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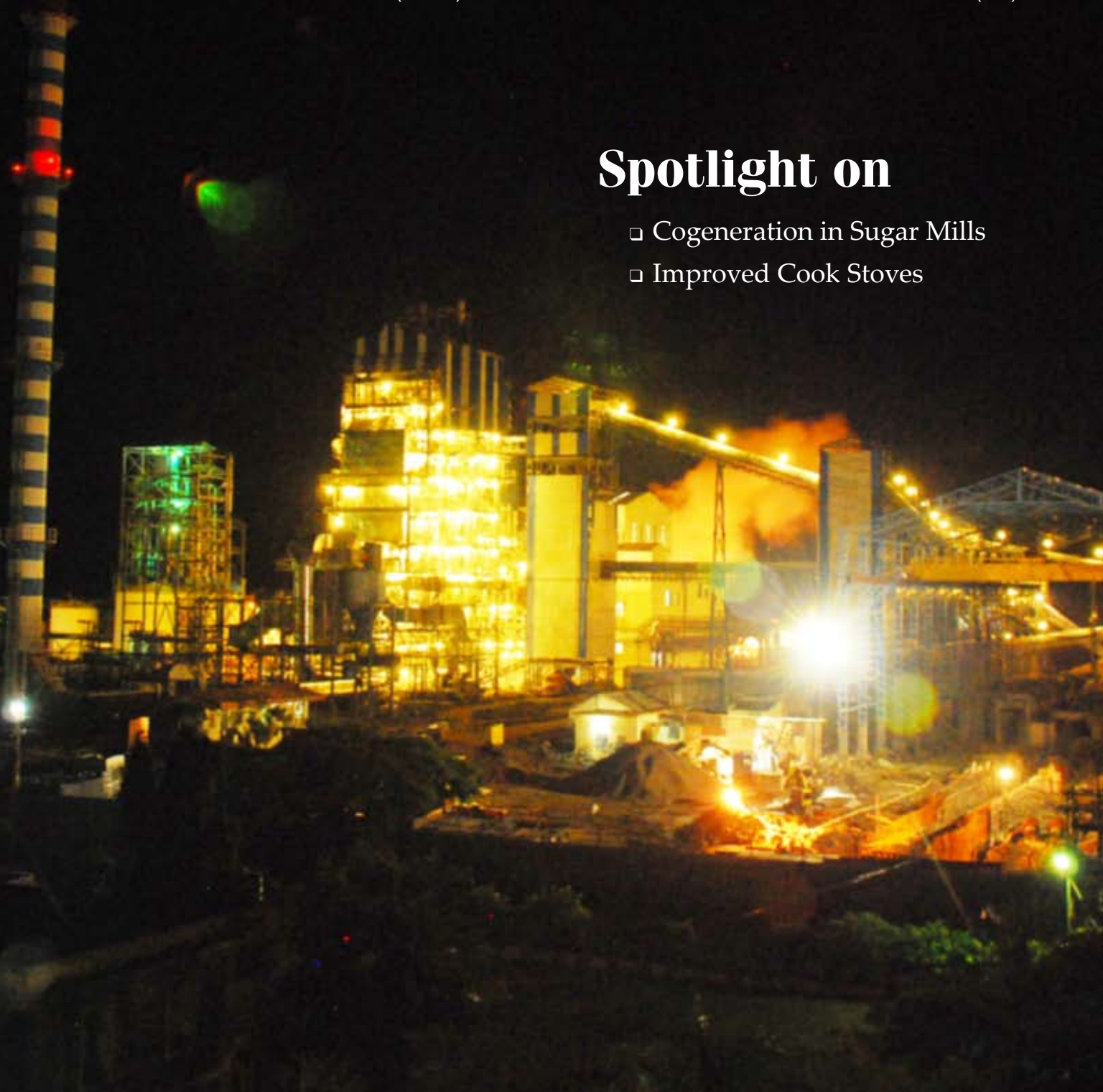
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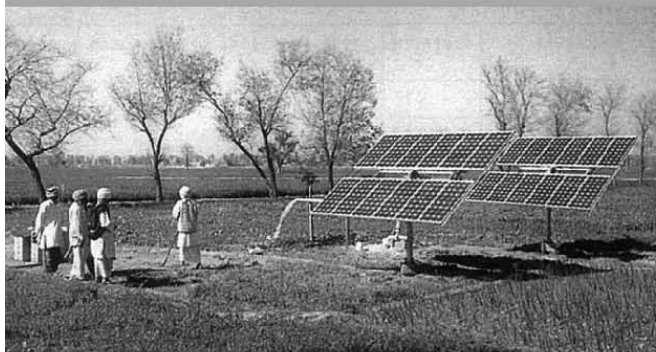
Spotlight on

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FROM THE EDITOR

Dear Readers,

It gives me immense satisfaction to present you with the fifth issue of Bioenergy India. And as we step into the second year of our journey, we have attempted to add a tinge of freshness and vibrancy to the magazine.

The cover story this time tries to put a focus on different viable business models and strategies aimed at promotion of cogeneration in relatively small sugar mills. Through a field visit to three cooperative owned cogeneration units in Maharashtra, the issue aims to put a perspective to the diverse topic. Cogeneration in sugar mills is not a new invention. The fact that it is being done at a larger level through usage of efficient technology surely makes it a subject of interest for surplus energy generation by sugar mills.

The issue also features snapshots from Renewable 2010 global status report, which among many other positive trends of Bioenergy across the globe, also identifies the fact that biomass cook stoves are used by 40% of the world's population. It also emphasizes on the new generation of more-efficient "improved" biomass cook stoves which has emerged over the years and are being used by more than 160 million households worldwide. This issue offers space to one of such commercially successful models of environment friendly and energy efficient wood burning cook stove from the roadside eateries in the southern state of Tamil Nadu.


Documenting best practises in the bioenergy sector has been a key focus area for the editorial team of the magazine. Taking this ideology forward, this issue features the success story of a small entrepreneur (who repairs agricultural machines in Hanumangarh in Rajasthan) whose innovative biomass based gasifier and engine got him an award from the National Innovation Foundation.

To keep our readers informed about the international scenario, we continue with our series of comparative analysis of biomass policy of other countries. This time, the focus is on the Brazilian policy, a country that has been instrumental in setting trends in bioenergy usage across the globe.

The magazine with encouraging feedbacks from the readers is constantly engaging itself to grow and mature as a contemporary and informative piece of reading. However, we strongly believe that for Bioenergy India to become a quality reading journal, we continue to greatly depend on our readers and contributors without whose inputs, this magazine would have never landed on your reading table.

With hopes that the magazine with the revised look refreshes your eyes and mind, we look forward to your support and participation.




(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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We found the publication very useful and informative and we are sure that your magazine will spread awareness about the bioenergy sector among the users.

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I have been following the Bioenergy India Magazine for a while now. It is really good. Good work!

*P Ramana Reddy,
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A road map for promotion of cogeneration in small sugar mills

The success of bagasse cogeneration is not only dependent on the choice of technology, but also on the soundness of the business model that ensures steady revenue stream. It streamlines the sale of electricity to the utility and proposes suitable strategies to overcome the barriers (technological, institutional and financial). This revenue stream helps sugar mills to overcome inherent fluctuations in the sugar market (which has an effect on the price of sugar and the mill's bottom line) so much so that some sugar mills consider themselves to be

in the business of producing electricity in which sugar is being considered only as a by-product by them.

Few viable business models, with estimated potential for cogeneration and strategies for promoting bagasse cogeneration in sugar mills are discussed below.

Business Models

Own investment model

The sugar mills implement the project with their own equity, borrowings from financial institutions and subsidies for commercial projects

from Ministry of New and Renewable Energy (MNRE) under the revised Program on Biomass Power/Biomass or Bagasse cogeneration. The sugar mill can avail loan from various financial institutions and banks after submitting a detailed project report. Cooperative sugar mills avail loan through National Cooperative Development Corporation (NCDC) and/or other financial institutions or banks. Soft loan is available from Sugar Development Corporation. Subsidy for reducing the loan amount can be availed from MNRE.

IPP-BOOT model

Investment model between Independent Power Producers (IPP) or Project developers and a sugar mill, with IPP developing the project on build, own, operate, and transfer



(BOOT) basis is also one of the viable models. In this mode, the project developer arranges for the equity and loans from financial institutions to implement the project. The project developer and the cooperative sugar mill sign a project development agreement for about 15 to 20 years under which the transfer of bagasse, water, condensate, and land comes from the sugar mill while steam, electricity, ash / effluent, incentive or royalty is to be provided by the project developer. At the end of the agreement, the project developer transfers the assets to the sugar mill or continues to operate. The advantages of this model are:

- ❑ All risks are borne by the developer who brings fund raising capabilities and project skills.
- ❑ Monetary benefits to sugar mill in addition to power and steam supply without any equity participation.
- ❑ Sugar mill could be incentivized for improved operational efficiency
- ❑ No difficulty in raising small size of capital
- ❑ Faster project implementation.

Joint Venture (JV) Model

In this model, the Joint Venture Company develops cogeneration facilities at sugar mills in the group on a BOOT basis. This model of development enables large IPP's to make sizeable investments in several cogeneration projects enabling standardization of design, equipment, and facilities. The concerned state government and sugar mills could invest a small equity portion with the balance equity coming from the JV Company.

Lease financing, under which the equipment required for the project can be leased out by leasing companies.

The range of lending norms of various Indian financial institutions is presented in table 1. The securities typically include a bank guarantee or government guarantee or equitable mortgage, post-dated cheques, letter of credit, personal guarantees of the directors, corporate guarantee and escrow account, all together or in combinations depending on individual norms.

Table 1: Range of lending norms

Item	Range
Debt Equity Ratio (DER)	4:1 to 2:1
Rate of Interest, %	14 to 15.5
Moratorium period	6 months to 3 years
Repayment period	10 to 12 years
Front end fees, % of loan amount	1 to 2
Processing fee, ₹	10,000 to 60,000

SPV Model

Special Purpose Vehicle (SPV) is formed by a company or associations or registered co-operative society to generate power. In this model, the owner of the bagasse based cogeneration project to be set up, adjacent to the sugar factories generating surplus power using bagasse as main fuel. The SPV will

export the surplus power thus generated (after meeting the mills captive power requirement) to the state electricity grid.

Joint Venture / IPP-Co-operative Mill Models

In order to address the growing needs of the co-operative / public sector sugar mill, private investments were facilitated through Joint Ventures and IPP-cooperative sugar mill models by a few state nodal agencies such as Maharashtra, Punjab and Tamil Nadu. Financial incentives in the form capital subsidy to these models are provided by MNRE. The capital grant amount is increased as the temperature pressure configuration increases. Joint Venture partner will bring in state-of-art technology, skills in project implementation, and operation and maintenance. It is possible to standardize equipment for individual cogeneration projects and thus, avail bulk discounts to bring down project costs.

Estimated potential for cogeneration in Sugar mills of less than 2500 TCD

The cogeneration potential from about 128 sugar mills of 1,250 to 2,499

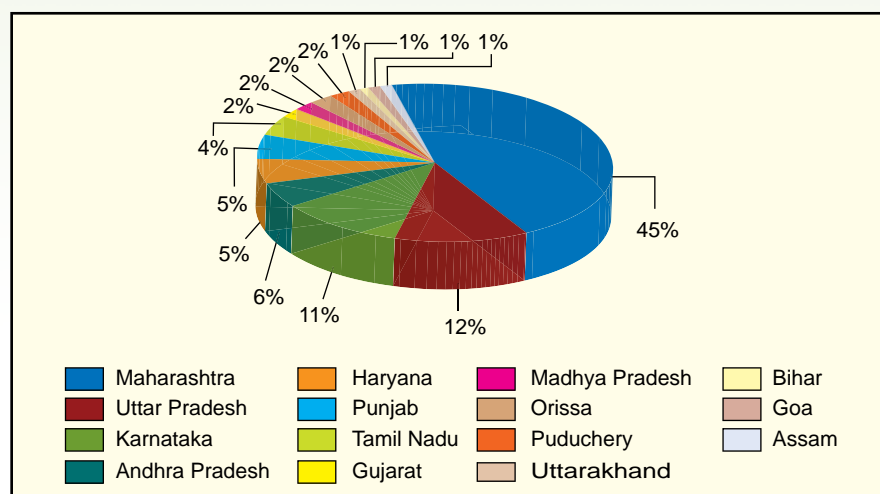


Figure 1: Share of different states in cogeneration potential in sugar mill

TCD spread across 15 states has been estimated at 1,074 MW, as per a study sponsored by MNRE if it involves deployment of high pressure boiler configurations of 60 ata and above, against the conventional 22 ata or 32 ata pressure boilers used in the sugar mills. Figure 1 shows the share of each state as percentage of total estimated potential.

Strategies

Of the potential of 1074 MW, the surplus power that can be exported to grid is estimated approximately 644 MW (assuming that 40% of the power generated by cogeneration plant will be consumed in sugar mill (26%), colony and administration (2%), and cogeneration plant auxiliary consumption (12%). However, as discussed earlier, there are layers of financial, regulatory and technical barriers to realize this potential. The strategies for overcoming these barriers, which would facilitate promotion of cogeneration in small sugar mills, are discussed below. For ease of comprehension, the recommendations are categorized into three broad heads: (1) technical, (2) institutional, and (3) financial.

Technical

Standardization of technologies & packages

The lack of standardization of cogeneration technologies for high pressure configuration in small sugar mills is a major technical barrier. Hence, there is an urgent need to standardize, package document, and validate the technologies for economically viable and technically feasible export oriented cogeneration in these mills. The benchmarks for performance and evaluation for different institutional and business

models should be developed and documented for wider publication through workshops.

Need for setting up demonstration units

There is a dearth of success stories on the performance of high pressure cogeneration system for small sugar mills. It is critical to design, develop and demonstrate technically and economically viable cogeneration in small sugar mills. Hence, the sugar mills which are financially doing well, keen to improve business shall be identified in major sugar producing states such as Maharashtra, Uttar Pradesh, Karnataka, and Andhra Pradesh for exploiting cogeneration potential. The Ministry may consider additional incentives for the first few demonstration projects over and above the incentive schemes in vogue for cogeneration projects. Such demonstration projects shall help in up scaling/mainstreaming high pressure cogeneration projects in small sugar mills and also contributing to instill confidence in FI and bankers.

