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Bio mass gasifiers in Andhra Pradesh: A Viable Source of Energy*

R. Venkata Ravi**

In this day and age, all activities are based on the application of energy from different sources. The energy has been recognized as one of the most important inputs for socio-economic development. Indian energy scene is characterized by very low per capita consumption as compared with other countries. So, increase in the energy consumption depends on two options: (i) availability of recoverable fossil fuel resources, which are limited in nature and not eco-friendly, (ii) making use of locally available non-conventional and renewable energy sources. The second option is highly suitable to Indian conditions, because India is endowed with large quantity of renewable energy sources (Kanniappan and others, 2002). The available large potential for application of renewable energy sources for various applications in the context of paucity of funds and also to accelerate sustainable socio-economic development.

On excessive use of conventional sources of energy has endangered the environment and ecology with negative effects on the existing natural resources. It would also lead to a situation wherein polluted environment, pressures on socio-economic phenomenon and also spriling effects of these changes. It is capable of affecting the sustainable development process in any economy. Hence, non-conventional or renewable soruces of energy have attracted attention and evoked interest among planners, policy makers, economists and activists as a viable alternative to achieve the much cherished goal of sustainable development. Many international organizations and World Bank have started focusing on the renewable sources of energy to achieve the sustainable development with judicious usage of such energy sources.

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On realisation of the need for tapping the renewable sources of energy, the Government of India has initiated, strategies at various levels way back in eighties and also established institutional mechanism for promotion of renewable energy sources. India has earned the distinction of being the only one in the world to have an exclusive Ministry for the promotion and development of non-conventional energy sources. The Ministry has formulated a policy on Renewable Energy to bring about a smooth change over from the fossil fuel based economy towards a sustainable economy with rationale use of renewable energy sources. The policy is mainly focused on meeting the minimum rural energy needs, decentralised energy supply for agriculture, industry and other applications. To achieve, the Ministry has introduced strategic programme to promote sutiable technology and devices to tap the various renewable energy sources. They are mainly bio-gas, improved chulhas, bio-mass gasifiers, solar lighting, and solar heater etc.

Biomass Energy

Biomass meets major energy needs of the rural areas, as it is locally available in plenty. The Biomass is refered to all organic matter produced by plants and their dervations including crop residues, crops grown for energy productions. Biomass is considered as renewable energy source, because it can be renewed by growing repeatedly. Biomass resources are available in the agro-processing units, farms and cattle sheds. But the technologies for conversion into energy are quite different for each type of biomass. The various application of biomass energy includes –Thermal Energy (domestic fuel or industrial heating), Mechanical Energy and Electrical power generation. There are methods for conversion of biomass to energy such as co-generation, combustion, and gasification.

In our country, with strong agrarian base, bio-mass is produced and locally available as very convenient fuel. There are proven technologies for effectively and efficiently convert the available bio-mass into energy. The important technology are bio-gas plants, improved smokeless chulhas, and bio-mass gasifiers. The renewable energy technologies are for

- Improve the efficiency in converting the bio-mass into energy by effective combusting method.
- Reduce the pollution and protect the environment.
- Scope for recycling of the waste such as slurry and fly ash for productive purpose.

- Decentralized energy production with local resources.
- Various operations can be done with bio-mass energy produced.

Biomass Gasifiers

Biomass Gasification Technology is basically conversion of solid biomass into combustible gas normally called "producer gas". The entire machineries and appliances to convert the biomass into gas is known as Biomass Gasifier. The Biomass Gasifiers (BMG) can be used for thermal, electrical and mechanical energy applications. The technology and device used to convert bio-mass into combustible gas is known as Biomass Gasifiers. The gas produced is known as ''Producer Gas'' that can be burned like natureal gas for various energy purpose. The energy application mainly for thermal that include heating and large quantum processing, another is electrical – to produce electricity by infecting the biomass gas into dual-fuel generator for power production. The bio-mass gasifiers has advantages like

- Effective conversion of bio-mass into gas.
- Reducing pollution and wastage.
- Efficient conversion of gas into thermal and electrical energy.
- Can generate employment in operating gasifier.
- Can be an alternative and cost effective power source.
- The bye-product fly ash can be productively used.
- Captive power generation in a decentralized manner.
- Reduce the indiscriminate use of fuel wood and other bio mass.

