

# Bioenergy for enhanced quality of rural life and national economic resurgence

- Bioresidue based cooking solutions with advanced gasifier stoves
- Distributed electricity generation from modern fuel-flex gasifiers
- High output first generation liquid fuels from seeds/fruits – bio-diesel.
- A combined bio-energy solution in a low cost PPP approach to generate liquid and solid bio-fuel capitalizing on the culturable wasteland whose magnitude was 30 mHa (2005) in India.
- A solution strategy applicable to all oil-importing developing countries

H. S. Mukunda

Indian Institute of Science, Bangalore

([mukunda@cgpl.iisc.ernet.in](mailto:mukunda@cgpl.iisc.ernet.in); <http://cgpl.iisc.ernet.in>)

# Bioresidue for cooking

1. Bioresidue based cooking is practiced in about 100 million house-holds (mmh) in India using about 450 mmt of firewood + agroresidues and about 500 million hhs across the world using 2.5 billion tonnes of agro-residues. In some African countries, dependence of biomass is as much as 95 %. The amount of biomass used for cooking in India is comparable to the coal used for power generation.
2. Large international donor agencies are involved in funding these efforts.
3. They assume (incorrectly) any improved stove must function with a variety of solid bio-fuels despite variation in (a) size, (b) shape and (c) density all of which have significant influence on the efficiency and emissions. In recent times, only moisture has been recognized as the enemy of good combustion. Good Science that has been applied to most other fields is largely missing here. It is enthusiasts field!
4. Three aspects that are to be considered are:
  - Biomass stoves that show in the laboratory high efficiency (water boiling) and low emissions (called HELE designs) have been developed. It is shown and now better recognized that unless fan based designs are deployed, one cannot get HELE benefits. These devices can bring down the biomass for cooking to about 150 mmt in India. This is substantive.
  - Grow biomass, process them to sizes and shapes and create a supply chain for quality fuels. It is important to recognize solid bio-fuel also needs to be supplied as mainstream fuel like LPG and kerosene.
  - Allow market forces to create competition for the supply of these stoves with governmental intervention limited to quality standards, monitoring by involving private partners, policy directives limited to helping below poverty line people with procedures that are subverted little.



**Gasifier based domestic pellet stove. Fan based Reverse downdraft Technology transferred to First Energy Pvt Ltd, Pune.**

They industrialized the product to help common house-hold buying the stove feeling that it is indeed new and “fashionable” to acquire.

Pellets made of agro-residues – bagasse, groundnut shell and other bio-residues; cost Rs. 5 (0.09 US cents) /kg and affordable for most Families; sold 0.5 million semi-commercially, Excellent user feedback.

Now fuel costs thrice of the earlier price – raw fuel cost rise and other aspects. Domestic market has collapsed due to fuel costs. Diversification to larger power systems for survival.– about 5000 systems have been built and sold to large cooking establishments .

For domestic applications, stove can be taken to be available in any scaled amounts including millions. However, achieving low cost pellet fuel production is the prime need.

Water boiling efficiency = 50 %, CO: 0.75 g/MJ, CO/CO<sub>2</sub> ~ 0.015 to 0.02  
Very low particulate emissions.



