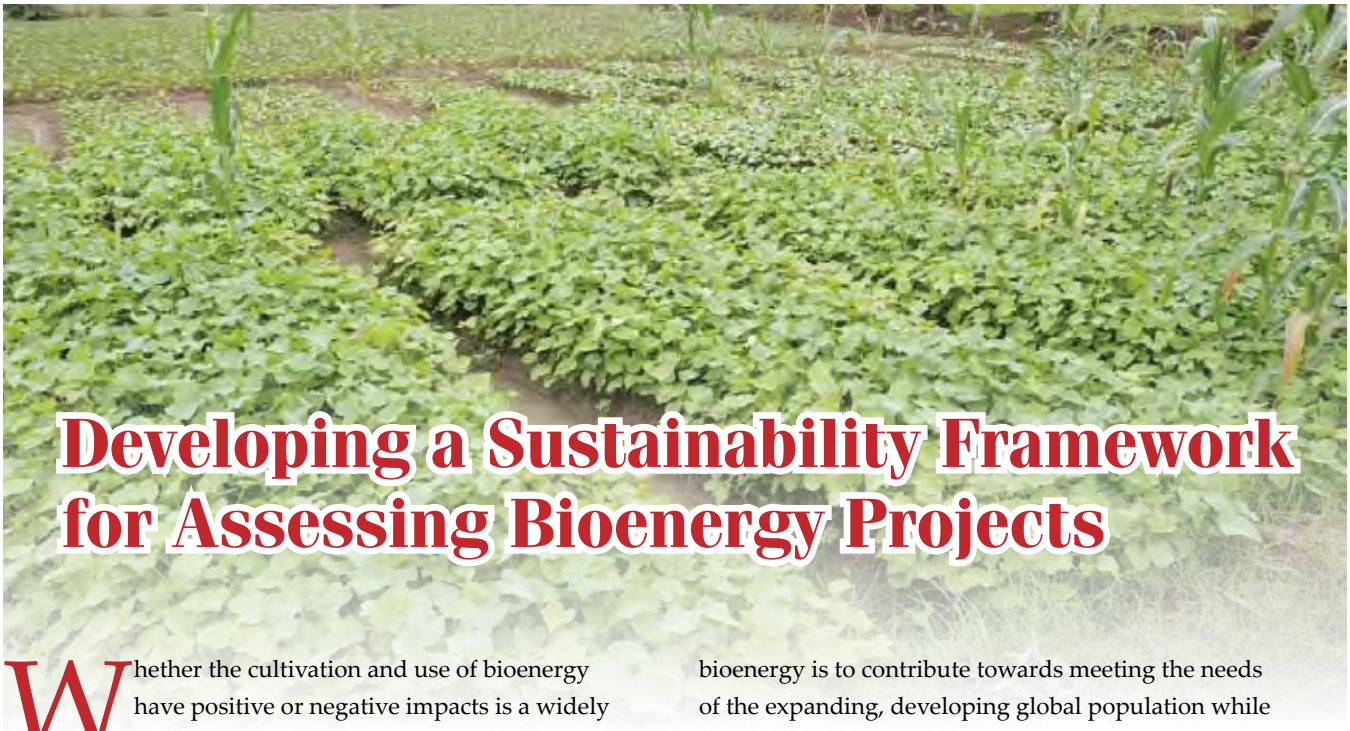

# Developing a Sustainability Framework for Assessing Bioenergy Projects

Whether the cultivation and use of bioenergy have positive or negative impacts is a widely disputed and fiercely contentious current issue globally. Cultivation of crops as feedstock for energy production has been occurring for centuries but has experienced renewed political and public interest over the last decades. The alarming rate of population expansion, simultaneous per capita consumption hikes and the increased cost of importing fossil fuels mean that secure energy supplies are a major global concern; so supplying sustainable energy production systems has become an urgent and unavoidable necessity. On top of supply concerns, renewable energy options such as biomass are being pursued in the expectation that they will provide cleaner and more environmentally friendly energy sources for future generations; as well as having positive rural development outcomes. More recently, opposition to the increasing cultivation of bioenergy crops has emerged strongly because projects where large-scale deforestation has occurred to make way for monoculture plantations, and those where local people are negatively impacted, have been widely publicized. There are also situations, using starchy crops such as wheat, where carbon balances have been shown to be negative and effects on global food prices have been proven [1]. These issues have all contributed towards a change in the public perception of whether or not bioenergy programmes can contribute positively towards global development.

The concept of sustainability has become synonymous with development discussions, such as those described above, in the 21st Century. Therefore, the challenge for bioenergy is to contribute towards meeting the needs of the expanding, developing global population while protecting natural resources and the environment; all essential characteristics of sustainable development. There have been numerous global efforts to provide frameworks for sustainability assessment of bioenergy programmes including international certification schemes and national policies or guidelines [2; 3]. The RE-Impact "Rural Energy Production from Bioenergy Projects: Providing regulatory and impact assessment frameworks, furthering sustainable biomass production policies and reducing associated risks" (www.ceg.ncl.ac.uk/reimpact) project has drawn on case studies in India, China, South Africa and Uganda to develop a sustainability framework for setting goals and criteria against which to assess sustainability of bioenergy programmes in a given context; and provides methodologies for furthering stakeholder understanding of specific aspects of sustainability.

Focusing on one of the four RE-Impact case study countries, namely India, this paper provides an analysis of the currently available methodologies for assessing the varied impacts, both positive and negative, of bioenergy production. This contextual information is then framed within a perspective of planning for sustainability; and the reasoning behind development of the RE-Impact framework, drawing particularly from field experience, is presented.

## Currently Available Methodologies

Environmental Impact Assessment (EIA), which is a procedure for measuring the effects that a planned development will be likely to have on the physical

environment in which it is placed, is currently the most commonly and widely used methodology for impact assessment globally. The technique and process of EIA have an established history of application spanning the past 40 years, having first been legislated in the USA in the National Environmental Policy Act of 1969 [4]. Later versions do include variables for assessment of economic and social issues but still focus primarily on identifying and evaluating these issues separately and in isolation from ecological ones, which are seen as central. It is only thereafter that attempts are made to integrate the implications of these effects, so that a more comprehensive picture of the holistic impact of the proposed development can be obtained. The practice of EIA is widely used by law for the formulation of new projects or programs (particularly large ones) and included in policies; however it is generally not seen as a participatory exercise, and takes place after the conception of a particular project or program. In addition, EIA traditionally does not address potential effects that may manifest over time, and is most often used to evaluate a proposal at a "snapshot" in time. The result is that the nature, extent and dimensions of that project must be constant for the analysis to take place, and so changes in the project over time constitute a "new project", which must then be subjected to a new EIA.

Social Impact Assessment (SIA) is an increasingly recognized methodology for quantifying what the likely impacts of a planned intervention may be on the host population and community structures in advance [5]. This approach has evolved as a separate entity to EIA because the scant coverage of social issues in the former is often deemed insufficient for social science practitioners. The process differs from EIA in that it generally has a strong emphasis on participation as it involves a certain amount of consultation with stakeholders to see what their current situations and views are. Some iterations will go further and encourage multi-stakeholder consultation (MSC) to formulate in depth knowledge of the social context and perceptions prior to commencement of an intervention, even continuing the participation throughout the decision making processes.

Strategic Environmental Assessment (SEA) is a now well established framework for consideration of the probable impact that a planned development will have on the social, environmental and economic aspects of a host area in advance. Building on the foundation of EIA, but including the full sustainability triple bottom line theory and proceeding in an entirely participatory manner; this has represented a real step forward in the incorporation of sustainability into planning frameworks. As the name of the tool implies, SEA is intended to facilitate the consideration of environmental effects from a strategic perspective, so that broader considerations than only those seemingly applicable to individual projects, are taken into account during planning. SEA has been widely used over the past 20 years to improve the incorporation of environmental issues into development policy, plans and programmes [6]. More recently, developments of SEA, namely Objectives-led SEA and Objectives-led Integrated Assessment, have been constructed. The latter seeks to integrate economic, social and environmental concerns in the assessment process and both are based on a common shared vision of the stakeholders set out in the planning process.

## A Planning for Sustainability Perspective

Achieving sustainability is a core challenge for most development programs, partly as it is not a measurable target or an accurate science. Sustainability can only be achieved if, at the planning and implementation stages, there is as clear an understanding as possible of the expected and potential impacts of the intervention – both positive and negative. The term sustainability itself is subjective; depending as it does on the desired outcomes of the end user, which means a relatively strict framework for use is vital. The objective of planning for sustainability at the onset is to foster and preserve the social ecological system in which the project or program is to occur so that it remains dynamic, adaptive, resilient and therefore durable over time [4].

This new area of impact assessment methodology builds on all previously used procedures, particularly the Objectives-led SEA; looking to optimise the process for a more sustainability oriented outcome. This method, entitled Sustainability Assessment (SA) aims to identify the entry point or goal for a particular area and bring sustainability into the planning procedure from the very outset to accomplish that goal. Separate targets are set, which are deemed markers for sustainability and, importantly, outlined by those stakeholders affected. So ideally this framework comes in to the planning process before a particular project or development is conceived, and is used to establish as many options for meeting the goal as possible. In addition, and in practice this may prove to be a common use of the tool, planning for sustainability can also be used to see whether a particular project, which has already been conceived, represents the most sustainable way of achieving the identified goal and what potential alternatives are available.

It is in this way, outlined above, that SA differs from the conventional approach to EIA; which is used to provide information for decision making, based on the level of potential environmental impacts that are considered acceptable, or which can be managed through mitigation. Although the more traditional assessment tools such as EIA or Life Cycle Analysis (LCA) have their place in the SA framework, the planning process throughout is expressly sustainability led, rather than having as its goal the identification and mitigation of potential negative environmental effects.

Building on the successes of the SIA and SEA approaches, the participatory element of SA has been incorporated as intrinsic to the process. Going even further than the previous methodologies, this approach seeks to identify and consult with stakeholders at the point of setting goals and targets, ideally before individual projects are even conceived, so that the participation is evident at all stages of the developmental planning procedure.

As well as in terms of the process objectives, SA differs primarily from the first two generation tools in that it focuses on the sustainability of the intervention under investigation, rather than having only an environmental focus. Further, in the case of the EIA approach; the lack of consideration of cumulative effects has been seen to be a major downfall [5; 6]. The SEA approach has attempted to address the limitations of EIA, in part at least, by considering environmental concerns from a strategic perspective and thus incorporating them in the planning process [6]. Though the SEA process has contributed towards incorporating environmental concerns in development planning, it does not necessarily contribute towards planning for sustainability, as it is driven by the strategies formulated for individual projects at its core rather than sustainability. The developments of Objectives-led SEA and Integrated Assessment, however, have proved to be important steps towards SA and the notion of planning for sustainability.

Sustainability is the *desired outcome* of the SA approach rather than merely the mitigation or minimization of potential adverse environmental impacts. The approach is inherently integrative, participatory, positive and future-oriented. The first and most important step in this direction is for all stakeholders to jointly define a sustainability goal (or vision), namely the desired outcomes of the intervention upon which the planning for it should be focused [7]. Next, in order to assess whether the proposed intervention achieves the goals, sustainability principles and criteria would need to be defined. These criteria would be context specific, taking into account local economic, social and environmental conditions, as well as the relationships between these components for the given set of stakeholders [4]. Understanding the interrelationships between economic, social and environmental components is critical and should influence the setting of the sustainability goals and criteria. It has been strongly advocated by proponents of the SA approach that it must be focused on these interrelationships and their character, resilience to change and adaptability, and the sustainability goals should embody such an orientation [8]. Therefore, the SA process has to be iterative and cyclic in nature so that the learning generated at each of the steps can be fed back into the process, thus allowing for goals and criteria to be revised as necessary. The SA approach is clearly a challenging one both practically and intellectually, but in order to incorporate sustainability as the key driving element in the development planning process, it is a crucial step that that authors believe must be taken for achieving sustainable development.