The promotion and sustained use of bio-mass gasifiers can help the organization / industrial unit to sustain their main processing and production activities without any interruption in energy supply. The bio-mass production and utilization for energy has scope for backward and forward linkages and resultant positive socio-economic implications such as employment and income generation in the bio-mass production.

Situation

A study in Tamil Nadu (Kanniappan and Others, 2002) indicates that the bio-mass gasifier for thermal application has reduced the cost of fuel in the processing units such as silk reeling, wax-candle making, dyeing units. The technology has helped to reduce or replace the use of kerosene and fuel wood for heating purpose. Another experience in Karnataka (Cheya Chengapa

and Abraham, 2000) show that the bio-mass gasification based power plants utilize locally available bio-mass in around the 16 villages to generate electricity. The heat generated in the method can also be utilized for dyeing and heating in the process. At the same time, decentralized energy production paved way for plantation of bio-mass in the waste land and agro-forestry methods.

According to the Annual Report (2000) of MNES, a quite energy revolution brought about in Rayagada district of Orissa. The electricity is produced with biomass gasifiers by using locally available biomass. The demand for lighting in houses and streets in Similiguds village (Orissa) is met by the biomass gasifiers by using locally availble plants, weeds, paddy husk, etc., resulting in energy production and environmental hygiene. Kushal P.S. Yadav (2003) observed that the decentralized power generation by bio-mass gasification would be key for rural electrification in the villages which are being as remote and inaccessible areas for electricity supply. Moreover, the biomass gasification process eliminates all the environmental pollution due to directly burning of bio-mass for energy.

The Government of India through the State Government has been promoting the biomass gasifiers in the Andhra Pradesh for thermal and electrical applications. Andhra Pradesh has been one of the pioneer in promoting the gasifiers in the country.

Andhra Pradesh has large number of biomass gasifiers installed in the country. By the end of March 2003, the state has more than 165 biomass gasifiers. The state has potential for application of biomass energy in various segments like – industrial units, residential schools, ashrams and non-government organizations. In Andhra Pradesh, the biomass gasifier is mostly used for thermal and electrical application.

Source of Data

In this background, the operational viability of gasifier, for electricity production in Andhra Pradesh is examined in this paper. The paper has following specific objectives [1] to estimate the effect of gasifier on diesel savings in power generation, [2] to estimate the direct employment generation in running the gasifiers, [3] to analyse the viability in operating the gasifier for power generation and also [4] to enlist the factors determining the utilization of gasifiers. The paper is based on a sample study in Andhra Pradesh among the users of the gasifiers both for thermal and electrical applications. The

study was conducted in 1999 among the 75 sample installations drawn out of 148 installations commissioned during period of 1993-1999. However, the economics and viability in electrical application have been worked considering the recent (2003) electricity charges in the State.

Mode and Users

The gasifiers are used for thermal and electrical applications. The thermal mode gasifier has been used in Industries (canteens), School kitchens and Non-Government Organizations, Ashrams for quantity cooking and processing. Whereas, electrical mode gasifiers have been used for alternative power generation in the industrial units like - Rice mills, Ice factories, Cold storage, Spinning mills, Oil mill, Confectionaries, Engineering & Medical production. The thermal mode gasifiers are found utilized only wood for gasification. But, electrical mode gasifiers are based either on Rice Husk or wood. The study covered a sample of 28 wood gasifiers for thermal, 18 Rice Husk gasifiers and 29 wood gasifiers for electrical applications.

Diesel Savings

Biomass gasification is to produce the gas and inject the same into duel-fuel generator set for electrical power generation. Resultantly, the gas could replace (save) the diesel used for power generation. Based on the study of 47 electrical mode gasifiers with 100 KW capacity, the average diesel replacement is estimated. The study considered that a 100 KW generator consumes on an average 22 litres of diesel per hour.