Establishing off-season fuel linkages

Establishing off-season fuel linkage is critical for extending the cogeneration plant operation to function beyond the crushing season (100 to 180 days of crushing depending on state and agro climatic conditions) and for improving commercial viability of the cogeneration project. Some sugar mills like Panduranaga SSK Ltd and Ugar Sugar Ltd have successfully demonstrated innovative off-season supply system comprising of utilization of cane trash as fuel. MNRE can also promote establishment of distributed decentralized biomass collection centers / biomass banks for collection of biomass residues directly

from farmers, dealers, industries, municipalities, etc.

Optimization of sugar mill performance

The inefficient technologies of small sugar mills significantly restricted the generation of surplus electricity and results in high bagasse/biomass consumption. Upgradation of existing sugar mill operations is an important aspect for ensuring the success of a cogeneration power plant. The operative efficiency needs to be improved through replacement of various process section equipments. The additional investment varies from ` 3 to ` 10 crore for mills of various capacities and simple payback period ranges from 15 to 30 months depending on the size of the mills and the choice of technological options. To ascertain power availability throughout the year, multi-fuel fired boilers should be promoted / encouraged.

Institutional/Regulatory/Policy

Awareness generation

One of the major barriers is lack of awareness amongst the industry and key stakeholders regarding opportunities and benefits of implementing exportable power from cogeneration projects. Keeping this in mind, MNRE may seriously consider supporting conduction of awareness raising events, information dissemination campaigns regarding technologies, potential for cogeneration, benefits of cogeneration (profitability, environmental & social, etc), financing aspects, financing schemes of financial institutions & banks, fiscal incentives and other incentives offered by the central government, state governments, tariff related information, project

development issues, regulatory and policy aspects, etc.

Capacity strengthening of sugar mills

As sugar mills today employ outdated systems, there is a lack of technical and managerial capacity in small sugar mills for implementation of high pressure configurations for export of surplus power to the grid. Hence, there is a need to address this issue by identifying specific capacity building needs, devise time bound capacity building programs and implement the same in primary focus states. As MNRE previously has supported such capacity strengthening projects for mills above 2,500 TCD, the same can be organized for the small sugar mills too in different states focusing on technology, O&M, project development, off-season fuel linkages etc. In plant training and workshops would help in dealing with operational risk using upgraded systems.

Need for appropriate replication strategy

There is a need for developing roadmap and time bound replication

strategy for accelerated deployment of advanced cogeneration, which may encompass and integrate technical assistance, capacity building of stakeholders, information dissemination, and financial support.

Financial

BOOT- the most suitable business model

The promising approach to implement bagasse cogeneration projects in small sugar mills, given the challenges faced by the sector (lack of financing, perceived risks, lack of managerial & technical capacity of the mills, etc.) is the BOOT method, which is explained in detail in the previous section. Such viable business models will also improve the confidence levels of investors and regulators.

Extending SDF funding

At present, sugar mills lesser than 2,500 TCD are not eligible for receiving funding from Sugar Development Fund (SDF) for setting up bagasse cogeneration projects. MNRE may recommend to the Ministry of Food Processing & Civil supplies for

considering sugar mills of 1,250 to 2,499 TCD for financing under the present SDF scheme for sugar mill cogeneration.

Norms for financing

MNRE may formulate suitable norms separately for bagasse cogeneration schemes of 1,250 to 2,499 TCD sugar mills (like minimum boiler pressure/ temperature, eligible capacity range of sugar mills) for availing the capital subsidy for setting up cogeneration projects.

Conclusion

It is concluded that there is a good potential for bagasse cogeneration from 128 units and implementation of bagasse cogeneration system can be successfully achieved by adopting the above business models and strategies which would generate additional green power and income to the owners of the sugar mills.

*Courtesy: Sobhanbabu PRK, Program Manager and CK Kumarswamy, Program Officer, Winrock International India, Hyderabad, AP
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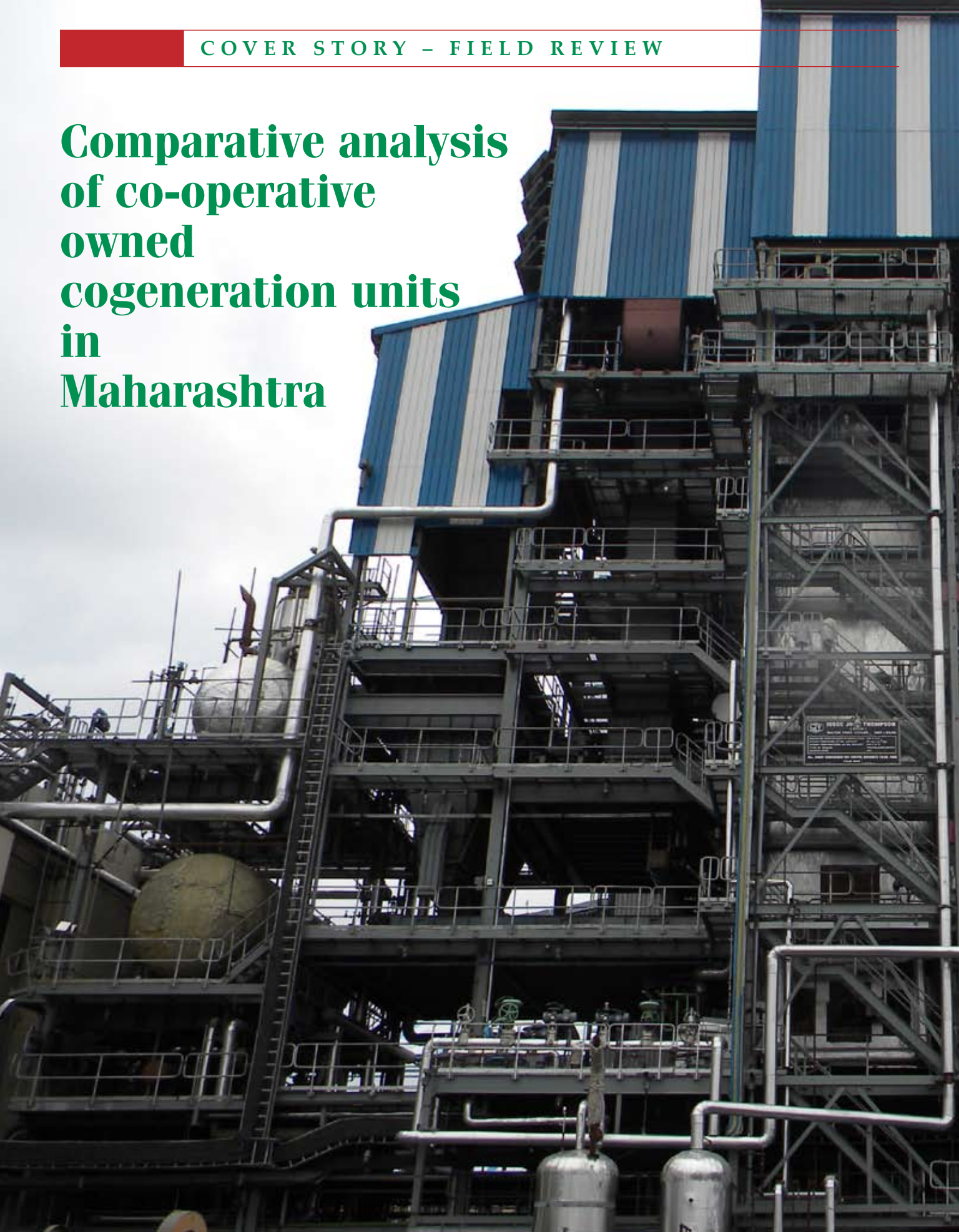
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Comparative analysis of co-operative owned cogeneration units in Maharashtra



Globally energy demand is increasing due to rapid industrialization and urbanization. In a developing economy like India, rate of growth of energy demand is at much faster pace than increase in supply. Increasing demand has led to increase in cost of energy, hence high power tariffs for consumers and therefore adding impetus to search for alternatives and new solutions.

The Ministry of New and Renewable Energy (MNRE) has been supporting grid-interactive power generation based on various renewable energy sources including bagasse based cogeneration projects. This article aims to present a comparative case study of three such initiatives in bagasse cogeneration projects by co-operative sugar mills in Pune and Satara districts of Maharashtra.

Situation Analysis

Being a country that is the second largest producer of sugar cane in the world after Brazil, the exportable surplus potential from about 525 operating sugar mills in India is about 5,000 MW. And despite sustained efforts of decade by MNRE and other agencies, only 20% of the estimated potential has been achieved till date. Though an additional 1,591 MW (30%) is achievable from projects under construction, however a huge potential remains untapped.

The cogeneration projects in the sugar mills has been a win – win case because over the years, due to the expansion and diversification of sugar mills, their energy needs, both during season and off-season, have multiplied. They often require high-cost grid power and additional fuel

Table 1: Details of the three co-operatives visited

Name of the Cooperative	Location	Year of start of operation	Sugarcane crushing capacity (MT per day)
Malegaon SSK ¹	Baramati	1955	4,000
Someshwar SSK	Baramati	1961	4,000
YM Krishna SSK	Satara	1955	7,200

¹SSK= *Sahakari Shakar Karkhana (Cooperative sugarcane factory)*

both during season and off-season. Therefore by putting up cogeneration projects, the sugar mills have not just fulfilled their energy needs but also generated an additional revenue stream by sale of exportable power to State Electricity Boards (or third party customers). The projects have also benefited the environment by reducing the greenhouse gases (GHGs) in the atmosphere in terms of the usage of biomass as fuel.

In this context, site visit of three sugarcane co-operatives in Maharashtra which have recently commissioned bagasse based cogeneration units, was undertaken by a team from WII. All the three sugarcane co-operatives which were visited for this study started their operations in the decade spanning 1950-1960. A summary of the three cooperatives is given in table 1.

Focus of the visit was to understand the similarities and differences in business models adopted by the three cooperatives for their cogeneration units. The next section tries to encapsulate the comparative picture on different criterion.

Comparative Assessment of Business Models

Comparative analysis of business models for the cogeneration units of these three cooperatives includes conception of business, raw material sourcing (feedstock), load

management, financing, processing technology, performance analysis, strategic linkages and the social impact envisaged by the cooperatives. This analysis will help readers and policy makers understand the similarities and differences which have figured these units, key conducive elements which have worked well and the one's where further policy dialogue is needed.

Conception of the Business

Advances in technology as well as unforeseen factors in the past few decades with rising sugarcane prices are now exerting pressure for yet another shift in the pattern of energy supply and consumption which hopefully can provide an optimal solution for the coming decades. This advantage coupled with upfront financial support from government led these three co-operatives for further increasing their sustainability by experimenting and setting up a cogeneration unit, which not only meets their captive power and heating requirement but also generates surplus power for creating a separate revenue chain for its farmer members. Summarily, conceptualization of business is on similar lines for all the three co-operatives, with difference lying only in size of power plant due to different crushing capacities. Therefore initiation of the cogeneration units has primarily happened due to proactive approach adopted by MNRE and broader outlook of the management of these three cooperatives.

Table 2: Bagasse required during season and off-season

Cooperative	Season					Off Season
	Cane crushed	Bagasse production	Available bagasse after deducting losses	Bagasse used for boiler	Bagasse saved for off-season (MT)	Bagasse required in off season (MT)
Malegaon SSK (21 MW)	200 TCH*	60 TPH	58 TPH	49 TPH	31,680	29,868 (For 6.76 MW)
Someshwar SSK (18 MW)	166.67 TCH				51,120	61,120
YM Krishna SSK (Current installation – 16 MW)	300 TCH	90 TPH		88 TPH (Cogen- 35 TPH, Sugar Mill - 48 TPH)	20,000-30,000	30,000-35,000 (50 days operation)

* Tonnes crushed/hour

❑ Raw Material Sourcing

Technically, sugarcane is a highly efficient converter of solar energy and, in fact, has the highest energy-to-volume ratio among energy crops. Bagasse² generated after crushing of sugarcane is proposed as main feedstock in all the three co-generation plants. During the season entire bagasse required is proposed to be procured from the cooperative's sugar plant. Internally, cost of bagasse is accounted as zero during season. The average number of days for which the power plant operates with bagasse as fuel ranges from 160-180 days. During off season, all three units propose to use saved bagasse. For additional requirement, they purchase bagasse from other sugar mills. Malegaon SSK puts into operation only 1/3rd of the installed capacity during off-season. Therefore, they have commissioned two different capacity boilers and turbo-generators. SSKL is more progressive in outlook for operating the power plant even in

off season by saving more bagasse.

They are trying to optimize the process steam consumption to about 38 percentage on cane (as against 45 percentage) which will lead to saving in higher quantity of bagasse. Summary of bagasse required against power generation for the three plants is presented in table 2.

Effective load management is the key for ensuring viability of renewable energy based power projects. Next section presents a comparison on strategy adopted for load management by the three cooperatives.

Load Management

Across the three cooperative's, power and steam generated from the cogeneration unit is used by:

- ❑ sugar mill
- ❑ for power requirement of distillery
- ❑ cogeneration unit for its internal consumption
- ❑ Surplus power exported to grid.

Cost of steam and power supplied to sugar plant by cogeneration unit is internally accounted as zero.

Remaining power and steam which is sold to distillery and grid is cost accounted in all the three cooperatives. A comparison of power distribution

planned in the three cogeneration units is presented in table 3.

Technology choice

The efficient operation of a cogeneration system intrinsically depends upon the technology chosen. This has a direct bearing on loss in power generation if entire power was exported to grid. Cogeneration based on Rankine Cycle is not new to the sugar industry, however cogeneration based on high pressure boilers and extraction condensing or straight condensing machines are definitely new. Cogeneration, by virtue of the fact that the excess power could be sold to the grid or to a third party for a price, puts a demand on the sugar industry for modernization, discipline and for energy conservation and this is new to the sugar industry. A study³ conducted on a 5,000 TCD sugar mill in Tamil Nadu which made transition in boiler technology from low pressure boiler system to high pressure boiler system reveals some of the critical factors affecting the power generation (quantified as loss in generation per day) as:

- ❑ 1% drop in bagasse % in cane: 18,300 units
- ❑ 1% increase in moisture content in bagasse: 6,800 – 10,200 units

² The sugar cane containing minimum 30% fiber is referred as bagasse and is used for the generation of power. The bagasse is fired in the boiler for producing steam at high pressure, which is extracted through various single high capacity turbines and used in the process.