## Requirement for the Re-Impact Framework – Drawing on Field Experience in India

There is currently no requirement for prior assessment of biofuels policies in India. This is due to the fact that biofuel production is seen as an agricultural undertaking and therefore categorised as a low risk activity. There has been an Indian Biofuels Program in existence for over 60 years, but significant momentum in this direction has only occurred in the past five years. The main drivers of the Indian National Biofuels Policy are:

- Generation of rural employment opportunities
- Saving of foreign exchange
- Promotion of energy security in the country
- Promotion of environmental security
- Achievement of climate change commitments
- Promotion of renewable energy sources

The initial focus of biofuels policy in India, until early 2000, has been on ethanol for gasoline blending, but more recently the Planning Commission, under the umbrella of the National Biodiesel Mission, identified *Jatropha curcas* (Jatropha) as the most suitable tree-borne oilseed for the production of biodiesel in 2003. The Biofuels Program was then expected to expand to substitute fossil diesel up to 20% by 2011-12, this move being supported additionally as an option to rehabilitate degraded lands by improving their water retention capacity [9].

> EIA is currently the most widely used assessment procedure in India, but even this is limited to large development programs such as river valley projects, highways, thermal power plants and mining.

The use of vast amounts of waste and degraded lands for India's Biofuels Program has been devised as part of the Government's focus to promote rural development, in this case through bioenergy plantations. Until recently plantation activities, which have been occurring in some states where political will is strong, were often funded by Government schemes such as the Mahatma Gandhi National Rural Employment Guarantee Scheme. The responsibility for storage, distribution and marketing of biofuels once feedstock is being produced in any quantity presently rests with oil marketing companies in the country.

Most states have considered implementation strategies and a number of proactive state governments have actually set up Biofuel Boards and State Authorities. Some, such as Chhattisgarh, have already undertaken to plant up large areas under bioenergy feedstock crops such as *Jatropha curcas* meaning that there are initial results emerging, but there is certainly still time remaining for learning to be passed on to other states and, even more broadly, to other countries. For testing and development of this SA methodology for bioenergy projects in a real case there is a good balance of implementation occurring and policy development in the early stages in India, so the chance to learn from experiences certainly exists, but there is also an opportunity to influence policy, particularly at the State level.

**Issues and concerns regarding India's biofuels plans**

A number of civil society organizations have raised issues and concerns regarding the implementation of the biofuels program [10]. These include question marks over the existence of such large areas of wasteland, and the possible negative impacts that monoculture bioenergy plantations could have on biodiversity and local ecosystems (correspondingly the livelihoods of the poor). In fact, there is some suggestion that the identification of wasteland areas and plans to crop them will prove to be a strong mechanism for preventing community members from expanding their tenure into marginal areas.

In a practical sense it seems that initial yield predictions for crops such as Jatropha have not come to fruition in the time since the biofuels program has been implemented, leading to concerns regarding the lag time in seed production and unreliability of existing planting material. In addition it is feared that, as an indirect effect of the above, high external inputs such as fertilizers and irrigation to ensure economical production of biofuel feedstocks could lead to the diversion of good agricultural land away from food production. However, in some cases where seed has been produced, the inadequacy of market support has led to the incurring of major losses by those who had invested in the planting material.

It is clear that, for the introduction of bioenergy feedstock cultivation to be a successful practice in India and to avoid the undesired consequences mentioned above, there needs to be an acceptable degree of harmony between the drivers for the biofuels program and the local level impacts. The number of cross cutting sectors involved in this program is virtually unrivalled; consider for example: energy, natural resources, rural development, agricultural production, trade, and foreign exchange saving. Ensuring that one sector does not develop at the cost of another, and understanding the complex relationships between them, has to be central to the planning of bioenergy expansion in the country if the issues and concerns raised thus far are to be ameliorated fully.

**Current impact assessment procedures in India**

EIA is currently the most widely used assessment procedure in India, but even this is limited to large development programs such as river valley projects, highways, thermal power plants and mining. EIA is not administered in the case of other land use change interventions such as large scale plantation activities, e.g. jatropha plantations, even though they have economic, social and environmental impacts. Furthermore, a common critique of EIAs undertaken in the country is that they are largely focused on technical aspects (and therefore most often beyond the comprehension of the lay person) with minimal regard to social components, and are undertaken in a non participatory manner. In addition to those limitations already mentioned, EIAs provide only a snapshot capturing a static moment in time and not the whole (effects over time) which have a bearing on the sustainability of the proposed intervention, as described in section 2. If the intention of development planning in the 21st Century is to ensure sustainability, particularly that of poor, rural populations engaged in marginal farming, and thereby make sustainable development a tangible option, a

new tool is required. The authors recommend that the best such tool available currently is SA, and have designed the RE-Impact SA framework accordingly.

In the context of bioenergy in general, and India more specifically, it would be a great injustice not to consider the numerous linkages in the bioenergy system. The interrelationship between the so-called pillars of sustainability (ecology, economics and society) have already been discussed, but there are also vital linkages between all forms of governance looking at both strategic and project levels; between geographic areas (both within and outside the country) and between forms of knowledge whether indigenous, traditional or otherwise [8]. The RE-Impact SA approach must therefore consider these relationships as part of the process itself, and this certainly represents a step forward from previous forms of impact assessment.

**Assessment of bioenergy projects**

A brief survey of assessment methodologies described in the literature, and currently in use for the assessment of bioenergy projects, has been undertaken for RE-Impact [4]. This survey revealed that there are essentially two levels at which these assessments are conducted. The first level comprises a technology assessment approach where multi-criteria decision making (MCDM) is most commonly used for the purpose of assessment [11; 12]. Included in the discussion of MCDM methods in this work, is reference to Decision Support Systems, which in these contexts are computer based tools to assist decision makers in systematically conducting "optimized" energy planning [12], where tradeoffs are made between several objectives.

At the second level are a range of approaches that attempt to incorporate sustainable development considerations into energy planning, and provide an integrated assessment perspective [3]. These approaches aim to design methods to address more comprehensively, and in a more integrated manner, the three pillars of sustainability, as well as stakeholder participation in (bio) energy planning. Unlike in the previously mentioned technology assessment approaches, the focus of their enquiry is broader and more comprehensive. In addition the methods they outline would seem to have significant utility as they stand, for sustainability assessment of bioenergy projects, plans, programs and strategies. However, they have followed the conventional approach of investigation: looking at the three pillars first, with integration later [4].

Considering the previous approaches and learning from SA, key considerations and components of SA of bioenergy projects, plans, programmes and strategies, should be that:

A. A comprehensive LCA approach must be taken from feedstock production through to final use of the fuel produced
B. Inputs, outputs, interactions and interdependencies at each stage of the supply / value chain must be comprehensively identified, understood and investigated
C. All ecological, social and economic issues arising at every step in the supply chain, and all of the interdependencies and interactions between them, must be comprehensively investigated
D. All of the above must take place in a deliberative process of continuous engagement with all stakeholders throughout the entire planning for sustainability process. [4]

## The Re-Impact Framework

This output comprises the application of the theoretical SA framework outlined above which has been used to evaluate the Indian situation with regards to bioenergy production. It is expected that this tool will help to guide and support planning and decision making for bioenergy production in countries such as India, where bioenergy development must be viewed within the context of existing poverty and prevalent resource management systems, i.e. the operating economic, social and environmental conditions and their interrelationships. In the RE-Impact project, a sustainable rural development SA framework has been developed for assessing bioenergy projects, and initial testing has been completed in India. This framework is presented in Figure 1.

The prototype framework in Figure 1 is based in large measure on the SEA approach used in South Africa [6], and the SA approach proposed by the Australian Government [14], as well as the recent research on and analyses of SA [13; 7]. As shown in Figure 1, a key process of the SA is the MSC within which the sustainability goal, principles and criteria have been developed for the Indian state of Chhattisgarh. Detailed stakeholder mapping was completed in the state to identify, for example, those stakeholders who are at risk, and who have the most power in implementation of the program, and to map out the stakeholder hierarchy. MSC of the identified stakeholders has been taking place in Chhattisgarh since the project inception in early 2006, and reflects key consideration D, as it is a process of continuous,

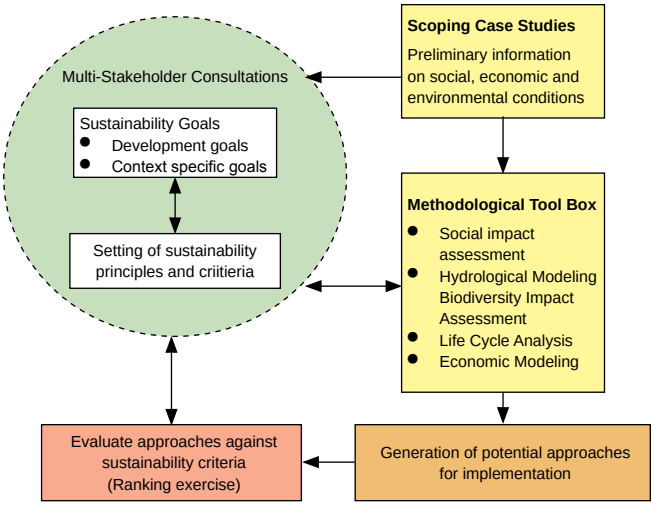


**Figure 1: Proposed Sustainable Rural Development Framework for SEA Bioenergy Projects from RE-Impact**

ongoing engagement. As discussed in earlier sections, the goal is the central point upon which planning of a development proposal should be focused and the criteria are then used to determine how successful current proposed interventions are at meeting that goal. These criteria will inherently take into account the context specific vision of the unique group of stakeholders [4].

In the Indian case the overall goal of the biofuels program has been defined as rural development. This has been continually drawn out from semi-structured interviews with stakeholders at all levels throughout the country, and in the state of Chhattisgarh. The sustainability criteria identified include rural employment, increased livelihood diversity, degraded land rehabilitation, rural electricity provision and economic gains from sale of feedstock. Stakeholders did not see biodiversity as a central criterion, and the issue of carbon storage and CDM was a secondary consideration, but only for potentially large-scale producers. The interrelating aspects could be identified early on in the process; for example village electrification could be described as a social issue but often electrification is required for agronomic irrigation purposes, so the impact on water resources could also become a consideration for water availability in an entire catchment. This understanding, right from the start, of how the social, economic and environmental aspects are interrelated; helps to fulfil key considerations A and C; investigation of the interactions at all levels of the supply chain.

The stakeholder facilitate the following objectives:

1. Provide a scientific basis for planning and decision making by the stakeholders
2. Provide the opportunity to integrate the learning from each of these studies in a manner that is most suitable to that particular context and for that set of stakeholders. [9]

Currently application of the SIA methodology developed under RE-Impact to directly feed into the SA is well underway, as a direct result of stakeholder identification of social issues as being central to the sustainability of the Biofuels Program. At this time the SIA into the production stage of the bioenergy production chain is complete, and the other stages will be considered in due course (though they have been identified as having lesser impact overall). In addition very detailed water resources modeling has been completed for the State, considering current and future climate change scenarios under existing and possible future increased levels of bioenergy feedstock cultivation. These extensively applied methodologies represent clearly the inclusion of key consideration B; looking at all stages of the supply chain. It is possible that carbon baseline assessment of areas planned for large scale plantations of jatropha may be completed, and simple economic modeling is currently in the early stages, so these will also be disseminated to stakeholders as they progress. So far the methodological tools have proved successful, and learning is feeding back into the MSC to enable optimisation of the most suitable options for sustainable bioenergy production in the state of Chhattisgarh.

It should be reiterated in conclusion that the MSC has been the process by which the particular detailed studies, selected from the methodological tool box, have been identified; and that not all are required in all cases. On the other hand the scoping case studies and the methodological studies are assisting in generating options for potential approaches for implementation, rather than simply satisfying the assessment of those particular criteria. These approaches can then be evaluated against the defined sustainability criteria and the most appropriate will be selected, again through a consultative process. This entire procedure is iterative and dynamic, requiring active participation from all stakeholders. This remains the key challenge of the SA approach. It is through this ongoing consultative process, supported by scientific studies, that the RE-Impact team continues to test this framework in the Action countries.