TABLE 1
Diesel Savings in Electrical Gasifiers

S.No	Details	Husk Gasifier	Wood Gasifier
1	Number of sample units	18	29
2	Expected average % of diesel savings*	65%	65%
3	Achieved average % of Diesel savings+	43.77% (9.63 litres)	38.72% (8.52 litres)
4	Co-efficient of various for % of diesel saved	29.45%	297.53%

Chi-sq. 32.26184, D.F. 2, significance : 0.0000Note : * Collected from M/s. Associated Engg. Works, Tanuku, Andhra Pradesh.+ On an Average 22 litres of diesel per hour required to run 100 KW generator.

The gasifiers could not perform as expected by the manufacturers of the gasifiers. Because only 9.63 litres of diesel saved by the Rice Husk gasifier; 8.52 litres of diesel replaced by the wood gasifier out of 22 litres required to run a generator per hour. So, the biomass gas could replace substantial quantity of diesel in power generation. The study also indicates that lower percentage of variance, more of stability in the husk gasifiers than the wood gasifiers. It implies that husk gasifiers could efficiently replace the diesel than the wood gasifiers.

Operating Viability

Based on the study, average operating cost has been estimated for electrical mode gasifiers based on Rice Husk and wood. The changes in the price of husk, wood, diesel have been taken into consideration while analyzing the operating viability of alternative power generation. The operation of gasifier considered viable, if the unit cost of power generated is lower than the tariff per unit of grid power. During 2003, Rs. 7.00 per unit has been charged for non-domestic consumers in Andhra Pradesh.

Rice Husk Gasifier

According to the study in 1999, the average cost of rice husk per tonn worked as Rs.690/-, which has been a main input for the husk gasifier. The operating viability of gasifier in the year 2003, estimated based on the following assumption.

- Same level of inputs of rice husk, diesel as in 1999.
- Power generation at 80% level in 100 KW generator
- Increase in the cost of husk up to 10% over 1999 price level
- Increase in the electricity rate (Rs. 7.00 per unit of non-domestic users in 2003)
- Increase in the cost of diesel

It is noticeable that even with substantial increase, in the cost of inputs, operating of BMG for electricity generation is viable. Because, comparative cost advantage makes the BMG more viable in power generation. Another aspect is that if the industrial units are using their own source of rice husk, the BMG can be most viable for power generation. As the opportunity cost for the available own source of husk is more when converted into electricity. The increase in the level of diesel saving from 44% to any further higher level will definitely make power generation

through BMG more viable. Hence, the comparative cost advantage is the basic factor that favour for the BMG based power generation for self consumption by the rice mills and others having their source of rice husk. The difference in the source of husk and its price, resultant economic of power generation need to be further examined at field level in different part of the country.

Wood Gasifier

According to the study conducted in 1999, the average cost of wood per tonn worked as Rs.1000/-. The operating viability of wood gasifier in the year 2003 has been estimated based on the following assumption.

- Same level of inputs of wood, diesel as in 1999.
- Power generation at 80% level in 100 KW generator
- Increase in the cost of wood up to 20% over 1999 price level
- Increase in the electricity rate (Rs. 7.00 per unit in non-domestic sector)
- Increase in the cost of diesel

It is observed that though cost of inputs have increased; the wood based BMG is viable for power generation. The comparative cost advantage makes the wood based BMG more viable. If the users have their own source of wood, it can improve the viability of power generation availability of cheap with wood for gasifiers. Suppose the diesel saving level improves from 39% to any upper level will surely make the wood BMG as promising source of alternative power generation. So, comparative cost advantage makes the wood BMG more viable. Moreover, the increasing grid power tariff, in context of power sector reforms, it is only BMG can help the industrial units to produce the biomass based power for sustaining their economic activities.