³ Venkatesh; Roy (May, 2010), GulBarga University

Table 3: Power distribution planned in the co-operatives

Cooperative	Season				Off-Season	
	Cogen internal consumption (MW)	Power to sugar plant (MW)	Power to distillery (MW)	Power exported (MW)	Cogen internal consumption (MW)	Power to sugar plant (MW)
Malegaon SSK (21 MW)	6.3	0.8	13.05	0.9	0.8	5.06
Someshwar SSK (18 MW)	1.8	4.0	0.3	11.9	1.75	0.3
YM Krishna SSK (Current installation –16 MW)	1.5	4.0	11.0	1.5	0.6	14.0

- ❑ 1% increase in process steam consumption: 4,200 units
- ❑ 1% drop in crushing rate: 5,000 – 7,400 units
- ❑ 1 hour downtime: 20,600 units.

Conclusions from this study reveal that choice of plant and machinery for cogeneration power projects is very critical for achieving high degree of efficiency. The cogeneration project with modernization and energy saving measures are expected to make optimum use of available bagasse generated during the season operation.

In sync with the conclusion from the above study, all the three cooperatives decided to undergo modernization and replaced the low pressure boilers with high pressure boilers. All three cogeneration units are employing extra high-pressure boiler configurations of 67 kg/cm² or 87 kg/cm² (against the conventional 32 kg/cm² or 42 kg/cm² pressure boilers used in the sugar mills). A comparison of BTG in terms of their capacity and manufacturer is presented in table 4.

Apart from revenue generation from sale of power, spill over effect of modernization is considerable. For illustration, Malegaon SSK anticipates savings to the tune of Rs. 166.8 Lakhs/

year due to modernization efforts. Break up of how this saving will be achieved is shown in table 5.

Financing Mechanism

Financing of the cogeneration units in the three cooperatives has been through a mix of debt and equity. Up to 10 percentage of the capital cost has been provided by farmers as member's equity. Remaining amount has been taken as loan from Sugar Development Fund (SDF), National Cooperative Development Corporation (NCDC) and other sources by the cooperatives. MNRE as a part of its initiative to support such renewable energy projects has provided upfront subsidy of the project cost to Someshwar SSK. From table 6, it's clear that average cost per MW is Rs. 4.5 crore except in Malegaon SSK for which the figure is 3.19 crore per MW. Project cost in Malegaon SSK appears to be under

valued considerably. Comparative study of sub-component costs reveals that cost of plant and machinery in Malegaon SSK is considerably lower (Rs. 2.33 crore per MW) than other two cogeneration plants. Summary of financing for the three projects is presented in table 6.

Performance Analysis

Performance analysis is attempted at two levels:

- a) Cogeneration units as an independent entity - Comparison on financial projections and operational costs is done for the cogeneration units
- b) As a combined unit with Cooperative - Comparison on power export potential of the three cooperatives.

At the outset, readers may kindly take a note of the fact that this performance analysis is based on projections and

Table 4: Boiler and turbine generator capacities

Cooperative	Boiler	Turbine Generator
Malegaon SSK (21 MW)	80 TPH+ 40 TPH	1* 14 MW (backpressure)
		1* 7 MW(double extraction condensing)
Someshwar SSK (18 MW)	100 TPH (87 ata, 515 °C)	1* 18 MW (extraction cum condensing)
YM Krishna SSK (Current installation –16 MW)	90 TPH (87 ata)	1* 16 MW (Double extraction condensing)

Table 5: Estimated savings in Maharashtra SSK plant

Savings	Amount (in Rs. lakh/year)
Savings in oil and lubricants	50
Savings in repair and maintenance	40
Savings in labor cost	60
Savings in power	41
Reduction in cost of production	20.80
Total savings	166.80

current installed capacity. Since two of the power plants have recently begun their operations and one is still under trial, therefore it will not be prudent to do a comparison on actual performance at this stage. On this understanding, this section presents the comparative performance analysis from the financial projections and pre-decided power sharing mix in the Detailed Project Report (DPR).

Projected Financial Strength

From the table of financial performance analysis (table 7) it can be inferred that Internal Rate of Return for Malegaon SSK is highest, however as discussed in the earlier section of financing mechanism, that this might be because of underestimation of total project cost. Figure of 32.2 % IRR in cogeneration projects is considered to be high and therefore Malegaon SSK, possibly needs to reconsider the assumptions taken for financial projections. Comparison with YM Krishna SSK couldn't be done as the organization was unwilling to provide the financial projections of its cogeneration unit.

Table 6: Financial details of the co-operatives

Cooperative	Total cost of project (lakhs)	SDF (%)	NCDC / MSC (%)	Member's equity (%)	Other sources (%)
Malegaon SSK ⁴ (21 MW)	6,717.92	40	50 (NCDC)	10	0
Someshwar SSK ⁵ (18 MW)	8,681.46	30	55	5	5 % (State Govt.) + 5% MNRE subsidy
YM Krishna SSK ⁶ (Current installation - 16 MW)	7,372	30	50	20	

⁴ Plant Capacity Utilization- 90% First year operation, 95% second year onwards

⁵ Plant Capacity Utilization- 80% First year operation, 85% second year and 90% from third year onwards.

⁶ Plant Capacity Utilization- 85% First year operation, 90% second year and 95% from third year onwards

Per Unit cost of Power Generation

Estimation of per unit cost of power generation is an important parameter to adjudge the operational efficiency of any power project. However in the three cogeneration units, with the information at hand, it's difficult to explicitly calculate the cost of power generation. Key cost elements like actual cost of bagasse from sugar mill to cogeneration unit during season, unit sale price of power and steam from cogeneration plant to sugar mill and salary structure of the staff directly involved with cogeneration unit and opportunity cost of the land could not be elicited during the visit.

Internally these cost elements have been taken under barter transaction and therefore cost calculations in DPR are not truly representing the cost of power and steam generation.

□ Power Export Potential

Ability to export more amount of power vis-à-vis what is internally used indicates cooperative's acumen in managing its internal heating and power requirement. From the table 3 of power distribution, we find that percentage per MW export of electricity during season in the three cooperatives stands at Malegaon SSK: Someshwar SSK: Yashwantrao

Table 7: Financial performance analysis

Cooperative	IRR (%)	Break Even Point (%)	NPV (Lakhs)	Pay-Back Period (years)	Average DSCR
Malegaon SSK (21 MW)	32.19	32.20	3,430.65	5	2.43
Someshwar SSK ⁷ (18 MW)	23.77	46.35	5,020.55	4.2	2.52
YM Krishna SSK (Current Installation – 16 MW)	NA ⁸	NA	NA	NA	NA

⁷ Based on Power Export price of Rs. 3.05/unit, however later on price has been revised to Rs. 4.79/unit

⁸ Financial figures were not divulged by the organization.

SSK= 62.12:66.1:68.79. Therefore, YM Krishna SSK will be able to generate better returns for its farmer members with sale of higher quantum of power to grid, when compared in terms of per MW installed capacity due to effective management of its internal energy requirement. Moreover, Yashwantrao SSK has tied up with Tata Power for sale of electricity at Rs. 4.89/ Unit which is higher than sale price of electricity by other two cooperatives who are in agreement with State Electricity Board.

Future Plans

Yashwant Rao SSK will further expand its installed capacity from 16 MW to 30 MW in the coming year. Other co-operatives will continue with the current installed capacity. Profit from the revenue generated through sale of electricity will not be shared with the farmers, in all three co-operatives, until complete debt is paid off. Discussion with officials of the co-operative revealed that after repayment of the entire debt, they are expecting to double the patronage refund to the farmers.

Social Impact

All the three cogeneration projects are institutionally within the ambit of respective sugarcane cooperatives. Therefore direct social impact from the cogeneration units cannot be visualized at this stage except the benefit of direct employment generation for about 30 persons in each plant. However within the “command area”, all three cooperatives have undertaken many social initiatives which will be discussed in this section. Management of the three cooperative's

feels that with additional revenue from sale of power, they will be able to give better returns to farmer members and the associated social activities will also see a boost up.

Malegaon SSK Ltd specially has been extremely focused in making increased social impact as an integral part of their growth story. The Shivanagar Vidya Prasarak Mandal established by the co-operative runs Schools, Polytechnic, Pharmacy, Degree Engineering College and even MBA course. Housing hostels for male and female student's along with production cum training to ensure

All the three cogeneration projects are institutionally within the ambit of respective sugarcane cooperatives which have also forayed into educational initiatives. The fact that the organizations are contributing back to the society by empowering kids and youths with education, sends a clear message about the commitments of the cooperatives.

the benefits of earning while learning to the students in the campus, these institutes taken together are a source of education to more than 3,000 students. Among many other activities, the cooperative has also played active role in construction of house for homeless in the locality and also contributed towards construction of a livestock and cattle breeding centre in the vicinity of the plant area.

Similarly, Someshwar SSK and Yashwant Rao Mohite SSK have also forayed into educational initiatives in their respective areas of operation. Though the activities are at the initial stages, nevertheless the fact that the organizations are contributing back to the society by empowering children and youths with education, which indeed is one of the most important tools driving the economy, sends a clear message about the commitments of the co-operatives.

Conclusion

Considering the dynamics under which co-operatives function, commissioning of high capacity cogeneration units by these co-operatives is definitely a daunting step, especially when seen from the fact that farmer members will not be deriving any benefit until entire loan is repaid. Adoption of modern high pressure boilers clearly reflects the commitment of these cooperative units towards becoming competitive vis-à-vis their private counterparts. The three key elements which these cooperatives have managed very well viz. developed linkages for financing of the project, institutional arrangement for sale of power and hiring professionals for operation of the cogeneration units would be the key pillars for success of the cogeneration units. However, it will be really worthwhile to see how two entirely different set of businesses viz. sugarcane crushing and power generation will be effectively managed by the co-operatives in the long run.

Courtesy: Sharda Prasad Gautam & Ashirbad S Raha
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IREDA and KfW promote Sustainable Biomass Power Generation India

The German KfW Development Bank and the Indian Renewable Energy Development Agency (IREDA) Limited have been working together successfully for 11 years in the area of promotion of renewable sources of energy and energy efficiency. In October 2009, KfW Development Bank opened a new chapter in their cooperation with the signing of a third loan agreement, which aims in particular at financing of Model Investment Projects in the field of biomass based power generation. By means of this loan (EUR 20 Million / approximately Rs 120 Crores), biomass power plants with model character are financed to find innovative solutions for technical, institutional and organizational problems which are still a hindrance in commercial use of such power generation.

Biomass, especially in the form of agricultural and industrial waste is available abundantly in India. Therefore, an efficient utilization of disposable biomass is consequent and can contribute to a climate friendly power generation. In order to identify "Model Investment Projects", KfW and IREDA tried something new in comparison to previous financial cooperation credit lines. A competition for the best project concepts was started and made public nationwide with the intention of reaching down to those projects, which are most

promising with respect to innovation, environment and social aspects.

Before the competition started, IREDA and KfW identified 4 project categories to promote, which are:

- ❑ Biomass power plants, which are based on bagasse and work together with sugar cooperatives
- ❑ Biomass power plants, which use agricultural waste
- ❑ Biomass power plants, which use industrial biomass waste aside from the sugar industry (e.g. paper industry)
- ❑ Biogas facilities

The project selection criteria for the "model investment projects" were presented in the call for bids and interested project developers were then called to make appropriate project proposals to finally "gain" an attractive financing for their project. Exclusion criteria were the violation of social and environmental standards, forest clearance, insufficient availability of biomass in the project region etc.

A total of 22 project proposals were rated under a scoring system with the help of the following criteria: innovation character, replicability in India, environmental and social aspects, reliability of biomass supply-concept, capacity of final borrowers, investors and developers, operating efficiency of the projects, etc.

Together with a Consultant team (Ecofys Germany and Winrock International India), a detailed assessment methodology was developed and the rating was executed by the biomass-division of IREDA. After that, IREDA and the Consultants visited 10 selected projects and verified their descriptions. Finally, IREDA chose seven best projects under the mentioned criteria. These model projects are to supply clean electricity to approximately 3,80,000 people and are following the objective of the Indian Government of a green, social and sustainable economic development.

As a result of this Indo-German initiative, one can hope to see several innovative biomass based projects being promoted. Two projects namely, M/s Shree Renuka Sugars Ltd (24 MW bagasse based cogeneration plant), Kolhapur District, Maharashtra and M/s Amreli Power Projects (P) Ltd (10 MW biomass power project), Amreli District, Gujarat have already been approved under this collaborative project. Five to six more innovative biomass projects across the country are in the pipeline, which will be approved under this credit line soon.

*Courtesy: Arndt Wierheim, Jan Schilling and Ramana Reddy, KfW Entwicklungsbank, Germany
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Opportunities and constraints for market driven stove enterprises

Cooking on the street side is a very common business, especially in small towns. The cooks work long hours preparing tea, snacks and meals and deliver low cost meals typically to migrant labor, students, and generally poor people away from home. Data collected by Technology Informatics Design Endeavor (TIDE) shows that these businesses operate for 330 days in a year and for 10-12 hours in a day and they end up consuming 50-250 kg of firewood / other biomass every day.

In India and other developing countries, firewood is the preferred cooking fuel of the informal industries and street food vendors because it is the cheapest fuel and is available everywhere. Research in just one state of south India, Tamil Nadu, shows that there are about 73,650

small and medium hotels, street food vendors and other commercial kitchens (making just dosas and fried foods) that use firewood signifying the need and the potential impact of intervention. Some of them use more than one stove. There is no regulation in the consumption or trade of firewood and its cost has increased by 250 percent in the past five years. The high cost of firewood is eroding the profitability of these small businesses and there is an urgent need to intervene technologically and financially with better cooking solutions.

Besides local impacts and accompanying challenges, the problem is also of resulting deforestation, avoidable use of fossil fuel for transportation of biomass contributing to climate change. The small

businesses source their fuel from the firewood depot. TIDE has tracked the movement of firewood from the point of generation (a wooded area) to the point of consumption (the small business). South India is an equatorial region with reasonably high rainfall, good forest cover and endangered biodiversity. High density mature wood coming from different species has been observed in the wood, lots being traded pointing to deforestation, loss of biodiversity, water runoff and other indicators of ecological disaster waiting to happen. There is an urgent need for an intervention with fuel efficient, safe cook stoves that would be acceptable both to the owner of commercial kitchens and also to the cook.

Traditionally, the dissemination of environment friendly and energy

efficient wood burning stoves was subsidized by the Ministry of New and Renewable Energy (MNRE) with the main objective of meeting social and environmental goals, rather than as a profit making, scalable business enterprise. There is an underlying assumption that clean technologies, especially cook stoves are not commercially viable. However, Sustaintech India Pvt. Ltd. (SIPL) a spin off commercial venture by key members of the Council of Management of TIDE believe that a market driven approach (undoubtedly tough, complex and demanding) would enable rapid and sustainable adoption of fuel efficient wood burning stoves. This is especially possible when improved cook stoves are sold to commercial kitchens where fuel is purchased unlike the household stoves where fuel is collected. This conviction is based on experiences with successful pilot projects with grass root entrepreneurs. Market research based data also suggests that it is entirely viable to set up a profitable business, focused on carefully identified stove designs but for commercial kitchens.