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# On the Waste Route

*The Bandeirantes and São João landfills already possess biogas-based thermopower plants*

An eternal target for environmentalists, garbage is now a feedstock for power production and ceases to be a problem to become a solution.

Garbage, one of the major villains for public health, has also become a serious problem for urbanization and logistics. The reason is that there is nowhere else to dump it: with the Brazilian growth in population and in purchase power, a greater disposal of inorganic waste is observed, which takes longer to decompose. More garbage is produced than nature is able to absorb, a situation which, at some point, will reach the edge.

According to data surveyed by the Brazilian Association of Public Cleaning and Special Waste Companies (Abrelpe), Brazil generates 182,728 tons (t) of solid urban waste per day. Of this total, 21,644 tons (12%) are not even collected, being dumped by civilians in open areas or into rivers, contributing to floods and to other problems.

Each Brazilian alone generates 1.152 kg of garbage per day. This number is not a bad indicator if compared to the average inhabitant in European Union countries, who generates 1.2 kg a day. The problem is that, in large urban centers in Brazil, the average is far greater. An individual in Brasília, for example, produces 1.698 kg of waste per day, whereas one in Rio de Janeiro, 1.617 kg, and one in São Paulo, 1.259 kg.

São Paulo, by the way, is an emblematic case. Pressed by environmental laws aiming to halt irresponsible dumping, the State municipalities began to spend more with their garbage. The State of São Paulo Environmental Sanitation Technology Company (Cetesb) made inspections stricter all over the State of São Paulo territory and started to close irregular dump sites and landfills and to force municipal governments to sign Conduct Adjustment Terms (TACs) which made them commit to carry out correct disposal. From the environmental viewpoint, it can be concluded that this worked very well: in the early 2007, the State counted on 143 dump sites – today, there are only three operating.

Conversely, the environmental laws siege was accompanied by a natural exhaustion of the landfill system. Bandeirantes, an important destination of the São Paulo garbage, was closed in 2007 and São João, which worked for 17 years and received a total 28 million tons of garbage, stopped receiving waste this year.

The result is that we have nowhere else to dump our garbage. With no options, the municipal governments started to export their waste. Araras, for example, sends its garbage to a private landfill in Paulínia, 120 km away. On the South coast, Itanhaém sends its waste on trucks uphill, pays toll and the waste is dumped in a landfill in Itaquaquecetuba. The capital also

exports its waste to other cities in the state, such as Guarulhos and Caieiras. All this logistics is surely costly: São Paulo City spends R$ 900 million a year on garbage, a large share going into transportation.

With the problem growing at alarming levels, a question emerges: what can we do with this garbage? The answer is to transform it into bioenergy.

## Gas-Derived Power

There are two ways of taking advantage of the power generated by garbage. The first is to burn it and to transform this thermal power into electric power by means of turbines moved by water steam. The second and, so far, the most popular way is to bury the garbage normally and to install, all along the landfill, a system that captures and conveys the biogas naturally generated by the waste. "Methane represents about 50% of all the biogas generated in the landfill, which is also composed of approximately 40% of carbon dioxide, 3% of oxygen and the rest of nitrogen", states Fernando Souza Nazareth de Freitas, operational coordinator of Essencis Soluções Ambientais.

For having this composition, this gas may be stored and used in engines, replacing natural gas, or else used to fuel adapted Otto cycle engines, which produce electric power and store it in generators. It is also possible to simply burn the gas, which happens in equipment called flares. Whatever is the destination chosen for the gas, the fact that the landfill prevents it from going into the atmosphere generates carbon credits that may be traded with the international community.

*With the saturation of landfills, the destination of garbage became a problem for municipalities in São Paulo*

Yet installing a biogas capturing system is not an easy task. "The first step is to install vertical drains that allow extracting biogas and the slurry outflow", states João Wagner Silva Alves, Board Advisor of the São Paulo Environmental Sanitation Technology Company (*Cetesb*). According to him, the drain installation has to comply with a spacing of about 30 m of radius. "Externally, as the disposition and coverage of the waste advance in the landfill, high density polyethylene pipes are interlinked in the internal vertical drains running along the whole waste mass", completes Fernando Freitas. These pipes are connected to blowers which conduct the continuous suction of biogas, 24 hours a day.

Besides the installation costs of this piping, which has to be expanded as the landfill advances, there is also the maintenance cost of the network already installed, which is subject to damages caused by external agents.

## Biogas in Brazil

Power generation through biogas capture already exists in Brazil. Starting

### Urban Solid Waste (USW): A Scenario

- 57 million tons of urban solid waste were produced in Brazil in 2009
- 7 million tons of this waste failed to be collected
- 6.6% was the increase in per USW capita generation in relation to 2008
- 1% was the real increase in the amount of USW discarded
- 53% is the Southeast participation in the total garbage collected, the largest among the Brazilian regions
- 6% is the North participation, the smaller among the regions
- 43% of the whole garbage collected in 2009 had inadequate destination
- 43.4% is the percentage of Brazilian municipalities not counting on any selective collection initiative
- 19.3% of the whole garbage collected still goes to dump sites (56.8% go to sanitary landfills and 23.9% to controlled landfills)
- 1,688 dump sites still exist in Brazil, against 3,877 landfills

*Source: Solid Waste Scenario in Brazil, Abrelpe, data concerning 2009*

its operations in 2004, the Bandeirantes landfill thermal power plant, in São Paulo, was the first methane-derived power generator to be installed in Brazil, with capacity to generate 175,000 MWh a year, using generating units. It was fully financed by Unibanco (now merged with Banco Itau) and by Biogas Energia Ambiental S.A. Eletropaulo also participated, accounting for the construction of a switching station to transfer the power to the conventional grid. According to governmental estimations, the plant will prevent about 8 million tons of carbon dioxide equivalent from being emitted until 2012.

The São João landfill thermopower plant, also in São Paulo, started operating in 2008, with capacity to generate 200,000 MWh a year, the equivalent to the consumption of a city with 400,000 inhabitants, by means of sixteen generating units. It prevents 800,000 tons of carbon dioxide equivalent a year from being emitted.

Biogas invested about US$ 30 million in the Bandeirantes Landfill and about US$ 50 million in the São Joao one. The carbon credits were already traded in two auctions, in 2007 and 2008, generating R$ 71 million for the municipal government, responsible for the trade, which invested the resources in projects in the landfills neighborhood.

For the late 2010, the conclusion of the Biogas Plant of the Metropolitan Landfill from Jardim Gramacho, in Duque de Caxias (RJ), is planned; it will be exploited by Gás Verde S.A. When the whole of the infrastructure is ready, the plant will capture about 200,000 $m^3$ of biogas daily. Besides being the largest Brazilian greenhouse gas reduction project, it will also be the largest one in the world in the landfill category, with capacity to obtain US$ 10 million in Reduced Emissions Certificates (RECs) in the next 15 years. Petrobras has a contract signed to buy the gas and use it as a source of energy in the Duque de Caxias Refinery.

Cenbio itself counts on a project for obtaining power from garbage. Its name is *Use of the biogas derived from solid and urban waste for generating power and lighting from gas.* By the project, in 2009, in the Caieiras Waste Treatment Center, in São Paulo, a 200 kW-powered Otto cycle engine started operating; its technology is Brazilian, and it transforms biogas into power. Only 2% of the biogas captured are sent to the engine, which is small – the rest is burned in flares. The energy available from the methane outflow in the Caieiras WTC is of approximately 340 MW per hour daily.

## Rural Waste: A New Market

In farms and other agricultural or livestock breeding activity environments, there is also a significant production of waste. "The difference between rural and urban waste is that the rural one is more homogeneous and rich in organic matter, whereas the urban one has the organic matter mixed with a series of other components, mainly toxic ones", explains João Wagner.

Due to this characteristic of the material, power production occurs by the use of biodigestors. A biodigestor is a fully closed compartment, with no air inflow, to which the waste is sent and anaerobically fermented, transforming biomass into biogas. The equipment works with fully organic matter or very close to that, which prevents its use in urban center landfills, where the garbage is only about 50% organic. The resulting biogas is used to generate power and the remaining material can be used as fertilizer for being rich in nitrogen, potassium and phosphorous.

After many years of discussion, today, finally, the farm owner can both use the power in the rural estate and sell it to a distributor. This is possible because, in the late 2008, the National Power Agency (Aneel) regulated power generation from biogas and its trade all over Brazil. According to the *Aneel Normative Resolution 390/2009,* from December 18, 2009, any power distributor can purchase power produced by biodigestors in private estates.

Besides power, of course, there is the credit carbon issue, as well. A study conducted by the Cenbio, coordinated by Dr. Suani Teixeira Coelho, based on data from the Brazilian Institute for Geography and Statistics (IBGE), revealed that there were almost 140 million bovines confined in Brazil, from the manure of which almost 3,400 MW a year could be generated. Considering the value of the carbon t to be US$ 10, it would be possible to collect US$ 150 million a year in certificates from bovine manure alone, that is, without counting manure from swine, equine, goat, etc.

There are initiatives pointing in that direction. The Alto Uruguay Project, for example, derived from a partnership between public and private institutions, seeks to disseminate the installation of biodigestors in farms of nineteen Santa Catarina municipalities and of ten ones in Rio Grande do Sul. In 2011, in the West region of Santa Catarina alone, more than 2,000 miniplants generating power from the use of swine manure are expected to exist.

One of the largest projects of the kind started in November this year, also in the South Region. The Itaipu hydropower plant, in a partnership with the Brazilian Agricultural Research Corporation (Embrapa), started to install biodigestors in 41 rural estates in Paraná. The biogas will be conveyed by gas pipelines for the thermopower plant to transform the biogas into power to be used by the farms producing it. The surplus will be sold to the Paraná Power Company (Copel), also a partner in the initiative.

Recently, The State University of Campinas (Unicamp), in a partnership with Cenbio, Usinazul and two international entities, Winrock International and the Renewable Energy & Energy Efficiency Partnership (REEEP), developed a software that, having the farm data, establishes the adequate biodigestor type. The software asks for information – such as the number of animals, the amount of manure produced in a given period and the power consumption of the estate – and returns information such as the adequate size of biodigestor for that situation, how much the farmer would spend in that installation project and the return rate. "The idea of the program developed by Cenbio and its partners is exactly to stimulate the implementation of systems for treating swine, meat cattle and dairy cattle-derived manure, in small and medium-sized estates, and the energy use of biogas", states the Cenbio chemical engineer and researcher, Vanessa Pecora Garcilasso.

## Sewage: Power from Biodigestors

Sewage is another waste source from which power production is already exploited. In this case, the use is also made by anaerobic biodigestion, in biodigestors. "What changes is the time for hydraulic retention, that is, the time it takes for the effluent to be treated within the biodigestors", states Vanessa. According to her, the sewage has a hydraulic retention time of eight to twelve hours, on average, and rural waste, mainly from swine, as they have greater organic load, take about thirty days to be treated.

Another difference is that sewage may have an initial separation of metals, solid parts, oils and other contaminants, so that only the liquid share is sent to the biodigestor.

Once again, the system is configured not only as a sustainable initiative, but also as a potential business. In the USA, the Synagro company alone earns US$ 320 million a year simply by collecting sewage sludge to sell to US farmers as a fertilizer (the company does not use the gas for power). Today, 15 million houses in rural China count on sewage connected to biodigestors to use their waste – it is the country that mostly transforms sewage waste into power all over the world.

In Brazil, where even sewage treatment is scarce, the reuse by biodigestors is still incipient. In states such as São Paulo and Mato Grosso, it is possible to find projects in rural areas, usually linked to environmental concerns. In 2005, Cenbio installed, as a way of presenting the technology, a conventional Otto cycle generator with a 30 kW microturbine at the Sabesp Sewage Treatment Station (ETE) in Barueri, São Paulo, operating with the biogas produced.

Nilton Seuaciuc, Sabesp New Businesses superintendent, claims that the economic advantages are still uncertain. "If we use [*the energy produced from the sewage*], we have to buy the demand for pauses, which makes the operation expensive", he says. "If we sell, we can obtain a good retail price," he believes.