**Horizontal domestic gasifier stove, Ejector induced gasification principle.**

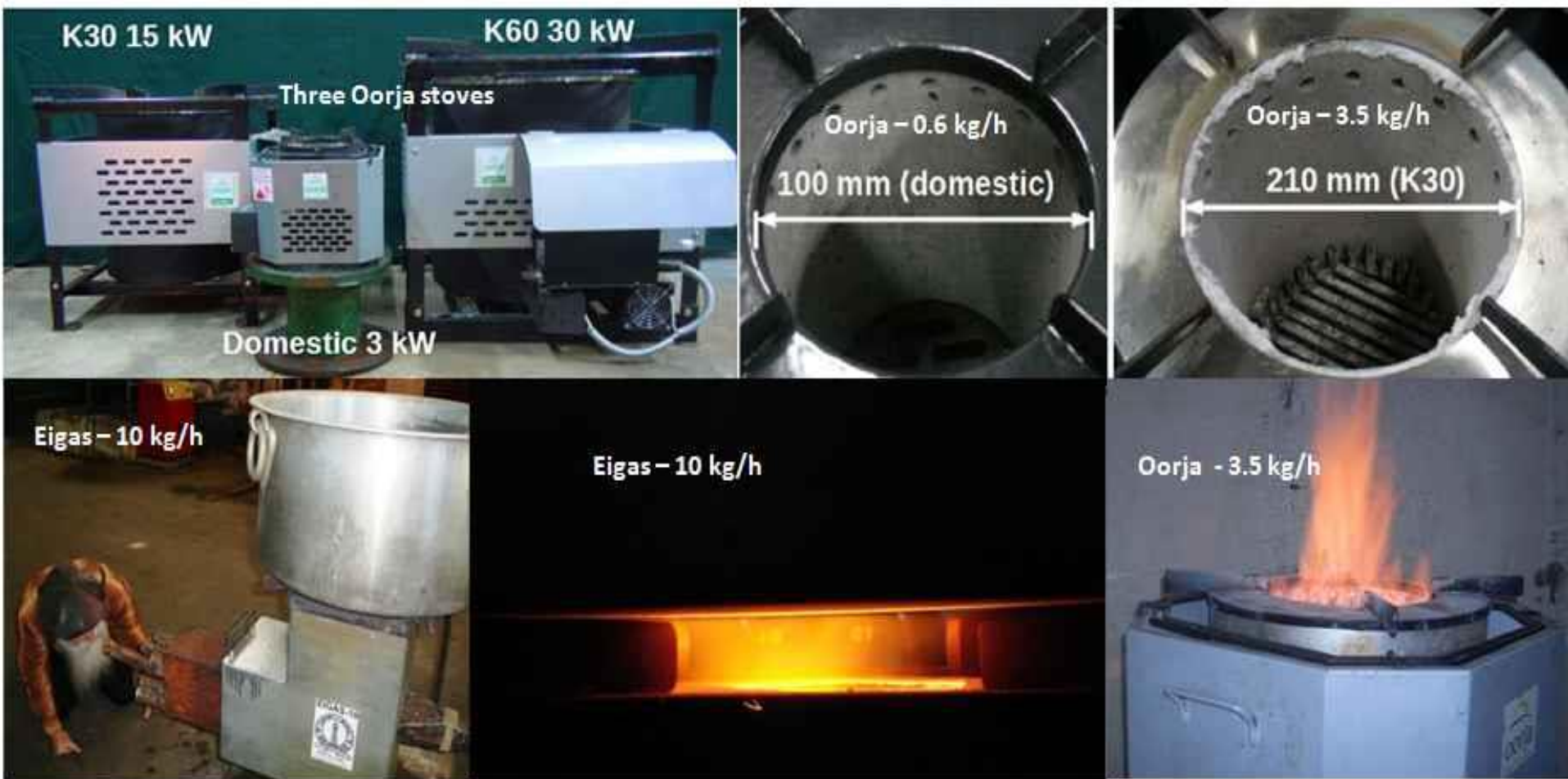
Smaller size sticks of firewood, cotton stock, pieces of coconut shell, etc. Particulate emissions meet the standard, but more than Oorja stove

**Just industrialized. Technology transferred to M/s Pointec energy Pvt Ltd.**

Various versions including 1 kg/h domestic stove, 2, 5, 10, 20, 30 kg/h semi-industrial systems have been built, tested and cleared.

M/s Pointec energy Pvt Ltd also intends to supply quality fuel to all the users – domestic or industrial.

Water boiling eff ~ 45 %, CO ~ 0.013 to 0.018 g/MJ, CO/CO<sub>2</sub> ~ 0.013 to 0.018