Expected social, economic and environmental impact

The environmental, social and economic benefits of a commercial cook stove venture are very high and this would lead to enormous goodwill for the business promoter. The promoters of SIPL are aware of both the potential profitability and the responsibility of reaching out to meet the needs of a fuel stressed segment of society – initially the street food vendors, who operate on push carts and where cooking is done inside the cart or on railway platforms, roadside shops and small hotels with a roof and some seating capacity.

Considering that the stoves are in operation for about 10 hours every day and each unit caters to a minimum of 100 clients every day and assuming that SIPL can sell 75,000 stoves with similar usage patterns then the stoves would offer a healthier and safer working environment to 75,000 cooks and 7.5 million people who eat around these stoves every day. India has a high incidence of respiratory ailments and a smoke free working environment would reduce the medical expenses of the affected people working around wood fires.

At the global level, shift to a fuel efficient wood stove would significantly abate CO₂ emission. At a projected sale of 75,000 stoves, and assuming the life of the stove to be five years, the stoves would abate close to 3.2 million tons of CO₂. Also, even at a very conservative selling price of ₹ 2,000 / ton for firewood over the next five years, the stoves for making *dosas*, fried snacks and tea alone would save ₹ 20,000 – ₹ 30,000 of fuel costs every year.

Understanding the market

To understand the magnitude of the business and to evolve a strategy for market penetration, TIDE commissioned a study with a market research agency. The study gave useful insights about what consumers were looking for in an improved stove which included the preferred attributes, their willingness to pay for an improved stove etc. The study also showed that firewood would continue to remain the cheapest and hence the preferred fuel and innovations around it have a potential of acceptability.

Other learnings from the survey were:

- ❑ Extensive market development efforts are required to build awareness, realize the potential and target stakeholders

- ❑ There is a need to educate customers on the cost benefit analysis and highlight the benefits holistically, besides the fuel savings. It is important to highlight the differences between fuel efficient stoves and other similar looking products.
- ❑ There is a need for several demonstrations of the fuel efficient stove at strategic locations with clear explanations.
- ❑ Establishing the network and creating awareness can take about 3-5 years, given the unorganized and widespread nature of the industry.
- ❑ Even customers extremely willing to use fuel efficient firewood stoves, have some concerns on the operation and fuel efficiency claimed. A good wood burning stove can displace a kerosene stove and it would reduce the stress associated with the procurement of kerosene and improve the profitability of the business.
- ❑ No suppliers have so far been able to survive/sustain in the market largely because of the need for multiple competencies especially during the start up phase. Sales can be expected to grow after the initial struggle of establishing the concept and its benefits.

The Business model

The business model and the proposed linkages between TIDE, SIPL and PYRO centres is presented in Figure 1.

Product range: The starting product range is the tava stove, the kadai stove and the tea boiler.

The PYRO Tava stove is a multipurpose stove where cooking is done on a flat plate. This is designed for making *dosas*, *chapattis*, *parothas*,

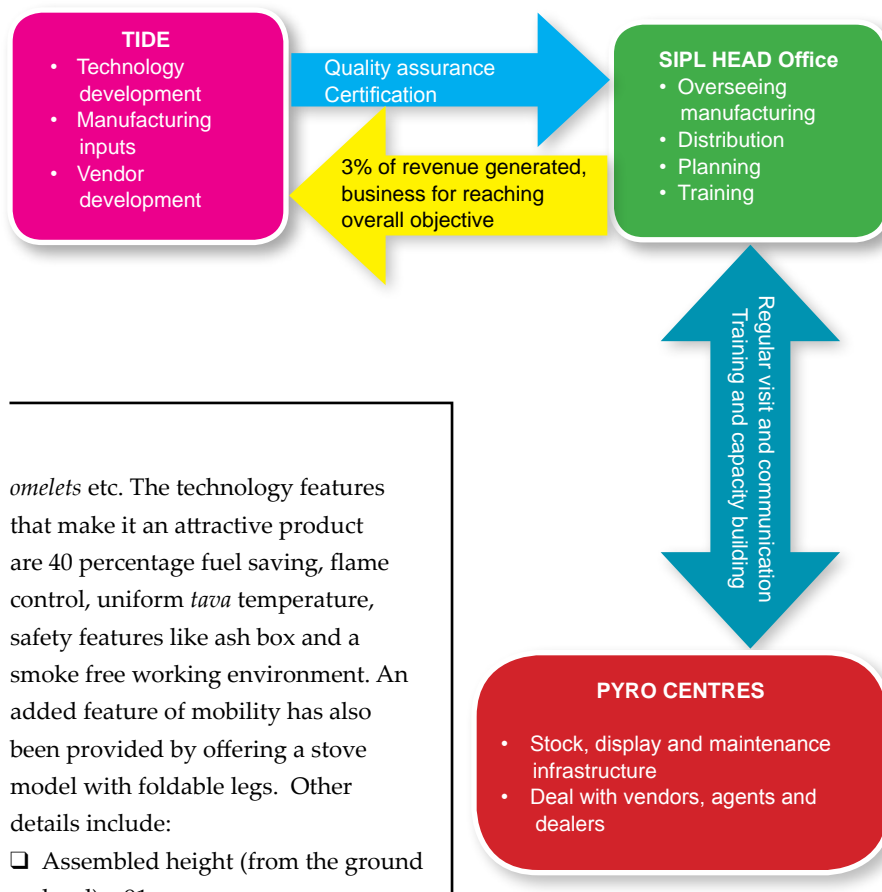


Figure 1: Business model and proposed linkages

omelets etc. The technology features that make it an attractive product are 40 percentage fuel saving, flame control, uniform *tava* temperature, safety features like ash box and a smoke free working environment. An added feature of mobility has also been provided by offering a stove model with foldable legs. Other details include:

- ❑ Assembled height (from the ground level) – 91 cms
- ❑ Total weight including legs – 110 kgs
- ❑ Tava dimensions: length: 90 cms; width: 60 cms
- ❑ Thickness: 16 mm
- ❑ Material: Mild Steel
- ❑ Insulation: Cold face insulation brick

The PYRO Kadai stove is a frying stove designed for user convenience when making *wadas*, *bajjis*, *bondas*, *murukkus*, etc. The technology features that make it an attractive product include a finned *kadai* (so that the heat transfer is better and the oil attains the high temperature very quickly), fuel efficiency, heat regulation, smokelessness (because of use of a chimney) and mobility. To ensure that the stove is useful when cooking is done either in a standing and sitting posture, there is a facility to embed the legs in the ground to adjust the height of the stove. Other details include:

- ❑ Assembled height (from the ground level) – 91 cms
- ❑ Total weight including legs – 44 kgs
- ❑ Kadai: outer diameter 50 cms, thickness 3 mm
- ❑ Material: Mild Steel,
- ❑ Insulation: Cold face insulation bricks

The PYRO Tea stove is a stove made of stainless steel and is used to prepare tea, coffee, boil milk in a water bath which is heated using firewood. The stove components include different vessels for tea / coffee decoction and for the milk / water that are fully dipped into the water bath. This water bath is always simmering to keep the liquids at the tea serving temperature. This stove occupies less space and it comes with its own stand. Other details include:

Weight of stainless steel – 23 kgs

- Capacity - 15 lts water bath for 3 lts milk & 25 lts water bath for 5 lts milk
- Kadai - outer diameter 50 cms, thickness 3 mm.
- Material - Stainless steel body with mild steel stand
- Insulation - Ceramic wool

The supply chain

Manufacturing

The manufacturing of the stoves has been outsourced to a manufacturer having the necessary infrastructure and surplus production capacity. More manufacturers are being located close to the current sales outlets. Except for the chimney that would be sourced locally, the manufactured stoves are ready to install in user sites. Before the stoves leave the manufacturing facility, they are quality certified by TIDE, branded and then released into the supply chain.

Sales & marketing / supply chain

SIPL has realized that its strength must lie in market penetration and distribution. It has proposed the creation of PYRO centres in about 25 locations and one centre is currently in operation. Each centre would have about 10 sales agents. These would serve as demo centres, stocking points for products, sales outlets and delivery points for sales, marketing efforts, also installation and support services.

SIPL is also leveraging existing distribution channels and has forged linkages with two distribution partners. SIPL Head Office and PYRO Centres would be responsible for all marketing related activities. The team at the Head Office is focused on identifying production partners and in production, inventory management, supply chain, market development &

expansion, brand building, advertising & promotion, decisions about expanding reach etc.

Product and customer support

SIPL is currently strengthening its PYRO centers and agents by providing marketing assistance, promotion / publicity material, stocks, commitment for installation and maintenance support, product and supply chain finance etc. All stoves carry a one year warranty. Post warranty repairs would form a revenue stream.

Credit from partner

SIPL has developed a consumer finance linkage with the Indian Overseas Bank. The bank is now offering consumer finance for SIPL products at very attractive financing schemes. This sector has not accessed consumer finance in the past and the success of the bank scheme is vital for the effective implementation of the business plan.

Barriers

The experience of TIDE and recently of SIPL in selling stoves has enabled them to identify key barriers, especially in the start up phase. These barriers are largely in four main categories (i) Technology matching (ii) Lack of awareness about the potential and positive aspects of improved stoves (iii) Absence of a distribution network and (iv) Financing.

i) Technology matching

For a stove business to be consistently successful, it is important to design stoves that meet the expectations of the users without compromising on key non negotiables like fuel efficiency, low emissions etc. Shift to a fuel efficient stove requires at least a minimal shift in cooking habits like feeding less firewood than in a conventional stove

and the cooks must align themselves with this change.

The factory produced stoves must also have features for easy transportability and be light weight to the extent possible. Again a trade off would be required between cost and life of the stove and stove manufacturing must optimize the use of steel. Here, lessons from household stoves cannot be applied because user perception of a stove for commercial cooking is that the stove must be heavy and rugged to be long lasting. This mind set influences the decision making of the owner and the cook. When attempting to make a sale, the customer usually asks for a customized solution, typically the stove must be able to use the existing flat plates (*tavas*) or frying pans (*kadais*). However, a factory produced stove cannot meet this user need. So, before developing standardized stove designs, SIPL carried out a survey amongst potential users of existing vessels etc. so that the standardized product is very close to user expectations.

ii) Lack of awareness about the positive aspects of improved stoves

SIPL experienced that there is both lack of awareness about the positive aspects of improved stoves amongst the potential customers and skepticism among the different elements in the supply chain especially the financial institutions. The most powerful marketing strategy has been the installation of demonstration units and allowing cooks and owners to experience comforts and profits with the shift to a new stove. This would create good word of mouth publicity which would then translate into sales. The TIDE experience in the past has shown that this strategy

has worked and for the launch of a new stove, it is very important to have several demonstration units at strategic locations and plan awareness campaigns around these stoves. Data collected from the users of the demonstration units has been the key in awareness meetings with industry associations, with government and for other promotional events. To create awareness in this manner, it is also important that the finances are planned and sought for the first critical number of stoves. Also in this case, awareness creation for a financing partner is very important because a consumer finance scheme is a critical need in an unsubsidized go to market strategy.

iii) Absence of a distribution network

Traditionally wood burning stoves are either constructed on site by masons or crude fabricated designs are made by local fabricators with no knowledge of biomass combustion or optimizing heat transfer. SIPL has explored distribution of improved institutional stoves through existing networks of kitchen equipment but rejected the option because the clientele of standard kitchen networks are families that buy electric chimneys, microwave ovens etc. A street food vendor does not visit these outlets. SIPL also explored the firewood depots as stockists of fuel efficient cook stoves where the owners of small hotels buy their fuel but as fuel efficient cook stoves would reduce the business potential of the firewood depot, this network rejected the stove. Currently, there is no distribution channel for the stoves and the fact that it has to be built from scratch is a major barrier to stove dissemination. Besides being an expensive option, building the network is also risky because a good product in a wrong network would destroy the market for the same. The

absence of a distribution network is perceived to be a very important barrier and extremely expensive to overcome.

iv) Financing

SIPL has experienced enormous resistance among financial institutions to accept that a product like a fuel efficient stove can have features like improved air quality, better respiratory health of the cooks, fuel saving, arrested deforestation and shift from fossil fuel usage. Financial institutions are only recently getting interested in energy products. There is a resistance amongst the financing community especially with regards to after sales service. Some MFIs have faced difficulties with energy loan products in the past due to poor technical performance after initial installation. In most cases, this has been due to low attention to after-sales service as a key component of the MFI/energy enterprise relationship and offering to clients. This service component of energy offerings is critical to the financial institution as

technical risk is time and again cited as the biggest obstacle to financing clean energy products. SIPL has encountered this challenge more than once in their attempt to forge alliances with consumer finance partners.

It has also been experienced that tie-up with MFIs would also pose challenges. The focus of MFIs is primarily on lending to groups and female clients. Considering that SIPL clients are both men and women and commercial cooking is not necessarily a group activity, it assessed that an MFI is not the appropriate consumer finance partner.

SIPL has been extremely fortunate to have recently forged an alliance with a visionary bank like the Indian Overseas Bank for its consumer finance scheme. A very user friendly consumer finance option eliminates the need for a long-term government subsidy. Another key challenge to the stove business is investor interest. SIPL has again been fortunate to attract

interest from investors who seek social and environmental returns and not just financial returns.

SIPL has thus understood all the aspects of commercialization of a stove business from the stage of innovation to that of enterprise. The innovation stage is exciting, but beyond innovation, biomass energy is an unglamorous grass root level business. A stove business must build on its expertise and experience of the promoters so that several thousands of people benefit through higher incomes and better health. As a pioneer in the business, SIPL also looks forward to make the business easy for other later entrants and create enabling mechanisms for other biomass energy businesses with potential to deliver public good.

*Courtesy: Svati Bhogle
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Biomass based gasifier

Rai Singh Dahiya (46) of Hanumangarh in Rajasthan has never been to school and yet he is no common man. Having developed an efficient biomass gasifier where he has changed the conventional design, especially of the filters and cooling unit to get clean gas, ensuring smooth operation of engine at low operational cost, he is one of those innovators from small pockets of the country who are weaving stories of silent changes.

By profession, Rai Singh is engaged in the repair of agricultural machines, pumps and allied machines. While he has had no formal education, he has gained knowledge on science and technology by dismantling and repairing gadgets, and exposure to radio programs.