Maybe the most successful initiative of the kind in Brazil operates in Petrópolis (RJ). About thirty families in popular neighborhoods received biodigestors in their homes so that their sewage was not dumped into rivers. Every 10 houses treating their sewage in biodigestors generate gas for one to be self-sufficient – measurements made by the NGO Environmental Institute (OIA), which supports the project, point out that the reduction in the waste organic load reaches 98%. Also according to the NGO, the cost for building a biodigestor capable of serving up to four houses varies from US$ 1,000 to US$ 1,500.

It is worth noting that there are several types of biodigestors. "For sewage treatment, the most used today is the RAFA [*Upward Flow Anaerobic Reactor*]. For rural waste, the rural biodigestor", states Vanessa. In April this year, researchers from the Faculty of Pharmaceutical Sciences (FCF) - USP and from Genoa University, Italy, developed a biodigestor which produces, on average, 40% more biogas from sewage than the commercially available ones. The equipment also purifies gas, making it generate about 50% more energy and making it more similar to vehicular natural gas (VNG). The goal is to have the product patented by April next year.

## National Solid Waste Policy

As for other initiatives connected to bioenergy in Brazil, the use of wastes lacks incentive laws. Yet this started to

## Opportunity Emerging from Ashes

With the saturation of landfills, burning garbage has become a more and more commented option in the waste management sector. Besides being a quick way of eliminating the material, it also allows obtaining power by means of steam formation, which is then used to move a turbine. The plants conducting this process are, therefore, thermopower ones and, in Brazil, they are usually called Power Recovery Plants (UREs).

All over the world, there are over six hundred plants of this type. In Europe and in Japan, the municipal governments forward the waste to the companies that conduct the process and pay them about R$ 250, or more, per ton of garbage. The European Community countries, by the way, no longer consider landfills an environmentally adequate solution and intend to ban them by 2020. Germany forbade the construction of landfills in 2005.

The emission of dioxins and furans, toxic substances causing cancer, used to be one of the major criticisms to incineration plants but, with technological advancements, the problem started to be controlled. In 2003, the USA Environmental Protection Agency (EPA) presented a study comparing dioxin emissions by the incinerators. Although the amount treated has been kept constant (about 30 million tons a year), there was an 86.5% reduction of pollutant emissions by the incinerators between 1987 and 2002. "No one else is threatened by the emission of toxins, dioxins or furans because the filters are extremely effective", claims Martin Langewellpott, representative of the State of Bavaria in Brazil. "These arguments prevailed in the political discussion twenty years ago. Modern plants are safe", he says. Bavaria has one of the best known incineration projects in the world and now counts on seventeen plants of the kind – receiving over 90% of the region garbage. The largest waste incineration plant in the planet is located in Amsterdam, in the Netherlands, processing 4,500 tons of garbage per day, generating 1 million MW and supplying 100% of the city public lighting. Furthermore, the incinerated waste is turned into feedstock for paving public roads and sidewalks and for being used in civil construction.

During the Stockholm Conference in 2001, Brazil signed a United Nations (UN) treaty which classifies waste incineration as one of the major sources for generating organic pollutants. The agreement recommends that the use of incinerators is gradually phased out. For this reason and also mainly for lack of financial incentives, incineration in Brazil is still latent, characterized by the existence of a large number of very small-sized incinerators, installed in hospitals, clinics and similar entities scattered in Brazil. However, the new world scenario has already started to change things here. In 2010, the Federal District government announced the study of a public-private partnership for developing a project similar to that of the Netherlands capital, supported by the construction of the first landfill in Brasília. The project may be started in 2011. In Recife this year, the *Recife Energia* consortium announced an incineration plant capable of processing 1,350 tons of garbage per day and of producing 27 MW.

The city of São Bernardo do Campo (SP) counts on a project to build the first domestic garbage incineration plant in the State. It will have capacity to receive thousands of t of domestic waste per day and the power generated, of 30 MW/hour, will be enough to daily supply a 300,000 inhabitant city. The work, still not bidden, includes an organic waste and recyclable separation sector and is estimated to cost R$ 220 million. The city government expects the plant to start operating by 2012.

Legally, the incineration practices are standardized in Brazil by *Conama* resolutions *n. 316 and n. 358*, which respectively provide on the procedures and criteria for operating waste thermal treatment systems and their application for health waste. The Brazilian Association of Technical Standards (ABNT) has *NBR 11157*, which presents definitions and standards for analyzing incinerator performance, emission standard, waste analysis, etc.

"The Brazilian garbage has calorific power ranging between 1,400 and 1,900 kCal/kg, with possible distortions, both above or below this range, due to the type of occupation of the generation area, to the season of the year and to the predominant social classes along the collection route, among others", states Milton Norio Sogabe, *Cetesb* Air Quality Area engineer. According to the estimation made by Pöyry, a Finnish company specializing in installing garbage thermopower plants, Brazil has capacity to generate 300 MW of power with the incineration of 12,000 tons of garbage a day. A plant with capacity for burning 1,000 tons of garbage per day costs about R$ 250 million, slightly less than building a landfill with the same capacity.

change in 2010. President Luiz Inácio Lula da Silva signed a bill establishing the National Solid Waste Policy (PNRS) in August, after its approval by the House of Representatives in March and by the Senate in July. The bill exists since over twenty years ago: it was presented to the House of Representatives in 1989, but only recently it did leave the House. It establishes "shared responsibility" among producers, consumers and government for managing and handling solid waste.

According to the Law, manufacturers, importers, distributors and vendors now have to create mechanisms to collect the containers after their use. The measure is valid for agrotoxic, batteries, tires, lubricating oils, electro-electronic sectors and for all sorts of lamp bulbs. Consumers, in turn, are incumbent with adequately packing the garbage for collection, which includes separation wherever there is selective collection. They are also forbidden from disposing solid waste in beaches, into seas, into rivers and into lakes.

The state and municipal governments are forbidden from creating dumping sites. They can only build landfills, where only waste that cannot be reused or composted can be deposited. All the governmental spheres are obliged to elaborate plans to treat solid waste, establishing goals and recycling programs. The municipalities will have to make a plan for managing solid waste in conformity with the new directives by 2014. This is also the deadline for phasing out dump sites.

To complete, the PNRS also stimulates collectors' work, which was welcome as a victory by the category. According to the project, the public sector will have to stimulate activities of recyclable waste collectors' cooperatives and associations and of recycling entities, by means of financing lines.

Another important PNRS point is to distinguish between waste and refuse. The first is the garbage that can still be reused or recycled; and the second is the garbage that is no longer fit for reuse. The project, however, does not contemplate animal manure from the rural area, which is characterized as "effluents". For Vanessa, a specific legislation concerning liquid effluents is lacking, in which sewage, vinasse and animal manure, among others, would fit.

Only one point caused heated discussion in the public opinion. Originally, the PNRS proposal provided that the energy use of waste could only be allowed after all the recyclable resources were separated, or if there were not technical feasibility for recycling. This section was removed from the text when it was passed in the Senate, which generated criticism by environmentalists for supposedly discouraging recycling and for opening excessive space for incineration.

For Fernando Freitas, the PNRS provides two great advantages. The first concerns landfills, which start to receive more biodegradable waste, making them have greater gas generation for power production. The other concerns recyclable materials, which may be used in other ways for power generation. The Essencis operational coordinator also believes that, for receiving less inorganic material, the landfills may gain an increase in their service lives.

Tiago Nascimento Silva, Biogas production manager, believes that the PNRS will encourage companies to seek alternatives to collect their waste and to give them an adequate end destination. "The companies that produce sugar cane ethanol today make cogeneration, which is burning the bagasse in boilers for producing process steam and electricity", he exemplifies.

This is the first Law of the kind with federal ambit. The State of São Paulo, for example, already counted on a Law on the subject, the *12.300/2006* one, although it did not include rural waste. Despite already having a character of Law and of having already been published in the *Official Gazette*, the PNRS has not yet been regulated. The government plan was to regulate it by November, but the deadline was not met due to the general elections.

Everybody is now waiting for the regulation: power companies, garbage collection companies, environmentalists and the society as a whole. With the triple potential of reducing the garbage load in the environment, generating power and yielding carbon credits, the energy use of garbage is a business that can only do good to the country. It is only necessary for this to be responsibly carried out.

***Courtesy:*** **S. T. Coelho,** *Editor &*
**A. Leite,** *Journalist in charge, On the Waste Route, Revista Brasileira de Bioenergia, Year 4, N. 9, November, 2010*
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# South African Bioenergy Policy – A View from Indian Policy Perspective

Biomass contributes about 20% of South Africa's commercial and non-commercial final energy supply. Non-commercial biomass sources are mainly from use of fuel wood, dung and waste. According to South Africa's biofuels industrial strategy[1], 2% penetration level of biofuels is planned for the first five years. This will amount to about 400 million litres of biofuels per annum. For biofuels production in South Africa, sugar cane and sugar beet are proposed for bioethanol production, and sunflower, canola and soya beans for biodiesel. For food security reasons, crops and plants such as maize and Jatropha are excluded. This clearly reflects the contrast in South African Biofuels approach and Indian approach. Ethanol production in the year 2005 accounted for 390 million litres and the production was mainly from sugar industry as potable alcohol for local and export markets. South Africa is becoming an active exporter of ethanol taking advantage of preferential trade arrangements with the EU. Until December 2005, South Africa benefited from a 15 percent tariff reduction under the Generalised System of Preferences scheme. From January 2006 South Africa is subjected to the full MFN duty. Thus focus of South African policy is on achieving a balance mix on climate change, energy security and rural development. A tabular comparison of the factors driving bioenergy sector is presented in Table 1.

## Evolution and Growth of Bioenergy Policy

In South Africa, transport fuels constitute 30% of energy consumption (by energy content) and 70% (by value). The White Paper on Energy Policy (1998) was the pioneer policy paper which set the agenda for South Africa's energy policy and acknowledged the importance of alternate transport fuels. Subsequently, in 2003, the White Paper on Renewable Energy mandated a renewable-energy target of 10,000 GWh to be achieved by 2013. The Petroleum Products Amendment Act, (2004), authorized the energy ministry to require licensed liquid fuel producers to supply[3] petroleum products made from "vegetable matter". This was an important legislative amendment for the biofuels development in the country. The exemption of 30% on fuel levy from biodiesel which was introduced in 2003 was increased further to 40% by the National Treasury (2005). Further, Department of Science and Technology (DST) led Biodiesel Joint Implementation Committee conducted a detailed examination and concluded that government support to biodiesel production can be justified due to its environmental and socio-economic benefits.

The National Treasury towards third quarter of 2005 also approved a Renewable Energy Capital Subsidy Scheme. In 2007, the Subsidy amounted for 16.7 c/l subsidy for bioethanol and 27.3 c/l for biodiesel, up to a maximum of R20 million. Effectively this proposed support amounts to 2% of the required investments. In December 2005, an Interdepartmental Biofuels Task team was established with the aim of developing the industrial strategy of the country's biofuels program which was approved in December 2007.

Thus it's evident that both South African Policy and Indian Policy don't have mandatory targets for electricity and heat, however both countries have clear focus on transport fuels. Table 2 presents a summary picture of the targets of biofuels policy of the two countries.