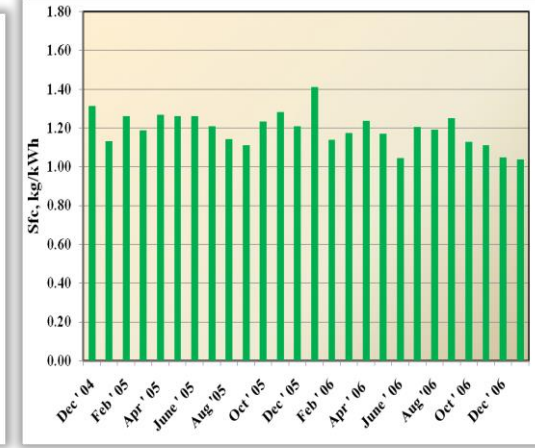
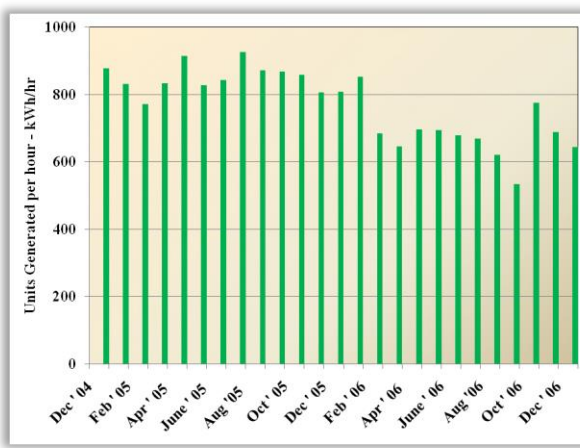
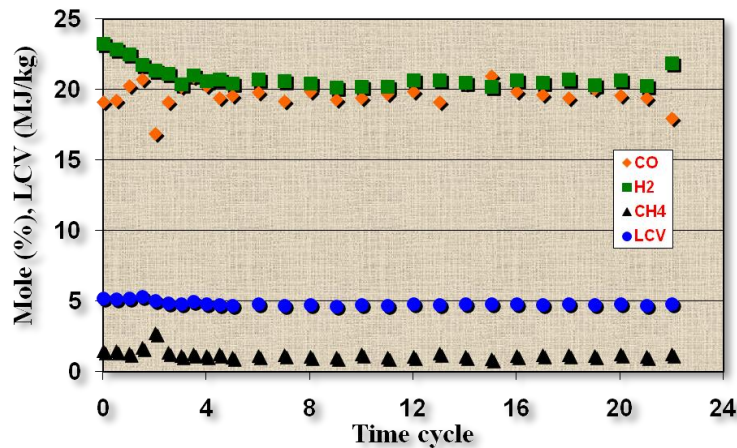


Power supply: The fan depends on a 2 W rechargeable battery source. A single charge allows three to four cooking operations. Larger systems for semi-industrial applications have power supply similarly designed. But charging in larger systems is not a matter of concern. Domestic stove has a single fan with controlled divided air supply. Larger systems have two fans – one for gasification and one for controlled combustion.

# Biomass for distributed electricity generation

- India (MNRE) has invested substantive finances into research, technology development; also for promotion largely by capital subsidy over the last two and a half decades.
- Consequently, tested technologies have been commercially marketed over the last decade both within India and overseas.
- Rigorous gasifier testing to establish “tar and particulate” performance to Euro standards was completed at IISc in 1995.
- The greatest progress made in the last decade and half is the winning-over of engine companies, though initially grudgingly, but overwhelmingly warmly *after rigorous laboratory tests and long field performance evaluation* of the gas engines operating on producer gas plant at 1 MWe class grid linked power station. **M/s Cummins engines, Pune took the lead.**
- This evaluation running over 18000 hours of operation with a full strip-down at 5000 hours enabled **Cummings engines, Pune to open a section on the supply of producer gas engines for the first time in producer gas engine history.**
- Power generation systems of 25, 100, 250, 1000 kWe (using multiple 250 kWe engines) have functioned for long durations on 24 x 7 basis. One system of 100 kWe in a project of the Karnataka Government operated for 1000 continuous hours.
- Many gasifier manufacturers have used other ideas for establishing power supply systems. M/s Heat power limited has built systems on rice husk in Bihar that work for 5 – 6 hours a day with much greater periodic maintenance; waste water treatment is absent from the power package.





H<sub>2</sub> & CO : 19 ± 1%; CH<sub>4</sub> : 1.5%; LCV 4.8 MJ/kg.  
Cold gas efficiency : 83 - 85%

Monthly average power output over 2 yrs.

Monthly average sfc

The power generation system has **waste water treatment, water recycling features.**

Large amount of experimental data on actual performance of gasifier based thermal and electricity generation systems at the laboratory and field systems are posted at the website <http://cgpl.iisc.ernet.in>.

These include small and large systems operating on coconut shells (nearly impossible for technologies other than IISc technology to work), Prosopis Juliflora, waste wood from forests, etc

# Issues and way forward

1. Operating gasifier based systems is more difficult than combustion based systems.
2. Problems posed as “IISc installed gasifier not working”, “wrong design” etc have all been traced largely to lack of necessary discipline in operating the systems – attention to biomass size and moisture and specific operating procedures.
3. Largely understandable since these systems are new for the user community. But even technical people mislead many a time largely because they do not understand and do not wish to say they do not!
4. There is widespread concern of tar and particulate problems largely **due to incorrect technology adopted largely from overseas** and nearly **complete lack of understanding of the processes involved**.
5. **Greater transparency in establishing quality of systems involving user community is needed. These data once established must be owned up by the Government – MNRE and published.**
6. Capital subsidy that is simpler to operate administratively should be replaced by generation based incentive (GBI). This will ensure that subsidy goes for performance and not for just “good intention”.
7. The tariff set for biomass power generation systems should at least match with the current tariffs for solar photovoltaic power generation.
8. When the biomass is urban solid waste, this tariff should even be higher since any action in this regard helps clean up the urban environment.