Being a regular listener to BBC radio for science programmes, such as "Gyan-Vigyan", since childhood, he enhanced his knowledge of science and technology. This program motivated him to tinker and develop new concepts. In 1979, he was working in the fields when the engine of a pump broke down. Instead of finding a mechanic, his brother asked him to fix it. He struggled the whole day but succeeded in setting it right finally. This gave him a new confidence and understanding about engines and their functioning. His major innovation so far has been the biomass based gasifier and engine that got him the award of

National Second in the Energy and Environment category in the Fifth National Grassroots Innovation Awards. He also developed other ideas like foot operated valve, car running on battery charged by windmill, which uses vehicle motion to rotate the windmill blades.

Genesis of Innovation

In 1982, he set up a kiln for baking bricks with a capacity of about 12,000 bricks at a time. In this kiln, he observed that burning of wood and other fuel was also producing some gas, which was burning more vigorously. Later in 1991, he set up his workshop for repairing tractors, jeep, trucks and other engines. Looking at the increasing demand of diesel engines in agricultural sector, he modified it to operate on LPG as the cost of diesel was growing and operating it on LPG was economical. When this experiment was successful, he wondered if it was possible to run the engine on the gas produced by burning wood instead of LPG and it was then that he decided to build a device to generate a gas to run diesel engines. After a series of experiments, he finally developed a system, which consisted of a gasifier that could convert biomass into producer gas. The conventional diesel engine was modified by replacing diesel injector set-up with a spark plug and a fuel pump with a distributor set up. This gasifier could run the modified diesel engine, but for a very short duration.

Rai Singh realized soon that the engine was not performing well due to the impurities in the producer gas fed into it. He worked out several mechanisms, and filtering sieves, and then developed a filtering mechanism so that pure gas could be supplied to the modified engine. Initially four such systems were developed and installed in the village and local people were trained to operate them. The latest unit of the gasifier system is capable enough to operate 40 hours continuously with reduced maintenance.

The Biomass Gasifier

The unit consists of a gasifier, which generates producer gas from biowaste and uses it to run an engine. The gasifier is conical in shape, compact in design and surrounded by a water jacket with the capability to handle multiple fuel sources. Fuel wood or briquettes from agricultural residues can be fed to this gasifier.

The air inlet is provided at the bottom. The system has two stages for removing ash, charred residue and tar. The primary filter unit comprises a series of rows of filtration units; each series consists of a rod over which semicircular baffles having perforation are welded. Perforation becomes progressively smaller from the first to the third filtration unit. The filter can easily be cleaned by pulling out the rod with the baffles. It is surrounded by a water jacket. The secondary filter

has layers of different sizes of sieves ranging from 2" to very fine size, with the cleaning gate at the bottom.

The Process

First, the bio-waste is deposited in the gasifier unit from the top. This unit acts as a furnace and heats up to 200 °C to generate the producer gas. The gasifier is monitored and fed continuously for about first 30 minutes. Aspirator is turned on for sucking producer gas until the flame appears. Later, the supply of air from the bottom is cut off. The producer gas is then passed through the first cyclone where water cooling is done; the gas is cooled and partial cleaning is also achieved. The gas then goes through the second cyclone, which removes carbon and ash based residues. Now the gas passes through the filtration unit consisting of sieve grills and cloth. This cleans up the gas completely. After cleaning, the gas is fed into the mixer unit, which mixes the gas with air in the right "fuel-air ratio", which is set for the engine and power rating. There is a calibration mark for optimal ratio based set by the innovator, but the user can override that and choose his settings. Alternatively, the nature of

the knocking sound, which changes at optimal ratio, can also be used as a cue for optimal mixing ratio setting. The fuel mixer then feeds the fuel air mixture onto the modified engine, which runs on this clean fuel. This biomass-based gasifier can process about 30 kilograms of bio-waste to run an engine of 30 HP for one hour. Also, the furnace in the gasifier unit can be built to different capacities as per availability of biomass and agricultural residue. Considering the cost of machine, fuel-biomass and local labor, this arrangement is estimated to cost less than half the cost per unit power when compared to normal electricity grids costing ₹ 4 per unit. Concept of biomass gasification, up draft gasification, cleaning by cyclone filter, and use of scrubber are well known in art. Prior art also discloses other such devices, however a compact gasifier surrounded by water jacket with the arrangement of two stage filters are not available in art. Accordingly, NIF filed a patent in Rai Singh's name.

Product Application and Dispersion

The biomass based gasifier can be used to operate pump sets in remote fields, lift water in homes, operate

basic machines such as saw mills, flour mills and generate electricity by charging the alternator. While similar systems with various configurations are in use, the Government of India has dedicated renewable schemes for the development, installation and use of such biomass based systems. The fuel consumption of Dahiya's gasifier is reported to be 1 kg/kVA. The prices vary from ₹ 1,25,000 for 10 kW unit to ₹ 3,25,000 for 35 kW unit.

As a result of support from the Micro Venture Innovation Fund (MVIF) of National Innovation Foundation through GIAN North, Jaipur, Rai Singh has been able to manufacture and sell over 50 units of varied capacity to farmers and owners of flour and saw mills. For his work, Rai Singh was also honored by Gram Panchayat in 2002 and by the District Collector in 2004. And perhaps with recognition from NIF, The journey has just begun for Rai Singh.

Source: Case study published in the Fifth National Grassroots Innovation Awards 2009 National Innovation Foundation

Snapshots from Renewable 2010 Global Status Report – A focus on Bioenergy

The year 2009 was unprecedented in the history of renewable energy, despite the headwinds posed by the global financial crisis, lower oil prices, and slow progress with climate policy. Indeed, as other economic sectors declined around the world, existing renewable capacity continued to grow at rates close to those in previous years, including grid-connected solar PV (53%), wind power (32%), solar hot water/heating (21%), geothermal power (4%), and hydropower (3%). Annual production of ethanol and biodiesel increased 10% and 9% respectively, despite layoffs and ethanol plant closures in the United States and Brazil.

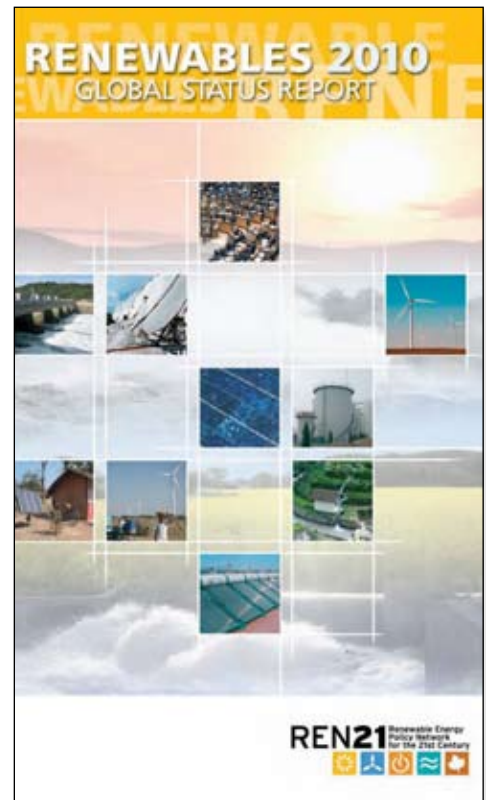
Changes in renewable energy markets, investments, industries, and policies have been so rapid in recent years that perceptions of the status of renewable energy can lag years behind the reality. This report captures that reality and provides a unique overview of renewable energy worldwide as of early 2010.

Though the report paints an integrated picture of the global renewable energy situation, here we would keep our focus on biomass power. It's a known fact that biomass power plants exist in over 50 countries around the world and supply a growing share of electricity. Several European countries are expanding their total share of power from biomass, including Austria (7%), Finland (20%), and Germany (5%). Biogas for power generation is also a growing trend in several countries.

The report finds out that many countries saw record biomass use in last one year. The most notable of them was Sweden, where biomass accounted for a larger share of energy supply than oil for the first time. Mentioning about the number of rural households served by renewable energy, the report says that biomass cook stoves are used by 40 percent of the world's population, and a new generation of more-efficient "improved" biomass cook stoves has emerged over the years. These stoves are being manufactured in factories and workshops worldwide, and more than 160 million households now use them. Recent increases in biomass use for power production have been seen in a number of European countries and in some developing countries, including China and India. According to the report, globally, an estimated 54 GW of biomass power capacity was in place by the end of 2009.

Leading the race are Germany and the United Kingdom who also generate increasing amounts of electricity with solid biomass through co-firing, and the capacity of biomass-only plants is rising rapidly across Europe. According to the findings, just over half of the electricity produced in the European Union from solid biomass in 2008 was generated in Germany, Finland, and Sweden.

The report also puts it across that biomass power has also grown significantly in several developing countries, including Brazil, Costa Rica, India, Mexico, Tanzania, Thailand,



and Uruguay. China's capacity rose 14 % in 2009 to 3.2 GW, and the country plans to install up to 30 GW by 2020. India generated 1.9 TWh of electricity with solid biomass in 2008. By the end of 2009, it had installed 835 MW of solid biomass capacity fueled by agricultural residues (up about 130 MW in 2009) and more than 1.5 GW of bagasse cogeneration plants (up nearly 300 MW in 2009, including off-grid and distributed systems); it aimed for 1.7 GW of capacity by 2012. Brazil has over 4.8 GW of biomass cogeneration plants at sugar mills, which generated more than 14 TWh of electricity in 2009; nearly 6 TWh of this total was excess that was fed into the grid.

The use of biogas to generate electricity is on the rise as well, with production increasing an estimated

7 % during 2008. Biogas is used for electricity generation mainly in OECD countries, with some 30 TWh produced in the OECD in 2008. But a number of developing countries also produce electricity with biogas, including Thailand, which nearly doubled its capacity in 2009 to 51 MW, and Malaysia, which is also seeing significant biogas power expansion.

Putting a focus on biodiesel, the report mentions that biodiesel production increased 9 percent in 2009, to 16.6 billion liters globally; this compares to a five-year average (end-2004 through 2009) of 51 percent. Biodiesel production is far less concentrated than ethanol, with the top 10 countries accounting for just under 77 percent of total production in 2009. The European Union remained the center of biodiesel production worldwide, representing nearly 50 percent of total output in 2009, and biodiesel still accounted for the vast majority of biofuels consumed in Europe. But growth in the region has slowed considerably over the past few years. Production increased less than 6 percent in 2009, down from 65 % growth in 2005 and 54 percent in 2006; at least half of existing plants remained idle during 2008-09.

Talking about biomass power and heat industries, the report mentions that a subsection of the industry, the wood pellet market, strengthened in 2009 following a fall in shipping costs, which can account for as much as 50 % of the pellet supply expense. This was accompanied by an increased demand for co-firing by Europe's coal-fired power plants. These developments led a growing number of firms to develop new projects for biomass power and heat. Though internationally, there is strong utility interest in biomass electric power generation for co-firing

with coal and repowering coal-fired plants to biomass, however the key challenges facing developers and facility operators as the industry grows include sourcing, transportation, and the storage and handling of feedstock.

The section of the report that talks about second-generation biofuels industry mentions that second-generation biofuels are not yet being produced commercially, but the European Union, United States, and Canada, along with China, Brazil, India, and Thailand, are investing in research and pilot production projects. In particular, the European Commission research program on bio-refineries, which focuses on second-generation biofuels, reflects the shift under way in the EU towards second-generation fuels and integrated systems that combine electricity, fuels, and commodities.

The report also puts emphasis on the fact that the second-generation biofuels industry continues to face challenges related to developing infrastructure, growing to commercial scale, acquiring reliable feedstock supply, and lowering enzyme costs. However, the synergies and sustainability in second-generation development in concert with other renewables, particularly in bio-refinery constructs, has driven substantial government support internationally, which is likely to continue.

Renewable biofuels meanwhile are making inroads in the transportation fuels market and are beginning to have a measurable impact on demand for petroleum fuels, contributing to a decline in oil consumption in the United States, in particular, starting in 2006. Although the rapid growth of previous years has slowed, production

of biofuels for transportation grew 58 % between 2007 and 2009. The 93 billion liters of biofuels produced worldwide in 2009 displaced the equivalent of an estimated 68 billion liters of gasoline, equal to about 5 % of world gasoline production.

As the scale of investment and visibility of renewables soared during the period 2005–10, the sustainability of various renewable energy technologies emerged as a prominent issue. The report interestingly mentions that recent policy attention has focused on bioenergy sustainability because the environmental, economic, and social costs of bioenergy can be quite high if sustainability safeguards are omitted. That is, policy measures for sustainability can have a large influence. This is especially true for lifecycle (net) greenhouse gas emissions, biodiversity impacts associated with crop production, impacts on food security, and land rights infringements on local population.

In addition to mandatory policies for sustainability, several voluntary initiatives exist around the world. One of the most comprehensive is the Roundtable on Sustainable Biofuels, another global initiative is the Global Bioenergy Partnership (GBEP). The International Organization for Standardization (ISO) also started work on a voluntary sustainability standard for bioenergy in 2010, but results are not expected for several years.

*Courtesy: Ashirbad S Raha,
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Brazilian biomass policy – A view from Indian policy perspective



Indian Perspective

Currently, more than 45 percent of Brazil's energy requirement is derived from renewable sources. This clearly reflects that Brazilian energy portfolio is one of the cleanest energy mixes in the world and there is a lot to learn for Indian renewable energy sector from Brazil at both policy and implementation levels. Renewable energy mix in the said share of 45 percent is shown in table 1.

Table 1: Renewable energy mix in Brazil

Renewable Energy Option	Composition in 45 % share of renewable sources
Hydroelectricity	14.8
Wood & Charcoal	12.6
Sugarcane Products	14.6
Other renewables	3

Biomass feedstock, which is in vogue in Brazil for power generation and heating requirement, primarily includes sugarcane bagasse, lixivia,

wood, biogas and rice chaff. Biomass based power plants represent 3.7 % of Brazilian annual electricity generation, which amounts to 4 GW. Sugarcane bagasse alone feeds 237 cogeneration power plants, which is equivalent to 74 % of the total installed capacity of biomass-based power plants. Of the total amount of energy generated via sugarcane bagasse, 85 % is consumed by the sugar and ethanol sector itself, while the remainder is traded with local electricity dealers. This mode of generation is expected to triple in 2016, both due to the opening of new units and modernization of the

already established power plants. A comparative picture of objectives driving evolution and growth of Bioenergy sector in India and Brazil is presented in table 2.

Table 2 clearly reflects that Brazilian Bioenergy policy has a holistic focus.