**Table 1: Objectives[2] Driving the Bioenergy Sector**

| Country | Objectives | | | | | | |
|---|---|---|---|---|---|---|---|
| | Climate Change | Environment | Energy Security | Rural Development | Agricultural Development | Technological Progress | Cost Effectiveness |
| South Africa | √ | | √ | √ | | | |
| India | | | √ | √ | | √ | √ |

1. *Biofuels Industrial Strategy, December 2007 http://www.info.gov.za/view/DownloadFileAction?id=77830*
2. *GBEP Report (2008)*
3. *http://www.info.gov.za/view/DownloadFileAction?id=77830*

**Table 2: Targets of Biofuels Policy**

| Country | Targets (M = mandatory; V = voluntary) | | |
|---|---|---|---|
| | Electricity | Heat | Transport Fuels |
| South Africa | 4% by 2013 (V) | No targets | Upto 8% by 2006 (10% under consideration) |
| India | No targets | No targets | A 20% blending mandate for ethanol is established before end of 2017 |

## Key Issues in Biofuels Strategy

The Biofuels Industrial Strategy is based on evolving partnerships along the value chain and across the affected sectors. Prima-facie the strategy attempts to target areas of South Africa that are worst hit by poverty. It aims to generate economic development, mainly, in the former homelands. Policy is very clear on the issue that only agricultural products grown in the previous homelands by historically disadvantaged farmers will qualify for the support. Biofuels plants that have been identified in the strategy paper will be supported and their location will be a condition of the issuing of a manufacturing license. Policy stresses that development of the biofuels industry based on imported feedstock will not be supported.

The Policy aims that cost of biofuels will be cross-subsidized and remunerated separately. Policy by design tries to ensure that farmers supplying the biofuels plant with feedstock, particularly emerging farmers, can organize themselves as co-operatives to maximize benefits and market power and also participate either fully or partially in the ownership of the biofuels plants. The Strategy with its focus on rural development envisages that contracts will be signed between farmers' cooperatives and individual biofuels producers. This is currently being practiced in the sugar Industry. It is thus clear that the development of a modest biofuels sector[4] is to be supplemented with target for bringing in to use under utilized land while leading to a minimal impact on both food security and prices. Currently 14% of arable land is under utilized, and most of it is in the former homelands. These areas lack market access, which biofuels plants will provide and infrastructure that agricultural and infrastructural support program should provide. Specifically the 2% level of biofuels proposed for support for the incubation phase will not compromise existing food markets, as this target can be achieved with about 300,000 ha of land or about 1.4% of national arable land. Much in sync with Indian Biofuels Policy, South African Biofuels Policy remains conspicuous of the possible impact of pursuing biofuels on food security and appears to attempt things in a very balanced way.

## Specific Policy Interventions

Policy thought alone can never lead to intended outcomes. It must be accompanied by specific policy interventions for achieving the intended goals. South African Biofuels Policy has placed in following specific policy interventions which are both regulatory and promoting in nature:

- **Licensing of Producers:** Biofuels producers, as per policy, need to be licensed by the Petroleum Products Controller. The license will be awarded only to qualifying producers up to a 2% penetration level of locally produced biofuels. Licensing on one hand will ensure that biofuels don't get promoted at the cost of food crops and also ensures that whenever required government can intervene and upscale production.
- **Off-take by Petroleum Wholesalers Based on Discounting:** This specific instrument as emerged from the learning that biofuels economics are optimized when logistics and associated costs are minimized. Hence the policy enunciates that preferred off-takers, excluding self use by producers and directly by consumers in proximity to biofuels plants, will be through the existing oil industry at the depots and refineries closest to the biofuels plants.
- **Fuel Levy Exemption:** Biodiesel plants with production capacity under 300,000 litres/annum are fuel tax exempt, and it is recommended by stakeholders that this fuel tax exemption status should continue. This was primarily done to simplify administrative procedures and when seen in comparison to oil industry, this is very low, where a typical refinery produces 20,000 times this volume.

A comparison of the policy instruments of South Africa and India is tabulated below. It is clear that focus of the instrument is on the transport sector and no incentives are being offered for electricity and heat sectors

4. http://www.scienceinafrica.co.za/2008/october/biodiesel.htm

**Table 3: Key Policy Instruments**

| Country | Energy Policy | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Binding Targets/ Mandates[1] | Voluntary Targets[1] | Direct Incentives[2] | Grants | Feed in Tariffs | Compulsory Grid Connection | Sustainability Criteria | Tariffs |
| Germany | | E*, T | (E), T | | | | | n/a |
| India | T, (E*) | | E | E,H,T | E | | | n/a |

*E: electricity; H: heat; T: transport; Eth: ethanol*
* target applies to all renewable energy sources
1 blending or market penetration
2 publicly financed incentives: tax reductions, subsidies, loan support/guarantees

in South Africa. This is plausibly in line with the fuel consumption pattern of the country.

## Conclusion

The policies set by the South African government aims to create the conditions for the development and commercialization of renewable energy technologies. Until now the use of biofuels for transportation fuel has received major attention from the government compared to the other final uses. It's very clear that South Africa is adopting a very cautious approach and not very ambitious in nature. Indian Policy however appears to approach biofuels very aggressively. In South Africa, timing for the proposed 10% blending will be determined by the level of support provided by the government which needs to ensure that the level of support is such that the interests of bio-ethanol investors and feedstock providers are balanced and in sync with those of fuel consumers and small-scale farmers. The two countries seem to be very closely following policy of protecting interest of small farmers first and achieving biofuels targets thereafter. Thus stakeholders can be rest assured that policy by design takes care of interest of farmers while ensuring energy security.

***Courtesy:*** **WII Editorial Team**

# Request for Articles

Bioenergy India offers a useful platform for experts, investors and other stakeholders to exchange their experiences, expertise and to discuss issues related to harnessing biomass energy in an efficient and cost effective manner. The magazine encompasses the full spectrum of biomass energy sector related information, which will help creating awareness about the same amongst the relevant audiences.

The magazine tries to bring an overall perspective by bringing out the experiences, information related to this key sector for a wider benefit of the Renewable Energy community. Bioenergy India therefore, is intended to meet the updated information requirements of a diverse cross-section of stakeholders from various end-use considerations, be it biomass combustion, gasification or cogeneration. To meet such an objective in a timely manner, the editorial team of the magazine invites articles, features, case studies and news items, etc., from academicians, researchers and industry professionals.

The contributions should be of about 2,000-2,500 words (approximately 5-6 pages, which would include relevant graphs, charts, figures and tables). The two lead articles would be given an honorarium of ₹ 1,500 each. Please send in your inputs along with relevant photographs to:

**Varnana Sarkar (varnana@winrockindia.org)**
Winrock International India: 788, Udyog Vihar, Phase V, Gurgaon-122 001; Phone: 0124-4303868

# Opportunities for Biomass Energy in Rural India

Despite being the fifth largest producer of electricity, India faces multiple problems over access to it. It has been estimated by the government that India will require an installed capacity of over 200,000 MW by 2012 to meet the electricity demand, which will be 60% more than what the country has at present. About 26% of India's installed capacity for electricity generation is from hydropower, and around 66% from thermal generation, including gas. By 2020, India will require 400,000 MW of electricity. Energy will be required in such a large quantity because of predictions for rapid economic growth.

## Electrification in India: Inter-State Disparities

- As of the end of March 2010, the government reported that 497,398 out of 593,015 villages in India had been electrified (Government of India, 2010) giving an 83.9% rate of village electrification.
- The number has increased rapidly in recent years due to government efforts under the accelerated rural electrification programs and initiatives for "inclusive growth".
- There exist wide inter-state disparities among richer and poorer states in access to electricity.Even in the advanced states, electrification at the village level is not a problem though access to electrification at the household level still remains a challenge.

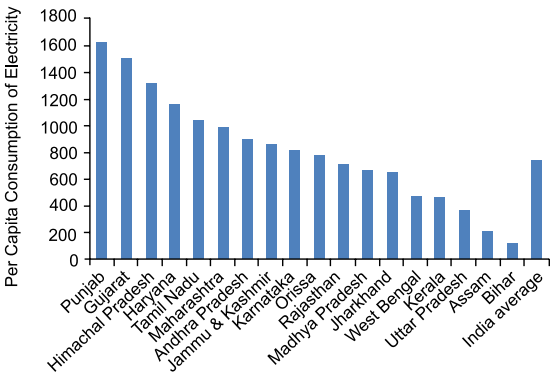
Under the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), the Indian Government aims to electrify all households in the nation by 2012 (Power for All by 2012), which corresponds to the final year of the 11th Five-year Plan (2007-08 - 2011-12). For the last five years from 2005-06 to 2009-10, about 72,000 villages were electrified. Under RGGVY, the central government provides a grant for 90% of the project, and the remaining 10% is loaned by the Rural Electrification Corporation Limited to the state governments. The principal actors in this process of rural electrification are the State Electricity Boards. They are responsible for power generation, transmission and distribution, and they own the intrastate lines. Generally, the easily-accessible villages (those close to the power plants) are connected first, while the remote villages are connected later.

From the table it is clear that there exists wide inter-state disparities among richer and poorer states in access to electricity.

- Bihar, Orissa, Assam, West Bengal and Uttar Pradesh have the lowest electrification rates
- In states such as Punjab and Haryana nearly all the villages had been already electrified by the early 1970s
- Among 16 major states, per capita electricity consumption of Punjab, Gujarat, Haryana, Tamil Nadu, and Maharashtra exceeded 1,000 kWh in 2007-08. On the other hand, for underdeveloped states such as Bihar the figure was as low as 10 kWh.

| State | Percentage of village electrified |
|---|---|
| Andhra Pradesh | 100 |
| Assam | 78.6 |
| Bihar | 61.3 |
| Jharkhand | 31.1 |
| Gujarat | 99.7 |
| Haryana | 100 |
| Himachal Pradesh | 98.2 |
| Jammu and Kashmir | 98.2 |
| Karnataka | 99.9 |
| Kerala | 100 |
| Madhya Pradesh | 96.4 |
| Maharashtra | 88.3 |
| Orissa | 62.6 |
| Punjab | 100 |
| Rajasthan | 71.5 |
| Tamil Nadu | 100 |
| Uttar Pradesh | 88.3 |
| West Bengal | 99.5 |

*Figures as of 31st March, 2010.*
*Source: Ministry of Power' web site (http// www.powermin.nic.in).*




*Source: Indiastat.com (http://www.indiastat.com)*

## Biomass as Fuel

Biomass (plant material) is a renewable energy source because the energy it contains comes from the sun. Through the process of photosynthesis, plants capture the sun's energy. When the plants are burned, they release the sun's energy they contain. In this way, biomass functions as a sort of

natural battery for storing solar energy. As long as biomass is produced sustainably, with only as much used as is grown, the battery will last indefinitely[2].

The amount of biomass resources in India is estimated to be about 565 million tons per year, including agricultural residues and forest residues. The surplus biomass resources available for power generation (not used for animal feed, cooking, or other purposes) annually is about 189 million tons, which can support about 25 GW of installed capacity.

Existing incentives for encouraging biogas production by the Ministry of New and Renewable Energy (MNRE) include:

- Financial incentives for turnkey operations in rural areas
- Loans for developing biogas plants in agricultural priority areas
- Automatic refinancing offered by the National Bank for Agriculture and Rural Development (NABARD).

Biomass resources in India are used for power generation in two general applications:

- Grid-connected biomass power plants (using combustion and gasification conversion technologies)
- Off-grid/distributed biomass power applications (using primarily gasification conversion technology).

## Biomass Gasifiers

Biomass gasifiers convert woody biomass and agricultural wastes like rice-husk, coconut waste, wood, agricultural residues, animal dung etc into a combustible gas which can be used in various applications:

- Burnt like a convenient gaseous fuel in burners for thermal applications
- Fed into diesel engines to save 65% to 85% of the normal diesel consumption
- Fed into gasoline engines to replace gasoline.

Biomass gasifier systems can replace fuels such as diesel, furnace oil and coal to provide electrical and thermal energy needs of industries. MNRE has been promoting comprehensive biomass gasifier programs in rural areas, where biomass such as rice husk, corn cab & stalks, arhar stalks, cotton stalks, small wood chips and other agro-residues are available in surplus and can be utilised locally for generating power.

Special emphasis is being laid on rice husk based power programs especially for rice growing eastern part of the country comprising of eastern Uttar Pradesh, Bihar, Orissa and West Bengal, which also happen to be the regions with lowest per capita electricity consumption. So far about 128 MW (MNRE, December 31, 2010) equivalent biomass gasifier systems have been set up in industries for captive power and thermal applications.