# Liquid biofuels - some irksome questions.

- GoI recently made an announcement “*India's oil import bill leaped 40 per cent to a record \$140 billion in 2011-12 as high oil prices shaved off much of the nation's GDP growth rate*”. That it was just 20 billion USD ten years ago shows the enormity of the problem.
- Very few who matter are concerned (PM, PM and FM) about resolution of the problem. Those who are concerned (like me, for instance and not too many, though) do not matter! .....and business as usual scenario
- Our current wealth – 30 mHa of culturable waste land (MRD-NRSA 2010 report - <http://www.indiawaterportal.org/taxonomy/3/Wasteland-Mapping> )
- With tropical climate and varied water resources, can't we grow high yield returning plantations of oil producing trees on these lands?
- Surely, it is not easy. Land is not fertile, there may not be enough ground water, etc, etc. And, it costs money. But.....is buying oil from overseas less expensive? – 140 billion USD/year at that. As of now most oil management in the country is a matter of largely trade.
- Unless we must move into large scale production no difference to the economy can be made. This to my mind, is the single largest economic issue (compared to any discussed in the last 5 years).
- Has nobody else done things like greening barren lands? The answer is **Israel** has done fabulous things – advanced agriculture in desert regions.
- Has anybody else benefited from bio-related liquid fuels (since usually following is easier than treading new paths – as they say!)?
- The answer is **Yes. Brazil, Malaysia and Indonesia** have done remarkable things.
- Should we be always concerned with poor yielding *Jatropha* circus (~ 1 t/ha/y)? Should we not consider Oil palms of very high yield (4 to 6 t/ha/y)? Should we be afraid of food vs. oil debate since it is there anyway with ethanol vs. sugar and true of all biogenic output?



# Liquid bio-fuels – some answers

- The GoI should entrust **IOCL and HPCL** with the responsibility of increasing the fraction of bio-fuels to some meaningful value – say 40 % in five years. It is up to them to use the Governmental machinery, R & D institutions and private industry to create wealth. As far as I know, only Brazil has thought wisely and entrusted **Petrobras** to factor bio-oil production in the country. We have not even debated these matters adequately.
- Leasing lands to a very large number of profit making private industries to grow multi-purpose plantations, of course largely oil producing, using all available knowledge in the space within or outside the country.
- Employing local labor including farmers will enhance the local employment –with each hectare accounting for at least six unskilled and skilled jobs. They get paid on a monthly basis because they are employed.
- Due to this reason, farmer suicides cannot occur since they get monthly salaries! Industries (with this land) have invested from their profits in returns that may take time – six to seven years. Facilitating long return time industrial investment in should be facilitated with Governmental fiscal support on taxes, etc.
- No other Governmental money need to flow into this sector. A number of subsidiary issues like involvement of local Panchayats and the work force will throw up human related problems. But then every new issue throws up human problems. These are not difficult to solve either since everybody benefits – **the people, the Government and the environment**.
- Brazil, Malaysia and Indonesia have benefited enormously from growing and producing bio-oils (Oil palms) and we should also benefit from it.

# And finally,

- Recognize that any oil produced constitutes 20 to 25 % of the biomass that the plant produces. Rest of the biomass is solid.
- Create a strategy to produce solid wastes into shaped, sized dry mass in the form of pellets, briquettes or sized firewood with identification of meaningful combustion properties – density and ash content and make them available in the market.
- This should be kick-started by Government. Private industry will then take over. Competition will bring down the cost of solid fuels.
- Making “good” solid fuel available allows private stove manufacturers to make a difference to the cooking solutions that are kitchen and environment friendly.
- Recognize that biomass is responsible for food, fuel, fiber and chemicals **unlike other renewables** and do not ignore it. Face debates squarely depending on rational data and not simply fears.
- Change fiscal incentives **from upfront to performance based**. Involve banks or other financial institutions as needed.
- Reduce the finance outgo from 120 billion USD to 20 billion USD in ten years... a good enough publically acceptable mandate!!.
- Remember the poor also benefit. The advanced stoves and good solid fuel will make their cooking environment very friendly.
- Small bio-power can also give them electricity that they can turn on and off as they want.

.....Thank you