Evolution and Growth of Bioenergy Policy - A comparison

Brazilian experience in bio-energy sector dates back to 1920's and by the year 1931 fuel produced from sugarcane officially began to be blended with petrol. Contrary to it, in India, historically, biomass has been a major source of household's energy. In India, biomass met the cooking energy needs of more than 70 percent of the rural households and half of the urban households (Shukla, 1996). Therefore, it will not be wrong to state that the Brazilian bioenergy usage focus and bioenergy usage in India have transcended across different sectors.

Brazil has been a pioneer in initiating national regulatory efforts for the bioenergy sector. It has gathered significant expertise in biofuels, specifically in the use of ethanol as a

Table 2: Objectives driving the Bioenergy sector

Country	Objectives						
	Climate Change	Environment	Energy Security	Rural Development	Agricultural Development	Technological Progress	Cost Effectiveness
Brazil	✓	✓	✓	✓	✓	✓	✓
India			✓	✓		✓	✓

transport fuel. In 1975, after the first oil crisis, the Brazilian Government launched the National Ethanol Program (ProAlcool). This program aimed at creating the conditions for the large-scale development of sugar and ethanol industry. The program was targeted at reducing energy imports and propagating energy independence for Brazil. Program's main goals were to introduce into the market, a mixture of petrol and anhydrous ethanol and to provide incentives for the development of vehicles that were fuelled exclusively with hydrated ethanol. In India, early policy perspective amongst Indian policy makers viewed biomass essentially as the solution to rural and remote area energy needs, primarily in locations and applications where the conventional technology was unavailable and usage of biomass for transport sector was not a priority.

Following the second major oil shock in 1979, Brazil launched a more ambitious and comprehensive program. This program aimed at promoting the development of new plantations and a fleet of purely ethanol-fuelled vehicles. A series of tax and financial incentives were introduced by the government. The program induced a strong response, with ethanol production rising rapidly along with the number of vehicles running exclusively on ethanol.

The period from 1989 to 2000 in Brazilian policy was characterized by the dismantling of the set of economic incentives for the program as part of a broader deregulation that affected Brazil's entire fuel supply system. From 1990 onwards, the planning and implementation of the industry's production, distribution and sales activities were gradually transferred

to the private sector. With the end of the subsidies, the use of hydrated ethanol as fuel diminished drastically. However, the mixture of anhydrous ethanol with petrol was boosted as government mandated blending requirement specifying that 22 % of

An important factor for the domestic market development in recent years in Brazil has been the investment of the automobile industry in bi-fuel or dual-fuel alcohol-petrol cars, also referred to as flex-fuel vehicles.

anhydrous ethanol must be added to all petrol at retail petrol stations in the year 1993. In the Indian policy scene, on a similar note in the 1990s decade, there has been a noticeable policy shift. Under the market oriented economic reforms policies pursued by the Government of India, the market forces were being allowed a greater role. Indian renewable energy sector witnessed a shift in the policy approach which was characterized by: i) higher emphasis on market instruments as compared to regulatory controls, ii) reorientation from technology push to market pull, and iii) enhanced role of private sector.

The most recent phase of the Brazilian ethanol experience began in 2000. It marked the revitalization of ethanol fuel usage as prices of ethanol were liberalized. This had a major effect on the dynamics of the sugar and ethanol industry as it began to depend

much more on market mechanisms, particularly in the international markets. Export of ethanol increased further due to high oil prices in the world market. Post 2000, the industry has made significant investments and expansion of production and modernization of technologies took place. An important factor for the domestic market development in recent years in Brazil has been the investment of the automobile industry in bi-fuel or dual-fuel alcohol-petrol cars, also referred to as flex-fuel vehicles. All gasoline sold is blended with 20-25% ethanol, and almost nine out of every ten new vehicles sold in the Brazilian market are flex-fuelled.

However, on the contrary, the policy evolution of biodiesel is still an infant industry in Brazil, and biodiesel policies are much more recent. The Biodiesel Law (2005) established mandatory minimum blending requirements of 2 percent and 5 percent, which are to be achieved by 2008 and 2013 respectively. This law reflected social inclusion and regional development concerns and introduced a system of tax incentives for the production of raw materials for biodiesel on small family farms in the north and northeast regions of Brazil. Under the "Social Fuel Seal" (Selo Combustível Social) program, an incentive in terms of rebate in tax was introduced for biodiesel producers who buy feedstock from small family farms in poor regions. The farmers are now being organized into cooperatives and also receive training from extension workers.

Current Strategy

Brazil's current strategy is designed along three levels: global, regional and bilateral. In its global approach, Brazil is advocating the adoption of

international standards. Objective of this advocacy effort is to facilitate the establishment of a global market for such products. In order to create a coordinating mechanism amongst the largest producers and consumers of biofuels, the International Biofuels Forum was created in March 2007, in New York. At the regional level, Brazil is advocating the energy integration in South America by promoting diversification of the energy mix across countries in South America. A Mercosur Memorandum of Understanding was signed to expand cooperation in this regard. The MoU was signed with an aim to promote a more effective use of the South American countries' competitive advantages in the biofuels field. This is supposed to happen by integration of the chain of production, distribution and sale of ethanol and biodiesel in the region and including applicable regulations and inspections. At the bilateral level, Brazil intends to cover technical cooperation initiatives, including research on alternative sources for producing biofuels, as well as promoting scientific and academic exchanges. In order to make such exchanges operational, Brazil has signed memoranda with India, South Africa (i.e. IBSA), Chile, Denmark, Ecuador, Paraguay, Sweden, Uruguay, and other countries.

Policy Instruments in Vogue- A comparison

The Brazilian Government has issued Agroenergy Policy Guidelines (2006-2011) as it's guiding document for bioenergy. This document recommends creation of the Inter-Ministerial Management Council to manage the agro-energy policy by working across (a) Development of Agroenergy (b) Agroenergy and food production; (c) Technology development; (d) Community energy self-sufficiency; (e) Job and income generation; (f) Optimizing the use of areas affected by anthropic actions; (h) Optimization of regional vocations; (i) Leadership in the international biofuels market (j) Compliance with environmental policy.

As is evident, the goal of the Brazilian Agroenergy Plan is to ensure the competitiveness of Brazilian agribusiness and support specific public policies, such as social inclusion, regional development, and environmental sustainability. A comparative analysis of Policy instruments adopted by Brazil and India is presented in table 3.

Major National Programs of Bionenergy

Two major national programs of promoting Bioenergy in Brazil are:

□ Brazilian Renewable Energy

Incentive Program (PROINFA): This program was started in April 2002 in order to secure the participation of a greater number of states through provision of incentives to national industries. Program established the inclusion of 3,300 MW of energy into the National Energy Grid supplied in equal amounts by wind sources, biomass and small hydroelectric centrals (PCHs). Subsidies/ incentives were funded from the Energy Development Account. Consumers pay into this account through an increase on energy bills (from which low-income sectors were exempted). PROINFA is considered as a milestone in the regulatory framework applicable to renewables in Brazil.

□ National Program for the Production and Use of Biodiesel. The Biodiesel Law established minimal percentiles of 2 % (B2) and 5 % (B5) of biodiesel to diesel, to be accomplished by 2008 and 2013, respectively. Indian program on Biodiesel essentially relies on the National Mission on Biofuels, the main strategy of which has been to promote *Jatropha Curcas*; a perennial shrub that bears nonedible oil seeds that can be used to produce biodiesel. The cultivation of *Jatropha Curcas* is to be undertaken mostly on wastelands. Thus, there is a stark difference in approach adopted by the two countries.

A summarized comparison of targets set by Brazilian and Indian government in electricity, heating and transport sector is presented in Table 4.

Table 3: Key Policy Instruments

Country	Energy Policy				
	Binding Targets/ Mandates ¹	Direct Incentives ²	Grants	Feed in tariffs	Tariffs
Brazil	E, T	T			Eth
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

Table 4: Bioenergy targets set by Brazil and India

Country	Targets (M= mandatory; V= voluntary)		
	Electricity	Heat	Transport Fuels
Brazil	Inclusion of 3,300 MW of energy into National Energy Grid supplied in equal amounts from wind, biomass and small hydroelectric is required (M)	No targets	Mandatory blend of 20 to 25% anhydrous ethanol w/gasoline; minimum blending of 2% (B2) biodiesel to diesel by 2008 and 5% (B5) by 2013
India	5000 MW of biomass power by 2022	NA	Regarding biodiesel, the Indian National Biodiesel Policy provides an indicative target to blend 20% biodiesel with diesel by the year 2017.

Social Impacts of Bioenergy Policy

In Brazil, the sugar and ethanol industry is amongst the most productive sectors which has created about one million direct jobs (including in family companies and cooperatives) and six million indirect jobs. It has been observed that working conditions on sugar cane farms are better as compared to other industrial sectors of the Brazilian economy. The average family income of these employees ranks in the upper 50 percentile. An analysis of the growth sustained by the industry provides evidence to negate the concerns that growing sugar cane for the purpose of producing ethanol is harmful to the environment. On the contrary, biofuels have had positive social and environmental impacts, by recovering previously deforested areas, providing crop rotation and aeration of farmlands used for food production, in addition to employing almost one million workers, included through a system of family cooperatives.

Challenges before Brazil

In spite of having expertise in bioenergy domain and being the pioneer in its application in transport

Brazil is facing challenge in involving government policies and the larger public and private investments required to meet the growing domestic and foreign demand. This requires coordinated planning and action by both government and private sector.

sector, Brazil is facing challenge in involving government policies and the larger public and private investments required to meet the growing domestic and foreign demand. This requires coordinated planning and action by both government and private sector. Therefore, it is important to seek partnerships and collaborative activity, particularly with other sugar-cane producing countries focusing upon those having a large demand. Efforts are required to work together for defining international technical specifications for fuel alcohol. India, in

its biofuels policy program might also face similar challenges, specifically from the automobile manufacturers. The blending norms announced by the government will have to be decided after having consultation with the engine manufacturers.

Another consideration on the Brazilian external agenda is to work diligently to increase business liquidity and fluidity in the biofuel market. This will require some amendment of the legislation and major networking with and among the private production sector and the trade sector in Brazil and abroad. The biggest challenge to be tackled by Brazil is the expansion of the sugar and ethanol industry. This includes considerations on spatial concentration of production and a renewed focus on greater energy efficiency on the part of producing units. From Indian perspective, this issue is all the more important as experiences till now in India clearly show a strong deficit in terms of production of oil from non edible energy plantations.

Conclusion

Bioenergy program of Brazil opens new insights specifically in promoting ethanol for transport purpose. Although Indian policy's focus towards energy plantation is quite different, still mechanisms and incentives adopted in Brazil's bioenergy policy can provide inputs for policy makers in India, especially for meeting electricity and heating requirement through bio-energy. Structural elements PROINFA, can provide good policy leads for diversification of Indian energy mix.

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Gold Standard cook-stove methodology

Introduction to Gold Standard

The Gold Standard Foundation registers projects that reduce greenhouse gas emissions in ways that contribute to sustainable development and certifies their carbon credits for sale on both compliance and voluntary offset markets. Renewable energy and end-use energy efficiency projects with sustainable development benefits are eligible to apply for registration with the Gold Standard (GS). GS Voluntary Emissions Reduction (VERs) are issued for eligible projects that make use of a GS-VER methodology and GS labels are issued for carbon credits of qualifying CDM and Joint Implement projects.

Gold Standard Benefits

The Gold Standard credits provide the following advantages to project developers:

- ❑ Thorough consideration of the SD aspects
- ❑ Environmental integrity

The methodology calculates baseline emissions based on the woody carbon content of the non-renewable biomass unlike the CDM methodology that assumes the use of fossil fuels for meeting the thermal energy needs in the baseline scenario.

- ❑ Endorsed by NGOs worldwide
- ❑ Involvement of local stakeholders
- ❑ Transparent procedures
- ❑ Premium prices

Voluntary Market Methodologies

The Gold Standard allows the use of applicable UNFCCC methodologies and also GS-VER methodologies. It is the constant endeavor of the Gold Standard (GS) to invite submissions for GS-VER methodologies. A list of GS voluntary market methodologies approved by GS can be found at - <http://www.cdmgoldstandard.org/Gold-Standard-Methodologies.347.0.html>

The GS Cook Stove Methodology

The GS cook stove methodology is applicable to programs or activities that involve use of improved cook stoves and water treatment technologies in households and institutions. The methodology does not allow for individual households or an institution to be project participants and instead provides this right to a project coordinator.

The methodology can be applied under the following conditions:

- ❑ Replacement of relatively high-emission baseline scenarios by low-emission cook-stoves
- ❑ The project boundary can be clearly identified, and the cook stoves that are part of the project activity are not included in another voluntary market or CDM project. This is to ensure that no double counting takes place.

- ❑ The project is located in a single country. For projects taking a Programme of Activities (PoA) approach, the individual units could be spread across several countries.
- ❑ The improved cook stoves or water treatment technology do not number more than ten per kitchen and each have continuous useful energy outputs of less than 50 kW (defined as total energy delivered usefully from start to end of operation divided by time of operation).

Examples of project technologies are improved biomass stoves, use of stoves displacing technologies such as solar cookers, water purifiers, filters, etc.

Some of the salient features of this methodology are:

- ❑ The methodology calculates baseline emissions based on the woody carbon content of the non-renewable biomass unlike the CDM methodology that assumes the use of fossil fuels for meeting the thermal energy needs in the baseline scenario.
- ❑ The methodology also uses the concept of suppressed demand. For a certain section of people, the total level of energy service in the baseline scenario may not be enough to meet the basic human needs due to a lack of finances and/or energy infrastructure. When the opportunity to achieve a satisfactory level of service (increase in energy delivered as a result of using the energy-efficient cook stove as compared to the baseline) is available through carbon financing calculated from

Eligibility of biomass based projects for CDM

Renewable biomass - Projects that make use of renewable biomass by replacing fossil fuels/non-renewable biomass for generating heat/electricity

Non-renewable biomass – Projects that make use of appliances that add efficiency improvements in the thermal applications of non-renewable biomass.

the baseline level of service of their peers or from the project level of service achievable, then the appropriate adjustment to baseline energy delivered and hence the baseline emissions is made.

- ❑ The methodology is applicable to large-scale project activities when available CDM methodologies for similar activities are of small-scale and thus requires the use of PoAs for large volumes of emission reductions.
- ❑ Emission reductions can be availed from reduction in methane and nitrous oxide apart from carbon dioxide which is not possible in the corresponding CDM methodology that gives benefits only from reducing carbon dioxide emissions.
- ❑ The methodology also takes into account aging or non-usage of the stoves. In practice, the cook-stoves become less efficient over time as a result of the wear and tear and there are also cases where the stoves are not used at all as users revert to the stoves being used earlier (in the baseline) or other means. In order to tackle these situations and to make sure that the emission reductions are conservative, an aging test is carried out once every two years.