Small power plants of up to 2 MW capacity can be installed locally in a village/hamlet and hence reduce transmission losses by up to 5-7% as compared to large plants of 50-100 MW which have to be installed at a central location and then transmission lines have to be laid to distribute the generated power to generally two or more villages. The same approach would work for biomass based power plants as the logistics of fuel management would become much more manageable and more environment friendly. It is envisaged that hundreds of such plants will come up in the next few years thus improving the transmission infrastructure. Such a role can only be played by renewable sources.

*A 5x100 kW Biomass Gasifier at Gosaba Rural Energy Cooperative, West Bengal*

*A 9 kW Gasifier system installed for Odanthurai Panchayat water supply system in Tamil Nadu*

*A 40 kW Gasifier installed at Pallipalayam Panchayat in Tamil Nadu*

## Gasifier Technology

In the process of gasification, solid biomass is transformed into a gas

that consists mainly of nitrogen (50%), carbon monoxide (20%), and hydrogen (15%). The process results in a combustible gas that can be used in a gas turbine to generate electricity. A turbine based biomass gasifier system can be implemented with the following three technologies:

- Steam Turbine Cycle Technology: This is the conventional technology. However it has very low operating efficiency and requires negative mass biomass feedstock as its input.
- Gas Turbine Technology: Per unit costs in this technology are low and these costs are insensitive to the scale of operation. They are usually of two types:
  - Heavy duty
  - Light turbines
- Combined Cycle Technology

A Gas Turbine Combined Cycle (GTCC) plant uses the hot turbine exhaust gases to generate steam in a waste heat boiler, driving a steam turbine power generator.

## Cost Effectiveness

The energy is generated and supplied in the same area; therefore installation of large power transmission lines is unnecessary.

A small capacity (up to 2 MW) biomass based system can provide sufficient electricity for the following:

- Water pumps
- Battery charging
- Paddy mill
- Welding
- Lighting for households
- Street lighting
- Rice mill
- Aata chakki

## Conclusion

Ernst and Young ranked India the fourth most attractive country for renewable energy investment in the world, only behind the United States, China, and Germany. 150 villages have been covered in last 2 years through mini grid by rice-husk based gasification systems in Bihar.

MNRE has plans to cover about 10,000 villages from biomass-based systems and over 1,000 villages from solar power up to 2022. Renewable power generation capacity in India has been set up largely through private sector investments and has been possible mainly due to a conducive, strong and clear policy framework and investor friendly environment.

New investment is the most potent indicator of growth of the sector. As per an estimate, in 2009 the total financial investment in clean energy in India was at ₹135 billion. Apart from this, Indian Renewable Energy Development Agency (IREDA) and other public sector agencies are also actively funding renewable energy projects.

Maharashtra has a huge potential for biomass power and is also the largest producer of sugar in India. Maharashtra sugar industry is one of the most notable among the large-scale sugar manufacturing sectors in the country. Therefore, small capacity cogeneration plants in sugar mills in Maharashtra using combined cycle biomass turbine based technology can be set up to electrify villages. Private players possessing this technology can collaborate with the Maharashtra state government to set up such plants, since Maharashtra Energy Development Agency (MEDA) already has ambitious plans to set up renewable energy power plants in the rural areas.

The nine districts where huge potential for biomass has been identified, can be used for a pilot launch of such plants and then this technology can be used to set up plants in other states where there is low rural electrification. Since India is the second largest producer of sugar in the word, there exists a huge potential for this technology in states such as Uttar Pradesh, Bihar, Gujarat and Karnataka.

## Endnotes

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***Courtesy:*** **Poonam Gangwal**
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# National Workshop on Dedicated Plantation based Biomass Power and Energy

India has large tracts of degraded/ wastelands, both in forest and non-forest areas. This could be used for raising dedicated plantations of fast growing high yielding plant species suitable for supply of biomass for meeting decentralized electricity and other energy demands on sustainable basis in rural areas. In addition, small megawatt biomass power plants could be set up for feeding power at the tail end of the grid (11 kV line). These plants would ensure power to many villages. Besides they would improve voltage and reduce transmission and distribution losses. In this context, the Ministry of New & Renewable Energy (MNRE) brought together different stakeholders associated in raising such dedicated plantations with the objective to formulate a strategy to provide sustainable and reliable energy solutions at an affordable cost at the grass root level in an integrated and environment friendly manner.

MNRE organized a "National Workshop on Dedicated Plantation based Biomass Power and Energy" during March 22-23, 2011 at Bangalore in association with Karnataka State Forest Industries Corporation Ltd.

The workshop was attended by Mr Deepak Gupta, Secretary, MNRE, Chairman, Karnataka State Forest Industries Corporation Ltd., Bangalore, Chief Secretary, Government of Karnataka, Ministry of Environment and Forest, State Forest Departments, National Bamboo Mission, Ministry of Agriculture, NABARD, State Nodal Agencies, private plantation developers, independent power producers, NGOs etc.

Mr Deepak Gupta, Secretary, MNRE during his inaugural address, stated that there appears to be a vast potential for utilization of dedicated and captive plantations on wasteland or degraded forest lands that would provide the required biomass for small (1-2 MW) plants to feed power into the distribution grid at the tail end. New fast growing varieties of bamboo and other tress have created opportunities for promotion of such dedicated plantations in a short period of time which may require relatively small areas.

Mr Gupta said that it also provides opportunities for greening of degraded land in a manner where trees continuously grow and are harvested thereby helping control emissions also. This would provide further opportunities for rural employment, apart from firm power which would particularly help supply to rural areas. He mentioned that there is a possibility of generating about 10,000 MW power from biomass grown in degraded and marginal lands linked with dedicated plantation of fast growing tree species. The power generation potential could increase many folds provided land become available.

The main aim of the workshop was to discuss and prepare an action plan for promoting dedicated and captive plantations on forest / non-forest degraded lands linked with biomass power projects which would provide the required biomass feed stock for small (1-2 MW) plants which would feed power into the distribution grid at the tail end.

Detailed discussions were held on new fast growing varieties of bamboo and other tress which have created opportunities for promotion of dedicated plantations in a short period of time. This aspect has been included as one of the initiatives under the proposed 'Mission on Green India'.

The main topics of discussion were on biomass plantation based Energy and Power Projects - Prospects & Challenges; Production of elite planting materials of fast growing bamboo; Policy for promoting energy plantation for biomass power projects announced by Government of Rajasthan; and Financing options for raising plantations.

The major issues emerged out during the workshop related to land availability and financing. It was

suggested that three different models need to be initiated.

Firstly, raising dedicated plantation on forest degraded land owned by the State Forest Departments in association with Joint Forest Management Committees and Independent biomass power producers.

Secondly, Forest Corporations raise plantations on their forest land and set up biomass power projects on Public-Private Partnership. A few pilot projects could be developed initially in association with Forest Corporations of Tamil Nadu, Karnataka and Madhya Pradesh.

The third option of developing dedicated plantations on private land.

However, on the major issues related to financing such plantation projects by the banks etc, it was suggested by NABARD that it would be useful to develop appraisal mechanisms for financing plantation projects in close interaction with private developers associated in plantations and state forest departments. It was decided to organize an interactive session with NABARD and other financial institutions during end of April / May 2011 at Madurai where private developers are already engaged in raising such plantations linked with power generation projects and are seeking finances from the banks.

***Courtesy:* Dr D K Khare**
*Director, Ministry of New & Renewable Energy, Government of India*
*Email: dkkhare@nic.in*

# CDM Performance: Analysis of Bioenergy Projects from India Registered During 2010-2011

One of the inherent aspects of the energy produced from biomass is the reduction in GHG emissions achieved when these natural fuels are used in place of conventional fossil fuels.

This principle forms the basis of methodologies available under the Clean Development Mechanism (CDM) to undertake projects that may accrue Certified Emissions Reductions (CERs) subject to successful validation, registration with the EB and subsequent verifications.

However, the quantum of CERs generated depends primarily on the quantity and quality (i.e. calorific value) of fossil fuel replaced. For a single project, if the quantity is substantial then this revenue source should be explored. The PoA approach provides an opportunity to combine small scale projects under one programme and reduce the transaction costs in procuring carbon credits. Hence, the sale of carbon credits to entities, with a commitment to emission cuts, becomes a viable potential source of income. This should be an important consideration for all projects seeking to implement or commercialize biomass solutions.

## Snapshot of CDM Performance

The year 2010-2011 saw the registration of 127 CDM projects, from India. During this period a total of 449 registered projects were hosted in China and 18 CDM projects out of a total of 739 CDM projects registered in the year, were from Brazil.

The figure of 127 registered CDM projects showed an increase of 33, from the 94 projects registered from India during the calendar year 2009-2010.

The registration of projects in a particular year may not necessarily represent the intensity or popularity of CDM activities in that year since the registration period can vary from 3 months to 2 years. Nonetheless the increase in the number of registered projects points towards the carbon markets gaining momentum.

## Biomass CDM Projects

Specifically, the year 2010 saw 24 biomass energy generation CDM projects in our country. Out of these 19 were small-scale projects and 5 were large-scale projects. 5 small-scale projects also involved other parties i.e. organizations from other countries (like United Kingdom, Northern Ireland, Switzerland and Spain) providing indirect assistance. An annual reduction of 963,037 tons of $CO_2$ emissions is estimated through these projects.

## Applicable Methodologies

Analysis of these projects show that three methodologies, applicable to small scale activities, and two consolidated methodologies for large scale projects were followed in these projects. The names of these methodologies are given in Table 1 and 2.

## Analysis of Projects

All the methodologies belong to sectoral scope 1 – Energy industries (renewable / non-renewable sources). The distribution of the projects between the methodologies is shown in Figure 1.

A project, by Social Education and Development Society (SEDS) is setting up 5,000 biogas plants of $2m^3$ capacity for the rural poor in 5

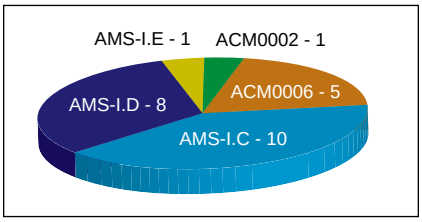



**Figure 1: Distribution of the projects**

**Table 1: Large-scale Methodologies**

| Reference Number | Title |
|---|---|
| ACM0002 | Consolidated baseline methodology for grid-connected electricity generation from renewable sources |
| ACM0006 | Consolidated methodology for electricity and heat generation from biomass residues |

**Table 2: Small-scale Methodologies**

| Reference number | Title |
|---|---|
| AMS-I.C | Thermal energy production with or without electricity |
| AMS-I.D | Grid connected renewable electricity generation |
| AMS-I.E | Switch from Non-Renewable Biomass for Thermal Applications by the User |

Mandals of Anantpur District, Andhra Pradesh. The remaining projects focus on thermal energy or electricity generation for captive purposes and / or feeding into regional grids.

The total power generation capacity from these projects is estimated to be 179 MW. Of this power capacity, up to 150 MW is for the purpose of supplying electricity to the regional grids close to the project locations. The rest of the generation capacity is for captive purposes.

The different types of biomass used in these projects are:

- Rice husk
- *Prosopis Juliflora*
- Bagasse
- Redgram stalks and Bengalgram stalks
- Mustard husk
- Cotton stalks, Chilly stalks
- Saw dust, plywood and other waste wood
- Other agro industrial residues – ground nut shells, cashew nut shells, dal
- Surplus biomass for e.g. stem of tapioca, coconut residue, cane trash, mango kernels,
- Cattle dung (for the biogas CDM project)

Almost all projects used a mix of different types of available biomass with one primary fuel. Figure 2 shows the distribution of the projects on the basis of primary biomass fuel used.

Clearly, rice husk is the most popular type of biomass fuel because of its ready availability, especially in regions with a well developed agriculture sector. The state-wise distribution of projects shows (Figure 3) that the southern states are making efforts to tap into revenue through CDM.

Tamil Nadu registered the highest number of biomass CDM projects during the last year. Andhra Pradesh, Uttar Pradesh, Punjab, Karnataka and Chattisgarh also had more than one registered CDM project. In the coming years, project developers and governments should also focus on developing projects in the North-East regions as such projects contribute towards energy security, provide additional income and add impetus to development of the rural and agricultural sectors.