The analysis indicates that rice husk gasifier can be viable than the wood gasifiers in the context of increasing diesel and wood price. The Rice husk gasifier can be viable as the Rice mills are utilizing their own husk for *captive power generation*. Thus, the gasifier can be operated at "viable level" to generate power which cost much less than the grid power.

Employment Aspect

The direct employment generation is possible in operating the gasifiers as it requires labour for loading and cleaning the system. The study also

noticed that: Women workers are found operating only the thermal mode gasifiers in the schools and NGOs whereas in industrial units, gasifiers have been operated by men workers. And the electrical mode gasifiers have been operated only by the men workers as they mostly used in industrial units like Mills, Factories, Fabrication units.

The implication is that schools and NGOs have employed women workers in their kitchen and moreover operating thermal mode gasifier is not much complex and so operated by women. Whereas, operating the electrical mode gasifiers is a technical process and it also necessitates only men workers due to heavy operations involved in the process. The study indicates that direct employment generation in terms of person days is directly related to the number of days the system has been utilised. However, indirect employment generation could be in servicing and maintenance of gasifiers, "demand pushed" expansion of bio-mass production and gasifier fabrication. The indirect employment would be generated in rural and semi-urban areas in creating and maintaining the energy plantation in wasteland and as agro-forestry.

Determinants of Utilisation

Based on the analysis of problems encountered by the users, SWOT analysis, the factors determining the utilisation of gasifiers are enlisted below :

Enables of Thermal Gasifier

- Availability of fuel wood from own source enabled to use the same for gasification. The private schools, NGOs have energy plantation in and around the campus.
- Moreover, sufficient workers are available with users to process the wood to combust in the gasifiers.

Unables of Thermal Gasifier

- Available thermal gasifiers can combust only wood and not rice husk which is available in plenty in the coastal Andhra Pradesh, where price of wood is higher.
- In many places Rice Husk is directly burned for generating heat energy, particularly in Coastal area of the state.

- In Government schools, catering in the hostel by the private contractors and they are free to make arrangements for cooking fuel. They prefer burning the wood as it produces charcoal, which can get extra benefits to the workers.
- The workers in the government schools are not sufficiently trained to operate the gasifiers, particularly to control the heat as per requirement.
- In the government schools, the fuel wood purchase is centralised. So, this has unabled local officers to purchase fuel wood suitable for gasification.

Hence, the study reveals that though the thermal gasifiers has many advantages, it cannot be extensively utilised by the industrial and non-industrial users, as they are facing operational problems such as, non-availability of fuel wood, increasing fuel wood price, available husk as feasible substitute for wood, non-suitability of gasifier to consume husk. Hence, the major challenges are :

- Develop the gasifiers, which can combust any type of biomass.
- Encouraging the schools, industrial units to produce biomass on their campus (energy plantation).
- Training programme for the workers operating the thermal gasifiers.
- Capacity of gasifier based on quantity of biomass available with the user.

Enables of Electrical Gasifiers

- Availability of Rice Husk from own source enabled to utilise the Rice Husk Gasifier for electrical application.
- Ready availability of firewood at cheap price facilitated the utilisation of wood gasifier for power generation in the early nineties.

Unables of Electrical Gasifiers

- In short-duration of power-cut, (less than an hour or for an hour) gasifier has not been utilised as it requires about half an hour to start the gasifiers.
- Assured supply of grid power in the state is also reason for non-utilisation of the gasifier for power generation.
- Opportunity cost for the Rice Husk has been increasing. Hence, mills are interested in selling out the Husk, particularly to oil extraction plants.
- Non-availability of suitable fuel wood and increasing price has been major hurdles for non-utilisation in the coastal Andhra Pradesh.

- To operate the gasifiers with generator set require exclusive trained technical workers.

Though the Bio-Mass gasifier technology is capable of converting the wood or Rice Husk into electrical energy, it cannot be extensively utilized despite of continuous promotional efforts because of increasing price of fuel wood, opportunity cost for Rice Husk. Moreover, the assured supply of power in the state has also resulted in utilisation of gasifier "as a stand-by source".