- ❑ The methodology includes a concept of evolving baseline. If the cook stoves are installed in a progressive fashion, dispersed over time, there is a good chance that the baseline may not remain the same. This may happen because the target populace may have changing cooking habits or they may use more efficient cook stoves. The methodology takes this into account and under these circumstances the methodology requires that an evolving baseline is used.
- ❑ The methodology also allows the use of a fixed baseline where it can be convincingly shown that the conditions (cooking habits, type of stove used etc.) do not change during the project period.

The methodology allows the use of the “Tool for the Demonstration and Assessment of Additionality” and any other additionality tool that has been approved by Gold Standard for VER projects. The project proponent must demonstrate that the high initial costs and the costs associated with the marketing, promotion, distribution and manufacture of the stoves make the project financially unviable without the carbon revenues. Alternatively, the project proponent can also demonstrate that the project activity faces several barriers (technical, investment etc) in its implementation and revenue from sale of VERs is critical in mitigating these barriers.

In order to arrive at the baseline emissions, the methodology requires a qualitative survey followed by quantitative measurements. These steps are called the Kitchen Survey at the end of which, the individual units within a project are classified into clusters (based on their similar

type of fuel used etc) and the Kitchen Test where a measurement is made of the factors that affect the quantity of GHG emissions like the quantum of fuel used etc. The tests are carried out in households within the cluster. The total number of household samples is determined using statistical methods.

To calculate the project emissions, an estimate of the factors that affect the GHG emissions are made for the project scenario involving the improved cook stoves.

The methodology also requires taking into consideration possible leakages for ex - use of the replaced stove outside the project boundary etc.

The monitoring involves the maintenance of a sales record and a detailed customer database that need to be updated regularly. The Kitchen Survey is adjusted every three months in order to capture the new households being added to the project activity and to ensure that the kitchen tests are representative.

It is also necessary to estimate the total fraction of non-renewable biomass that is being used in the baseline/ project scenario. This can be estimated by collecting evidence through field survey, existing literature and resource/population mapping studies.

The methodology would be revised soon and a new version would be made available shortly.

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Overview of Biomass Gasification Technology in India and some developed countries

India has a long history in the field of biomass gasification technology research, with the Ministry of New and Renewable Energy (MNRE) supporting research and development in the country since the early 1990s. It has supported four Action Research Centres (ARCs) to catalyze and coordinate R&D in various areas. The areas of specialisation of various ARCs¹ (IIT, Delhi; IIT, Mumbai; IISc, Bangalore and Madurai Kamraj University) range from topics as diverse as biomass characterization, technology modification, upgrading and upscaling wood based systems to monitoring revalidation and training to development of application packages including implementation.

Other than this, many organizations across India have been involved in R&D for the development of various aspects of biomass gasification technology. While the above mentioned organisations work with support from MNRE, others are doing so propelled by their commercial interests. Some of the organisations conducting R&D in the field of biomass gasification and their target end use are given in table 1.

An Insight to the Basics

Gasification is a thermo-chemical conversion of carbonaceous materials into gaseous fuel. The combustible gas, known as producer gas or synthesis gas (syngas) is composed of CO, CO₂, N₂, H₂ and CH₄ and has a calorific value in the range of 4.0 - 6.0 MJ/Nm³.

Table 1: List of organisations conducting Biomass Gasification R&D in India²

Name of Institution	Type of end-use
Associated Engineering Works, (AEW)	Thermal and electrical Electrical running on both dual-fuel and gas engine
Ankur Scientific Energy Technologies Pvt. Ltd.	Thermal and electrical
Cosmo Powertech Pvt. Ltd.	Thermal
Grain Processing Industries (India) Pvt. Ltd.	Mainly thermal Electrical also reported mainly dual-fuel A few electrical reported as under construction with 100% Gas engine
Southern Carbons (P) Ltd.	Thermal
The Energy & Resources Institute	Thermal
ABETS at Combustion Gasification Propulsion Lab (CGPL)	Thermal & electrical, including on 100% Producer Gas Engine
Rishipooja Energy & Engineering Company	Thermal & electrical

Based on the usage of the gas, biomass gasifiers are classified as Power Gasifiers and Heat Gasifiers. In case of power gasifiers, due to strict fuel quality requirement of IC engines, the gas needs to be passed through elaborate gas conditioning system. In contrast, heat gasifiers require no such system as the gas is burned in external burners requiring little or no gas conditioning. This results in their simple design, uncomplicated operation and low cost.

Biomass gasifiers, based on the technology can be classified into fixed

¹ Shivkumar A.R, Jayaram S N, Rajshekar S C, 2008, *Inventory of Existing Technologies on Biomass Gasification*, Karnataka State Council for Science and Technology

² Shivkumar A.R, Jayaram S N, Rajshekar S C, 2008, *Inventory of Existing Technologies on Biomass Gasification*, Karnataka State Council for Science and Technology

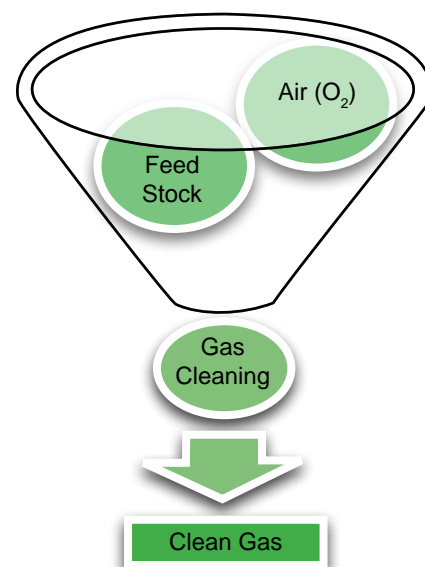


Figure 1: Overview of Biomass Gasification

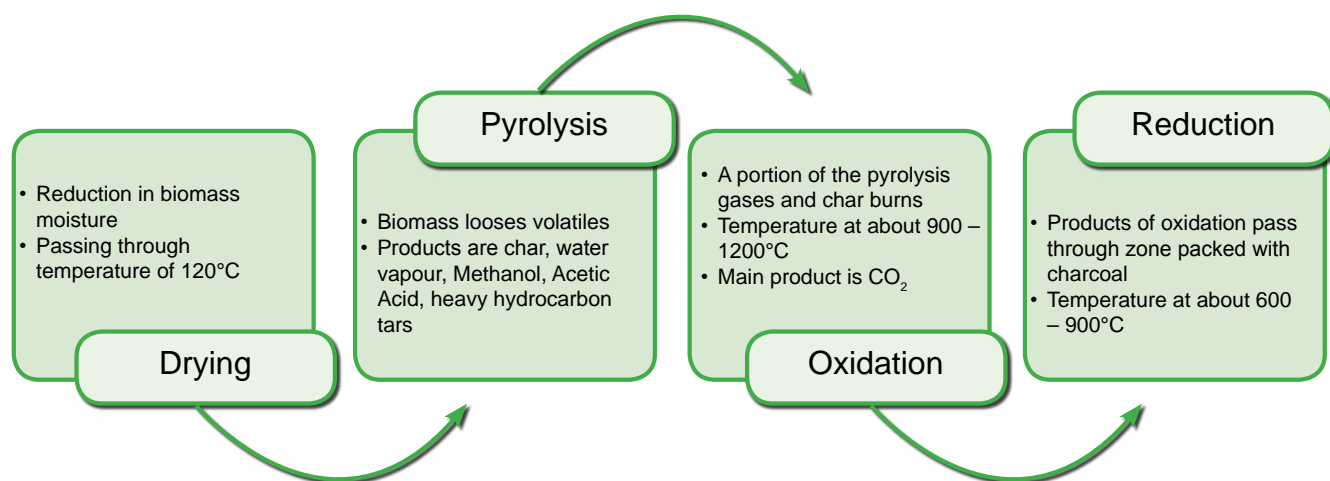


Figure 2: Various processes in a biomass gasifier

bed type, fluidised bed type and entrained flow type. Table 2 (next page) highlights the different aspects of these gasifiers.

Technology and Innovation in India

Although several companies are involved in production of biomass gasification systems in India, only few have been able to gain considerable market share. Many of them have taken technologies from prominent research institutes like Indian Institute of Science (IISc), The Energy and Resources Institute (TERI) etc and some of them have been able to develop their own technologies. Whereas, most players in India use down draft configuration for its low tar content advantage, a few people use up draft configuration due to its better efficiency. The updraft configuration is always accompanied with special cleaning mechanisms to produce clean producer gas.

Intensive research in India has led to development of several novel technologies. Still biomass gasification has not reached the expected scale. The major barriers faced by biomass gasification technology in India are:

- ❑ Tar formation due to the pyrolysis

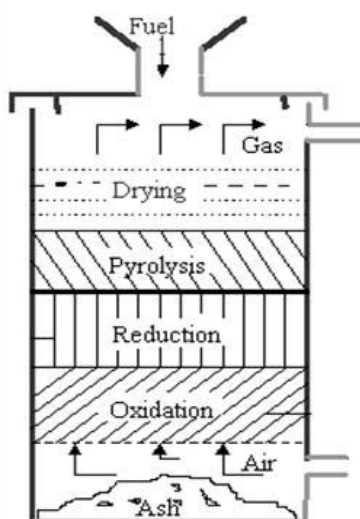


Figure 3: Updraft gasifier

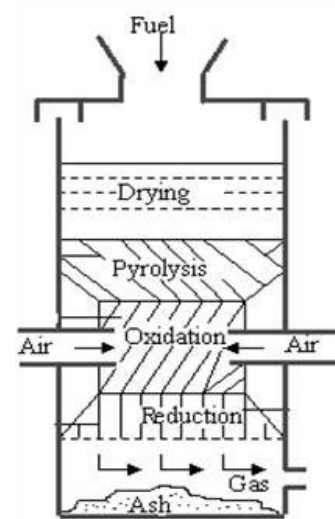


Figure 4: Downdraft gasifier

of biomass which chokes the pipe lines and engine parts. Also frequent cleaning of engine parts and replacements are required thus increasing the maintenance cost.

- ❑ The cooling and cleaning of producer gas is required for feeding it into IC engines, which is again a complicated process and technology is not widely available for the same.
- ❑ The concentrated oxidation zone causes sintering or slagging of ash resulting in clinker formation and consequent blocking of the constricted area.

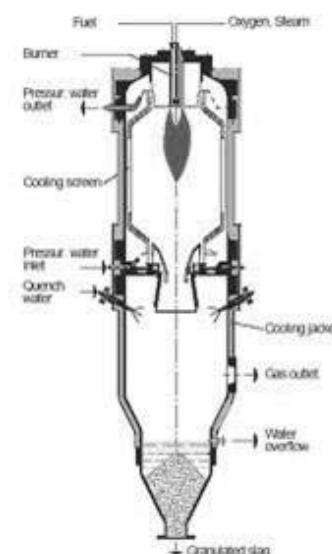


Figure 5: Entrained flow gasifier

Table 2: Advantages and drawbacks of different gasifier

Gasifiers	Advantages	Drawbacks
Fixed bed Updraft	High simplicity	High amount of tar and pyrolysis products
	High charcoal burn-out	Extensive gas cleaning required in power applications
	High gas efficiency	
	Use fuels with higher moisture content	
	Accepts fuel size variation	
Fixed bed downdraft	Lowest levels of tar	Limited scale up
	Best option for gas engines	At low temperatures, more quantity of tar produced
	At low load levels, less particles in the gas	High amount of ash and dust particles
		Strict requirements in fuels
Fixed bed downdraft: multistage	Decrease tar production	Major complexity in the design
	Optimization of each zone	
Fixed bed cross-draft	Fitted in very small scale operations	Minimal tar converting capability
	Due to the high temperatures, less requirements in gas cleaning	
Atmospheric Fluidized bed	Compact construction	High tar and dust content
	Low and uniform temperature profile	Alkali metals at high temperatures
	Accepts fuel size variation	Complexity in the air supply and solid fuel
	Ash melting points allowed	Power consumption
Pressurized Fluidized bed	Low level of power consumption	Complex fuel feeding
	Higher methane content	Cleaning problems
	Compact, low investment costs	Complexity of installations
	Sintering ash	High specific investments in low capacity installations
Entrained flow	Able to large capacities	High investments
	Short residence time	Strict fuel requirements

Technology in developed countries

Traditionally, European and western countries have been using updraft and downdraft gasifiers for separate purposes. The gas produced in the down draft process has been used for combustion in a boiler to generate heat. As purity of the gas is not significant for the combustion in boilers, updraft gasification has been prominently used for district heating applications. Down draft gasifiers have been used in Europe since World War II. With modifications in the down draft type, other types of gasifiers have also been developed and used.

Major support for small-scale gasification in the late 80s and early 90s led to the development of various technologies with capacities of less than 100 kW to a few MW. Technology was also exported to many developing countries with support from international bodies such as the World Bank. The key drivers pushing the development of novel technologies in Europe were rural development and electrification. Even with the major efforts that were put into the development of small scale gasification systems, the results have not been lucrative as yet. Small-scale biomass gasifiers are available in the market for various uses; however the sale has not been considerable due to a number of

Major support for small-scale gasification in the late 80s and early 90s led to the development of various technologies with capacities of less than 100 kW to a few MW

reasons such as maintenance of critical fuel quality and hence the need to buy expensive fuel, the required careful operation and high costs especially for

effective gas cleaning, given the severe emission standards in the EU.

Whereas in India gasification technology has not been able to go beyond a few MW units, Europe has excelled in development of large capacity (above 10 MW) gasification systems. These large capacity gasification systems are mainly Circulating Fluidised Bed Gasifiers (CFBG) or Atmospheric Circulating Fluidised Bed Gasifiers (AFBG) with a major share of CFBG.

Another innovation has been Biomass Integrated gasification/Combined Cycle (BIG/CC) systems which combine flexibility with respect to fuel characteristics and a high electrical efficiency. This balance between flexibility and efficiency seemed lucrative leading to several demonstration projects across Europe, US and Brazil. However, the costs

Another innovation has been Biomass Integrated gasification/Combined Cycle (BIG/CC) systems which combine flexibility with respect to fuel characteristics and a high electrical efficiency

of these technologies could not be brought down to make them more attractive widely. Depending on the scale, price levels of 5000–3500 €/kW were quoted, which was still far from the desired 1500–2000 €/kW, which could bring BIG/CC in a competitive area.