**Figure 2: CDM Biomass Projects**

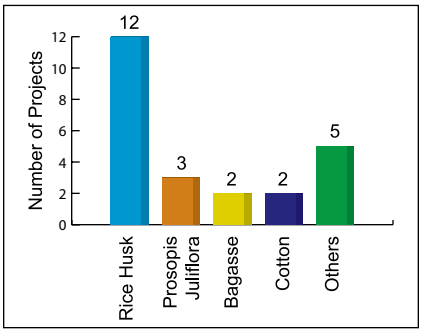



**Figure 3: State-wise CDM Projects**

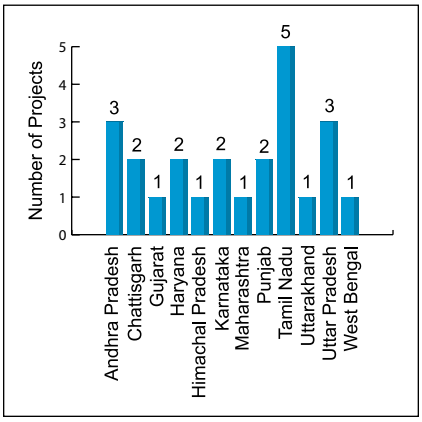



Table 3 gives the registration date, title, reference number and estimated emission reductions from the biomass CDM projects from India in 2010-2011.

## Financing Biomass Projects

There exists an availability of Central Financial Assistance and fiscal incentives at the central and state level and a host of promotional policies by the government of India. This is probably why India has 342, the largest number of registered biomass Energy CDM projects. In all, these projects have over 57,924 kCERs (thousand CERs) to their credit[1].

However, one of the reasons still cited for the inertia in exploring bioenergy alternatives by some project developers is the lack of access to financing options. Moreover, economies of scale have resulted in readily available fossil fuels as a cost-effective solution with established supply chains. In addition, many years of research on technologies which operate on fossil fuels makes their use financially attractive.

## Conclusion

Even though fossil fuels are 'convenient' and uncertainty looms over the CDM process in light of

1. *CDM Pipeline overview from http://cd4cdm.org/*

**Table 3: Registrered Biomass CDM Project from India (2010-2011)**

| Reference Number | Registration Date | Title | Estimated emission reductions in metric tonnes of $CO_2$ equivalent per annum |
|---|---|---|---|
| 2708 | 12-Jan-10 | 15 MW Biomass Residue Based Power Project at Ghazipur, India | 67,259 |
| 2952 | 6-Feb-10 | Biomass based steam generation project by Sterling Agro Industries Ltd. | 18,289 |
| 2998 | 17-Feb-10 | 8MW biomass based power plant at Phagwara | 29,393 |
| 2920 | 17-Mar-10 | 20 MW Biomass Power Project in Tamilnadu | 83,116 |
| 2895 | 6-Apr-10 | Biomass based Power Plant in Polakpalli Village, Gulbarga District, Karnataka | 30,845 |
| 2913 | 9-Apr-10 | Biomass Gasification based Power Generation by Beach Minerals Company Private Limited in India. | 7,936 |
| 3083 | 22-Apr-10 | 20 MW biomass based power project in Maharashtra, India | 71,369 |
| 3173 | 7-May-10 | Biomass based Power Generation near Bargur, Tamil Nadu | 43,488 |
| 2713 | 4-Jun-10 | Bagasse based cogeneration project of Nizam Deccan Sugars Limited (NDSL) | 26,781 |
| 3232 | 8-Jun-10 | Biomass based power project in Punjab, India | 42,657 |
| 3541 | 9-Sep-10 | Social Education and Development Society (SEDS) Biogas CDM project for the rural poor | 15,102 |
| 3563 | 27-Sep-10 | 10.0 MW Biomass based power plant project at Bankura, India | 45,048 |
| 3680 | 2-Oct-10 | Biomass based thermal energy generation at Saber Papers Limited | 74,692 |
| 3181 | 7-Oct-10 | Renewable biomass based thermal energy generation in Mangal Textile Mills (I) Pvt. Ltd. | 33,460 |
| 3591 | 13-Oct-10 | Rice husk based power generation project by MECBL at Raigarh | 59,856 |
| 3148 | 22-Oct-10 | Shree Nakoda Ispat Ltd 12 MW Biomass power generation project | 57,525 |
| 3184 | 2-Nov-10 | Biomass (Rice Husk) based Cogeneration project at M/s Rayana Paper Board Industries Ltd. (RPBIL), Vill: Dhaurahra, Post: Digha, Distt: Sant Kabir Nagar- 272 175, Uttar Pradesh | 10,100 |
| 3817 | 2-Dec-10 | Thermal energy generation from renewable biomass by AIPL | 30,037 |
| 3822 | 4-Dec-10 | 20MW Bagasse based Cogeneration power project at Bannari Amman Sugars Limited, Sathyamangalam, Tamil Nadu by Bannari Amman Sugars Limited | 80,385 |
| 3188 | 6-Dec-10 | Thermal energy generation from renewable biomass by Amir Chand Jagdish Kumar Exports Ltd. | 14,081 |
| 3907 | 18-Dec-10 | Rice Husk based cogeneration plant | 37,393 |
| 3441 | 21-Dec-10 | Biomass power project by Sri Jyoti Renewable Energy Pvt Ltd | 40,935 |
| 3485 | 24-Dec-10 | Biomass gasifier for thermal energy generation by Beach Minerals Company Private Ltd. | 8,102 |
| 3926 | 25-Dec-10 | Biomass based steam generation project at Raichur, India | 35,188 |

the impending expiry of the Kyoto Protocol, the need for reducing GHG emissions will not end with the 2012 calendar year. In any case it would be a fruitful exercise to document the GHG savings from activities focusing on deployment of energy efficiency measures in biomass consumption as well as using biomass as an alternative fuel source for energy generation, as these emission reductions will certainly be a valuable commodity for trading under various trading systems in the pipeline.

## Source

The project details and relevant data for the CDM projects has been obtained from the PDDs and other documentation available through the Project Cycle Search feature available on the UNFCCC website (http://cdm.unfccc.int)

***Courtesy:*** **Dinesh Kapur**
*CLC Division,Winrock International India*
*Email: dinesh@winrockindia.org*

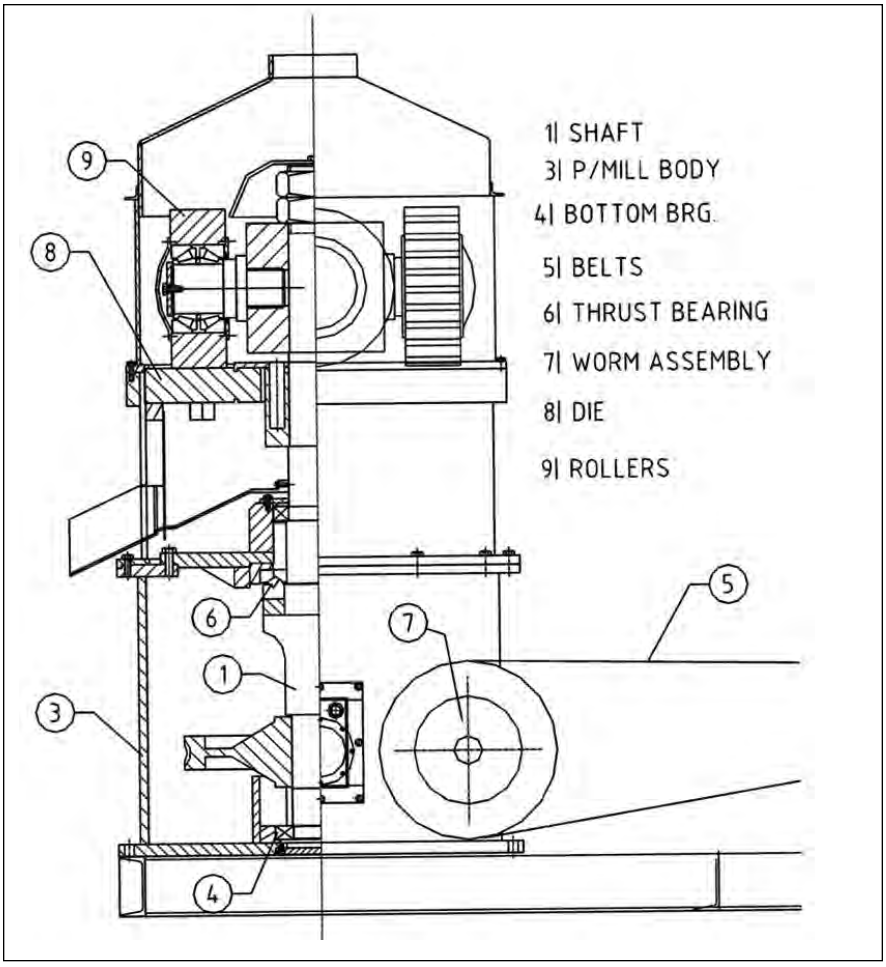
# Need for Pelletizing (Densification)

India with different agro climatic regimes produces 250 million tons surplus biomass annually, which is either not utilized or utilized sub optimally. Processing capacity of 200 million tons of biomass in 10 years till 2020 will not only eliminate import of coal but also cut down on liquid fuel import substantially. Processing capacity of 100,000 ton requires about $1 million and provides direct employment (+ 10 person) and indirect employment in rural areas (4-5 times of direct employment). Total investment in processing 200 million ton will be around $2 billion, which is an insignificant amount compared to renewal fund planned by year 2020.

## Lack of Development

India with more than 1,000 briquetting presses is the most advanced nation in the world in biomass densification. India produces about 3 million tons of briquettes. Addition of 10 million tons capacity each year is a big task. Briquetting is simpler technology as compared to other technologies but has severe limitations which will not allow its growth.

- Product is size specific and does not meet the requirement of user most of the time.
- Unit capacity is low as compared to other densification technology
- Energy consumption is higher
- Handling of briquette cannot be mechanized as per requirement
- Due to above factors briquetting facilities are not going to increase significantly.




## In Contrast to above Pelletizing has following Advantages

- Large plants up to 100,000 tons annual output can be built with one line of 25,000 or more
- Output size is not equipment specific and 8-25 mm dia pellets can be produced from any press
- It is possible to produce following pellet sizes
  - 8-10 mm dia for fluidised bed boiler (over bed fired)
  - 16-18 mm dia for stroker fired or traveling grate boiler
  - 22-25 mm dia for manually fixed grate boiler
- Pellet handling can be mechanized
  - It can be stored in bunkers and unloaded in trucks
  - It can be conveyed pneumatically
  - It can be fired mechanically in any boilers configuration

It is also possible to produce biomass granules having bulk density of 300-350 Kg/m$^3$ to (-6 mm size) convient to fire in under bed-fired fluidized bed boilers (pellet have bulk density of +650 Kg/m$^3$).

## Problems In Pelletizing Fibrous Biomass

Conventional pellet presses are of ring die type and are used for processing animal feed. Most materials are powdery with high bulk density of agglomerate (input feed to pelletizer). Pelletzing is done at a speed of 7-8 meter/sec and pellet die is restricted to 6 mm (quarter of an inch). These

restrictions are real and cannot be relaxed. Since die thickness is 35-50 mm and it cannot make pellet of higher dia than 6-10 mm. Speed cannot be less than this to enable lift of material against gravity.

These problems were solved to some extent. In flat die press speed can be reduced and die thickness can be increased to the extent desired. However moving die could not accommodate easily, thrust desired by fibrous biomass. This led to development of fixed flat die pelletizer. Fixed flat die pellet mill are sturdy and consume less power due to low rotating mass.

## Fixed Flat Die Pelletizer

Fixed flat die pellet presses are built on standard worm gear box with vertical output shaft. As die is fixed, thrust of pelletizing is upward instead downward thus improving working life of gear box.