Further Areas of Research

Recently many changes has taken place in the power tariff and also cost of inputs. Hence, there can be further analysis based on the updating the field level data on functioning of bio-mass gasifiers.

- The replacement of LPG, wood, kerosene can be studied and analyzed in thermal mode gasifiers.
- Problems related to utilization of various type of bio-mass for thermal mode gasifiers.
- Cost-effectiveness of own source of bio-mass and purchased sources.
- Improvement in the diesel replacement / saving due to bio-mass gasifiers under different situation – industry, non-industry, wood, rice husk, etc.
- Source and cost of biomass, its influence of the use of biomass gasifiers.
- Direct and indirect employment generation in operating the biomass gasifier.

Examining the effective micro-level planning for integrating the gasification, wasteland development, and agro-forestry and watershed development. It would help to generate power from waste and also take care of the environmental protection in rural areas.

In the backdrop of the foregone analysis, it can be noted that increasing in the cost of wood, diesel has influenced the viability of electrical mode gasifier. Hence, it is implied that either users should purchase biomass at lower price or utilise rice husk from own source for producing energy for their consumption. In this context the policy implication would be as observed by Dr. Kirit S. Parikh that "government policies that provide subsidies to encourage producers on actual power generation and not with capital subsidy". The capital subsidy only results in the installation of gasifiers, but not actually commissioned and sustained utilisation. The actual users of the gasifier have to be rewarded with tax concessions / relief to encourage them to use the gasifiers permanently

for captive power generation. Because the use of available biomass resource is no longer for alternative energy, but it is for the self-reliance and decentralised power generation.

TABLE 2
Rice Husk Gasifier Average Operating Cost at 1999

Sl. No.	Inputs	Quantity	Price *(in Rs.)*	Value *(in Rs.)*
1.	Rice Husk in Kgs	164	0.69	113.16
2.	Labour (Nos. for 2 hours)	2	11.47	22.94
3.	Diesel (Litres) Required	12.37	11.60	143.50
4.	Electricity (in Units)	4	3.60	14.40
5.	Average operating cost	-	-	294.00
6.	No. of Units produced per hour	80	-	-
7.	Cost per Unit of electricity generated	-	-	3.68

Table 3
Rice Husk Gasifier Average Operating Cost at 2003

Sl. No.	Inputs	Quantity	Price *(in Rs.)*	Value *(in Rs.)*
1.	Rice Husk in kgs	164	0.76	124.64
2.	Labour (Nos. for 2 hours)	2	11.47	22.94
3.	Diesel (Litres) required	12.37	21.00	259.77
4.	Electricity (in Units)	4	7.00	28.00
5.	Average operating cost	-	-	435.35
6.	No. of Units produced per hour	80	-	
7.	Cost per Unit of electricity generated	-	-	5.44

TABLE 4
Wood Gasifier Average Operating Cost at 1999

Sl. No.	Inputs	Quantity	Price*(in Rs.)*	Value*(in Rs.)*
1.	Fire wood in Kgs	94.48	1.00	94.48
2.	Labour (Nos. For 2 hours)	2 hrs.	11.47	22.94
3.	Diesel (Litres) required	13.48	11.60	156.37
4.	Electricity for cutting and blowing in Units	6.00	3.60	21.60
5.	Average Operating Cost	-	-	295.39
6.	No. of Units produced per hour	80	-	
7.	Cost per unit of Electricity generated	-	-	3.69

TABLE 5
Wood Gasifier Average Operating Cost at 2003

Sl. No.	Inputs	Quantity	Price(*in Rs.*)	Value(*in Rs.*)
1.	Fire wood in Kgs	94.48	1.20	113.38
2.	Labour (Nos. For 2 hours)	2 hrs.	11.47	22.94
3.	Diesel (Litres) required	13.48	21.00	283.08
4.	Electricity for cutting and blowing in Units	6.00	7.00	42.00
5.	Average Operating Cost	-	-	461.40
6.	No. of Units produced per hour	80	-	-
7.	Cost per unit of Electricity generated	-	-	5.77

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