The way ahead

At present, Indian market is dominated by fixed bed gasifiers and the scenario looks the same for the future. Even though some Indian players have started offering other types of gasifiers mainly sourced from Europe, they have not achieved much success due to the complexity in the design and higher costs.

Due to the obvious stress on rural electrification, some new developments are expected in the gas purification systems to make the gas conducive for power production through internal combustion engines.

*Courtesy: Ankit Kumar and
Balakishore Kollabathula
Emergent Ventures, Gurgaon
Email: ankit@emergent-ventures.com*

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:

Ashirbad S Raha (ashirbad@winrockindia.org)

Winrock International India: 788, Udyog Vihar, Phase V, Gurgaon-122 001; Phone: 0124-4303868

News Snippets on Biomass Power

1

Indian parliament to go green with solar panels and biomass plant

The Indian Parliament building, Sansad Bhavan, will soon be installed with solar PV systems, solar heaters and a biomass plant in an attempt to promote renewable energy technologies.

On behalf of the Parliament, the Punjab Energy Development Agency has invited bids for installing 80 kW solar PV system. The power system

would not only provide battery back up for the Parliament building but more than 50 % of the generated power would be fed to the grid.

A solar thermal system would also be set up in the Parliament House with a capacity of 2,000 liters. While it is mandatory for all new government buildings to install solar thermal system, this initiative is again a

voluntary step aimed at promoting green energy. A half tonne capacity biomass plant would also be installed which would utilize the food waste to generate energy through the process of decomposition.

Source: <http://www.scientificamerican.com/article.cfm?id=indian-parliament-to-go-green-with-2010-08>

2

Corporates in Haryana turn to biomass generation

With Haryana having a potential of generating 1,400 MW of power through biomass, various corporates are keen on exploring the same. Four projects where biogas-based power plants will be set up have already been approved by Haryana Renewable Energy Development Agency (HAREDA) and are likely to be

commissioned in 2010-11 fiscal.

"Besides these four projects, HAREDA is considering three new proposals that include a 3 MW biogas-based power plant to be set up by REI Agro at Rewari," a HAREDA official told Financial Express. He further added, "Another proposal is from Bahalgarh (Sonapat) based Sunstar Overseas for

1.95 MW. HP Bio Energy located at Nangthala in Hisar has also proposed to set up a one MW power plant based on cow, horse, poultry waste and maize stalks."

Source: <http://www.financialexpress.com/news/Corporates-in-Haryana-turn-to-biomass-generation/681104/>

3

Punjab to set up 36 biomass power plants

In the next two years, the Punjab Energy Development Agency (PEDA) would establish as many as 36 biomass power plants across Punjab, which would generate 350 MW. According to PEDA Chairman Manjit Singh, Punjab has substantial availability of biomass or agricultural waste, which is sufficient to produce about 1,000 MW of electricity.

Biomass, which includes agricultural crop residue, animal, agri-industrial and forest wastes, holds a great potential as these renewable energy sources can fulfill 20 per cent of the state's energy demand, he added.

PEDA has planned to promote and install biomass-based projects in tehsils



which holds potential to generate power. PEDA has so far identified and allocated 30 tehsils for setting up

of a total 332.5 MW capacity projects under the three phases.

A few biomass plants have already been installed at Awan, Phullokhera and Channo Pind villages in this direction," Singh informed.

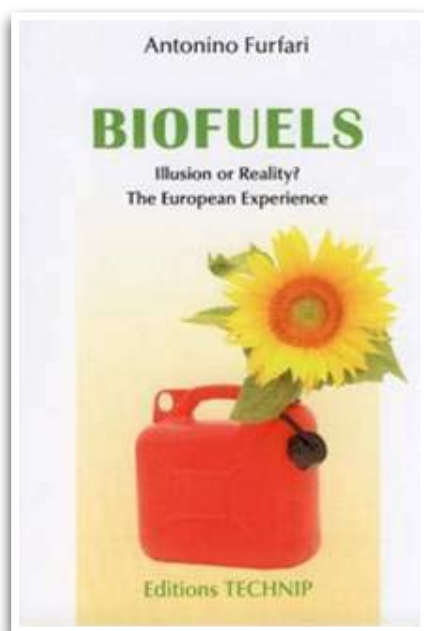
Source: <http://www.igovernment.in/site/punjab-set-up-36-biomass-power-plants-38263>

What to Read

Biofuels: Illusion or reality, The European Experience; Antonino Furfari

The author sets the backdrop of the book by calling production of ethanol in backyard as “Apprentice Sorcerer” and questions “Why are we not producing this ecological fuel on a bigger scale?” The author re-emphasizes on the fact that the automobile transport represents 40 % of the urban pollution and he assigns usage of 98 % of oil towards this. He further stresses that in spite of investment being done by automotive sector in R & D for research on new fuel, it's quite unlikely to obtain any other fuel which is as good as oil in near future. In this context Biofuels appears to be the best alternative which is on one hand liquid in nature and on other hand reduces GHG emissions.

While the author is advocating propagation of biofuels, he raises some serious concerns over the target fixation for the same by EU. Author's real doubt is over calling these targets as “ambitious but realistic”. Through



a series of questions like availability of land in Europe, drawbacks of intensive production, he tries to bring forth before readers “Is this a path really leading to sustainability”.

The book attempts to answer these queries by trying to build the complete picture through information collected from various ‘heterogeneous’ sources. The analysis is based on a model simulation taking into stock fuel consumption projections, land requirement to fulfill the target, actual savings in terms of GHG's. According to the author, analysis reveals that it's quite difficult for EU to achieve its biofuels targets. Key reason behind this is the enormous delay in production. He further stresses that although EU has sufficient land for meeting the target, but considering the quantity of biofuels needed, the approach will worsen the sustainability. He summarizes by saying that biofuels are far from being a sustainable path for road transport and therefore more R & D is needed to find a better alternative to fuel for road transport.

What to Attend

Southeast BIOMASS Conference & Trade Show

November 2-4, 2010
Atlanta, GA

With an exclusive focus on biomass utilization, the Southeast BIOMASS Conference & Expo will connect current and future producers of biomass-derived electricity, industrial heat and power, and advanced biofuels, with waste generators, aggregators, growers, municipal leaders, utilities, technology providers, equipment manufacturers, investors and policy makers.

For Details: <http://biomassconference.com/southeast>

Lignofuels 2010

December 1-2, 2010
Madrid, Spain

Lignofuels 2010 will be addressing all key issues relating to the commercialisation of fuels from lignocellulosic feedstocks such as policy developments, economic considerations, feedstock options, the role of the oil industry and the end markets in the form of the automotive and aviation industries as well as looking at six updates from lignofuel projects around the globe.

For Details: <http://biomass-events.com/lignofuels-2010-o28.html>

NextGenFuels 2010

November 30 – December 2, 2010
Delhi, NCR, India

NextGenFuels 2010, an International workshop, summit and exhibition shall be covering futuristic biofuels like drop in fuels, algae biofuels, Synfuels, Green Diesel, Biobutanol, biofuels from biomass, biofuels from all types of wastes, Cellulosic Ethanol etc. NextGenFuels 2010 will also discuss the entire spectrum of innovative 2nd, 3rd & 4th generation fuel pathways and conversion technologies that are under development and promise to soon become a commercial reality.

For Details: <http://nextgenfuels.web.of-ficelive.com/default.aspx>

Revised Procedure for Empanelment of Manufacturers, Benchmark Norms for Material Specifications and Performance Standards for Biomass Gasifiers

Ministry in the recent past had initiated several actions to promote large scale developments of Biomass Gasifiers in industry (Rice Mills) and for providing electricity in remote villages. Considering the fact that more entrepreneurs would be entering into the manufacturing of Biomass Gasifiers and also a quality certification system would be required by the financial institutions for financing such projects, a strong need was felt for development of Standards Specifications, Monitoring & Safety Instrumentation and the minimum infrastructure at the manufacturing site of Biomass Gasifiers.

Taking the above mentioned facts into consideration, a modified procedure for empanelment of Biomass Gasifier Manufacturers (existing as well as new manufacturers and / or their licensees including the foreign suppliers of the Biomass Gasifier Systems, both for thermal and electrical end use applications) has been proposed.

A brief on the revised procedure proposed to be followed is as under:

- ☐ All the biomass gasifier manufacturers are required to furnish in duplicate details of the package of their gasifier systems – material specifications, dimensions, performance parameters such as gas quality, biomass consumption, safety aspects, effluent disposals, company profile including facilities available at their works etc. in a structured format.
- ☐ The information received will be evaluated with respect to the benchmark qualifying criteria jointly by MNRE and the Test Centre / Sub centre.
- ☐ New gasifier manufacturers will be enrolled for MNRE subsidy only after successful completion of type testing by the Test Centre / Sub centre.

Based on evaluation, the gasifier manufacturers will be classified into different categories as given below:

Category I – Existing empanelled manufactures, who already have test report from any of the Biomass Action Research Centre earlier notified by MNRE for at least one of their gasifier models and who have qualified as per the benchmark criteria including the required facilities at works.

Category II – Gasifier manufactures who have one of their models tested earlier by any of the Biomass Action Research Centre earlier notified by MNRE but not meeting the qualifying benchmark criteria.

Category III – Gasifier manufactures who are meeting the qualifying criteria, but do not have one of their models tested earlier by any of the Biomass Action Research Centre notified by MNRE or the Gasifier Manufacturers who were empanelled without having tested their gasifier and also not meeting or meeting the qualifying benchmark criteria

Category IV – All the new manufacturers and / or their licenses and foreign suppliers or their representatives / dealers/ joint ventures in the country.

IIT Mumbai has been identified by the Ministry as the independent institution for evaluation of the documents and for carrying out field verification and testing of gasifier system. IIT will also train sub centres (such as IIT Kharagpur, IIT Roorkee, BIT Misra, BHU-IT Varanasi, Anna University etc.) to be identified by the Ministry in different regions as per demand.

The continuation of empanelment will be reviewed annually in the event of adverse reports from the Test Centre / Subcentre. MNRE will meet the entire expenditure incurred by the Testing Group for their first visit for Type Testing of the gasifiers at the works and for verification of the facilities. However, if the testing and / or verification could not be completed / successful because of the attributes to the manufacturers, the entire expenditure for retesting and / or facility verification will have to be met by the gasifier manufacturer. Further this retesting will be carried out as per the schedule decided by the testing centre and in no case earlier than 3 months.

Further details for the same can be downloaded from: <http://mnre.gov.in/pdf/biomass-gasifier-memorandum-2010.pdf>

Workshop on Renewable Energy for Rural Empowerment

October 27, 2010 - 10.00 To 17.00 Hours

Access to clean and affordable energy is vital to growing economies like India and other developing nations. It assumes great significance against a background of addressing poverty reduction, environmental concerns, livelihood issues and the overall quality of life. Renewable energy has a special role to play in improving access to cleaner energy in remote rural areas. Use of renewable energy technologies (RETs) can reduce drudgery of women & children particularly by providing more time for education, leisure and economic activity instead of collecting biomass for meeting energy needs. Demand for services associated with RETs can help generate local economic activity based on these technologies, in addition to the means to power local enterprises. Applications of RETs for productive activities can lead to job creation and improved livelihoods, both of which can contribute to significant increases in productivity in rural areas.

However, despite the potential of RETs to catalyse rural development, access to these technologies has not always translated into widespread adoption and effective performance. To overcome these barriers, there is an urgent need to develop appropriate models to accelerate the deployment of renewable energy that is designed around the needs of the community with adequate servicing and delivery infrastructure.

With the above background, a parallel workshop is proposed to be organised at Delhi International Renewable Energy Conference (DIREC) on 'Renewable Energy for Rural Empowerment'. The inaugural session of the workshop would provide an introduction to the background, objectives and framework of the workshop. It will be followed by a technical session on 'Access to Clean Energy and its Linkage to Women Empowerment and Livelihood Generation' that will focus on understanding how mainstreaming renewable energy can not only help in stimulating regional development and improving the quality of life, but also in enhancing livelihood opportunity of the vast majority of the rural population deprived of energy services. The second technical session will be on 'Innovative Business Models for Mainstreaming Renewable Energy in Rural Areas' which will focus towards understanding how some of models have succeeded in overcoming the barriers to RET deployment at scale and getting feedback and inputs for designing models for mainstreaming renewable energy. The purpose of this session will also be to review the existing policies, programs and funding mechanisms for promoting renewable energy based sound business models. The learnings and experiences shared at the workshop from the past renewable energy projects will help in getting feedback at the plenary/ concluding session of the workshop on the existing policies and programs for upscaling clean energy technology interventions to develop a realistic strategy and action plan for scaling up renewable energy for rural empowerment.

For more details, please contact: Mr K P Sukumaran

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An Official Side Event – Ministry of New and Renewable Energy

October 29, 2010

Biomass Cookstove Initiatives: Opportunities for Learning and Collaboration

An estimated 2.5 billion people across the developing world are dependent on biomass as their primary source of household cooking energy, with a range of negative consequences for these populations (especially health impacts from exposure to the indoor air pollution resulting from dirty combustion of this biomass and excessive time or money spent in gathering fuel wood, given the inefficiency of traditional cookstoves). In recent years, a much more sophisticated understanding of the health and social impacts as well as local and global environmental implications of burning biomass in traditional stoves have been. As a result, a number of developing-country governments have put together biomass cookstoves programs to deliver improved devices to their populations.

At the same time, we also have improved technologies, innovative deployment models, as well as new monitoring and evaluation technologies that allow us to better implement cookstove programs. This event aims to discuss existing or emerging cookstove programs in a number of developing countries, with the aim of understanding the aims and motivations of the programs, their institutional design and approaches, and the technology and deployment models being utilized to achieve these goals. The event will also discuss lessons that one can draw from these and other programs, explore what might be key elements necessary for meeting their goals, as well as highlight possible ways in which they could learn from each other, develop synergies, and collaborate in a mutually-beneficial manner. Through this, we hope to improve both the effectiveness of these programs and also begin to systematically develop a body of knowledge that would be useful for other programs that might emerge.

The side event will have two sessions focusing on (i) Best Practices and Models of Biomass Cookstoves and; (ii) Ministerial discussions on development of collaborative agreement for learning and sharing of experiences. The event will be participated by renowned international experts from USA, China, Peru, Uganda, Nepal, etc besides experts and organisations from India.

For more details, please contact: Mr V K Jain

Tel.: 011-24369788, E-mail: jainvk@nic.in

DIREC 2010



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- ➔ Business Trade Show
- ➔ Official Side Events
- ➔ Parallel Events on Thematic Cross Cutting Issues

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