Fixed Flat Die has following advantage over conventional die:

- It is possible to monitor pelletizing temperature and regulate the temperature by circulating water in the die
- Making the die is much simpler as compared to Ring die
- Replacement/Repair of die is easier
- Pellet press can work much longer in one setting

## Achievement so far in Use of Fixed Die Pelletizer

Although it has been possible to develop high quality fixed die pelletizer but use has not been wide spread due to following constraints:

- Since pelletizing speed is much lower, 2.5 to 3 meter/sec as compared to 7-8 meter/sec in Ring die, output is normally 1/3rd in fixed die as compared to Ring die press and that makes it costly, capacity wise
- There are few thousand Ring die pellet presses in production in India and introducing new and costly product is difficult
- It is a common concept that the pelletizing is not binder less technology and is costlier than Briquetting
- Large capacity biomass pelletizing necessitates, collection pre-processing for size economy, but so far only small capacity plant are operated
- Although there is big demand for pellet but confidence in manufacturing large quantities of pellet mill takes long time and will require some incentive package from MNRE.

## Conclusion

It is expected that based on the experience of few forthcoming pelletizing plants, we will see big growth of pellet plant in India in the next decade (2011-2020) and it will far strip the other technology for densification.

***Courtesy:*** **A.K. Khater,** *Director, Amrit Non Conventional Energy System Limited*
*Email: amritncesltd@gmail.com*

# What to Read


"The Green Miracle," by Clayton McNeff who is one of the creators of the Mcgyan Process is the story of how in less than four years, with the inkling of an idea from a college student, a new multi-feedstock production technology was created to produce biodiesel.

In 2006, McNeff was contacted by one of his former undergraduate college professors, Arlin Gyberg, at Augsburg College located in Minneapolis, Minnesota, on behalf of one of his chemistry students, Brian Krohn. Krohn, a sophomore at the time, and now Rhodes Scholar, was going to conduct a 10-week summer research project on biodiesel. Krohn wanted to pursue producing biodiesel using a catalyst after his research uncovered some relatively unknown papers relating to the subject. As McNeff explains, a catalyst is something that speeds up a reaction and does not get consumed in a chemical reaction.

At the time, current biodiesel production was done by a chemical process called "based catalyzed transesterification." In this process, oil and alcohol are chemically combined to produce esters (biodiesel) in a batch process where the reactants are put in a large tank, heated an stirred vigorously.

Krohn wanted to try using zirconia particles to catalyze the biodiesel reaction and although his experiments didn't work, he sent along some papers to McNeff and that got his mind working in overtime – to the point where he called a meeting during which he suggested they try the very experiment that led to the Mcgyan Process discovery. The name came about after the research team that created it – Clayton McNeff, Arlin Gyberg and Dr. Ben Yan.

So how is this process different? It's a continuous process where you combine an alcohol like ethanol and an oil like corn oil and run it through a reactor filled with a metal oxide catalyst. Then you add heat and pressure to the reactor and in a few seconds contact time the reaction is complete and you have biodiesel. This is all done without chemicals or water. And the Mcgyan Process has yet to meet an oil feedstock it couldn't covert to ASTM standard biodiesel.

If you can shorten a less than four year story even more, after thousands of experiments to understand the chemistry of what they had, the team built a pilot scale facility and from there, a commercial scale 3 million gallon plant called Ever Cat Fuels (Ever Catalyst). While McNeff talks about how he believes this discovery and the consequent journey was "meant to be" it was not without its hardships.

I would be remiss to say that there are hundreds, if not thousands of researchers and entrepreneurs out there looking for the next breakthrough. It's easy to get frustrated. The next time you do. Take a moment to read The Green Miracle. It won't take long to inspire you and along the way, you'll be reassured that America does in fact possess the willpower and the ingenuity to bring solutions to market to address our energy crisis today.

*Source: http://www.biofuelwar.com/2011/03/book-review-%E2%80%93-the-green-miracle/*

# What to Attend

### ACSEE- The Asian Conference on Sustainability , Energy and the Environment 2011

June, 2-5, 2011, Osaka, Japan

International Interdisciplinary Conference on Sustainability, Energy and the Environment is organized by the International Academic Forum (Japan) . Issues such as poverty, hunger, education, health care, and access to markets should be a part of the evolution of any comprehensive sustainability paradigm. ACSEE 2011 will address these various dimensions of human sustainability.

### 19th European Biomass Conference and Exhibition

June 6-10, 2011, Berlin, Germany

The Programme is coordinated by the European Commission, DG Joint Research Centre. For over 30 years now, the European Biomass Conference and Exhibition has combined a very renowned international Scientific Conference with an Industry Exhibition. The EU BC&E is held at different venues throughout Europe and ranks on top of the world's leading events in the Biomass sector.

### International Renewable Energy & Environment Conference 2011

June 24-26, 2011, Kuala Lumpur, Malaysia

The International Conferenceis the leading forum that will bring together renowned researchers, engineers and scientists in this domain of interest from all around the world. The aim is to provide a platform for researchers, engineers, academicians as well as industrial professionals from all over the world to present and share their research, results and experiences in Renewable Energy & Environment.

# News Snippets on Biomass Power

## 1 India's Bioenergy Potential

India's renewable energy sources have the potential to generate 68,000 MW of green power costing under ₹6 (€0.098) per unit, according to a report by funding agency The World Bank.

The study, titled Potential of Renewable Energy in India, states: 'Developing indigenous renewable energy sources, which have low marginal costs of generation, are more economically viable in the long run.'

According to the study, the 68,000 MW can be produced from a variety of renewable sources, including biomass, wind and hydro.

The nation currently produces around 1,70,229 MW of energy from all sources, but the nation's demand for electricity is expected to rise by 7.4% a year during the next quarter of a century. This will see generation capacity increase five-fold in India is to supply this growing demand.

The nation's government has set an ambitious target, which, if met, could see at least 40,000 MW of additional renewable energy capacity installed.

The state of Madhya Pradesh holds much of India's biomass potential, however this is currently largely undeveloped.

*Source: http://www.bioenergy-news.com/index.php?/Industry-News?item_id=3215*

## 2 Punjab to Generate 1,000 MW by 2015

In a bid to reduce manure pollution levels the state of Punjab, India aims to generate 1,000 MW of renewable energy from agricultural waste by 2015.

Excessive amounts of cow manure are proving problematic for cities such as Ludhiana and are a major source of pollution for the region.

In addition to livestock waste Punjab also produces 21 million tons of rice straw and other biomass crop residues annually. The Punjab government now plans to generate 10% of its total energy output from renewable sources in five years' time.

Already in operation near Ludhiana is a 1 MW biomethanation plant – a facility dedicated to enhancing the production of methane through the addition of microbes known as methanogens. The facility produces 18,000 kWh of electricity from 235 tons of cattle manure. It also makes 45 tonnes of organic manure a day which can be used to fertilise the fields.

To date, the Punjab Energy Development Agency has commissioned 318 MW of renewable energy projects. These include 250 MW of biomass co-generation plants, 28 MW of biomass power plants, 37 MW of small hydro projects and 2 MW of solar projects, in addition to the 1 MW biomethanation facility in Ludhiana.

However, according to the agency, there are a further 132 MW of renewable power developments currently under construction, including 100 MW of co-generation, 20 MW of standard biomass and 11 MW of hydro. This means that by 2012 around 700 MW of renewable energy will be generated in the state.

According to the deputy chief minister Sukhbir Singh Badal, farmers are now earning around ₹4,000 (€65) per acre per year by selling agro residues to biomass plants.

*Source: http://www.bioenergy-news.com/index.php?/Industry-News?item_id=2781*

## 3 Electricity from Waste for Bangalore

In Bangalore, India, a landfill waste-to-electricity plant has been installed at K R Puram. Following two decades of research Scalene Energy Research Institute (SERI) provided the technology for the power plant. Spiral Protium Accelerated Reactor Super Enrichment (SPARSE), SERI claims that its technology is the first of its kind in the world.

The technology has not yet been commercialised but the advisor to Ministry of New and Renewable Energy Mr. A. Shukla believes that the cities would become cleaner and less polluted should the technology be developed on a large-scale basis. A number of companies have expressed interest in erecting similar plants in the region, including the UB Group, Global Green Energy Parks and Malankara Plantations.

*Source: http://www.bioenergy-news.com/index.php?/Industry-News?item_id=2709*

## 4 IFC to Invest in SEGL

The International Finance Corporation (IFC), the private investment arm of the World Bank, could invest up to $30 million (€21.5 million) in Andhra Pradesh, India-based renewable energy company, Shalivahana Green Energy (SGEL).

$15 million of the funds will go towards financing SGEL's renewable power projects, while the other $15 million will be provided to the fully owned subsidiary of SGEL – Rake Power – in project debt financing.

To date SGEL's five operational biomass power plants generate 47 MW between them. The company will soon add an additional 200 MW to its production capacity once it's other projects, currently at various stages of implementation, have been completed. Three of SGEL's biomass plants are expected for Q2 2011, generating approximately 45 MW in total.

Rake Power, already with 10 MW of installed capacity, has two 23 MW plants planned for Jharkhand and Orissa, which will cost $25 million each. IFC's $15 million loan for Rake Power will be up to 12 years.

*Source: http://www.bioenergy-news.com/index.php?/Industry-News?item_id=3324*

## 5 Thermal, Biomass Power Plants to come up in Bihar

Electricity-starved Bihar is setting up five thermal power plants of 7,000 MW capacity and others based on gas and biomass, say officials adding the sector has attracted private investment worth hundreds of crores of rupees. "More than anything, Bihar attracted private investment in the power sector till March 31, 2011" said an official of the Bihar State Investment Promotion Board (SIPB).

The thermal power plants, of 1,320 MW each, will be set up at Kajra in Lakhisarai, Piparpainti in Bhagalpur, Areraj in East Champaran and one in Banka district. Besides, a plant of 2,640 MW will be set up at Rajauli in Nawada district. "The proposal for establishing five new thermal power plants has been approved by the government," an official said.

According to official sources, the plant in Lakhisarai is estimated to cost Rs.8,343 crore, Piparpainti Rs.7,374 crore, Areraj Rs.7,300 crore, Banka Rs.7,960 crore and Rajauli power plant Rs.14,800 crore.

SIPB officials said investment proposals to set up gas- and biomass-based power plants in Rohtas, Gaya and Kaimur districts have also been cleared. Industry Minister Renu Kumari Kushwaha said changing Bihar had attracted private investors.

"Big and small industrialists are showing a keen interest in Bihar after Chief Minister Mr Nitish Kumar initiated measures to develop infrastructure, including power," she said.

In view of the shortage of power, Mr Nitish Kumar has also asked top officials to review progress in procuring power from non-conventional energy sources.

Millions in Bihar are still living in the lantern age as electricity has become a luxury for people in most parts. Capital Patna is an exception of sorts, but most small towns and district headquarters are badly hit by the power shortage.

While the state has a daily requirement of 2,200-2,500 MW, it produces only 45-50 MW of power. The central government supplies around 750 to 900 MW. The state is facing a power deficit of around 1,000-1,200 MW a day, officials said. Energy Minister Mr Bijendra Prasad Yadav has said time and again the power situation cannot improve unless Bihar's own generation and central allocation is increased substantially.

*Source: http://articles.economictimes.indiatimes.com/2011-04-14/news/29417579_1_power-plants-sipb-power-sector*

## 6 Railways to Build Biodiesel Plants

According to a report in the Economic Times, two of the plants are to be built at Raipur and Chennai during the next two years, the other two units will be built later. Each plant is expected to cost Rs 300 million and will produce up to 30 tons of biodiesel a day. The plants will use waste oil, fatty acid and non-edible vegetable oil as a feedstock and the biodiesel will be blended with the HSD oil for running the trains the report says. The use of biodiesel is expected to earn the railways Rs 20 million a year in carbon credits. The Railways currently consumes 2.2 billion litres of diesel a year. Indian Railway Organisation for Alternative Fuels has been formed to take up projects to introduce alternative fuels such as CNG and biodiesel.

*Source: http://www.thebioenergysite.com/news/8082/railways-to-build-biodiesel-plants*

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