Biofuels for Latin America – a 2006 perspective

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The plan of the presentation

- Why Biofuels now?
- For whom are they needed immediately
- The biofuels – liquid and solid
- Principles for the most appropriate use
- The resource base
- Issues on liquid fuel use
- Issues on solid fuel use
- Summary of issues and recommendations

Why Biofuels now?

- Global prices of oil seem are on a rise.
- Some argue that it is linked to the global peaking of oil production.
- In any case, nobody argues that oil prices will decrease.
- This price rise will benefit the oil exporting countries on a short term.
- Oil importing countries will need to bear the brunt of these price rises.
- Eventually, everybody needs to learn to look for biofuel class of solutions, with some adopting earlier than others

For whom are they needed immediately?

- Oil importing developing countries
- Developed countries concerned with environment seriously
- Others for bettering the outreach into rural environment in the most economic way

Oil importing countries

Country	Populn Millions	GDP (PPP) per capita USD	Net Oil, KYP	Net NG, KYP
Haiti	8.31	1700	70	0.0
Nicaragua	5.57	2900	100	0.0
Bolivia	9.00	2900	30	E2750
Cuba	11.38	3500	580	0.0
El Salvador	6.82	4700	290	0.0
Guatemala	12.33	4700	180	0.0
Paraguay	5.64	4900	190	0.0
Peru	27.15	5900	60	19310
Panama	3.19	7300	1210	0.0
Uraguay	3.43	9500	540	33100

Oil Import generally implies lower GDP (PPP) per capita.All these countries have also a strong agriculture. Hence They can benefit from modern use of biofuels

Oil exporting LACs

Country	Populn Millions	GDP (PPP) /capita, USD	Net Oil, KYP	Net NG, KYP
Argentina	40.0	13100	370	3560
Brazil	188.0	8400	110	-3280*
Columbia	43.6	7900	280	0.0
Equador	13.5	4300	1240	0.0
Mexico	107.5	10000	770	-4300
Trinidad, Tobago	1.1	16700	5640	6570
Venezuala	25.7	6100	4820	0.0

Excepting Brazil and Mexico that import NG, other countries are export Positive. Several of these countries (like Brazil) have also strong Renewable energy track record.

Biofuels

- Fuels for motor vehicles
  - Alcohols for light motor vehicles
  - Biodiesel for heavy vehicles
- Fuels for electricity and high grade heat
  - Solid plantation residues
  - Solid agricultural residues
  - Urban solid waste

Principles for the most appropriate use

- Do not use a fuel that can serve a better purpose with ease.
- This principle appears simple, but does not seem to be recognized as such.
- Many enthusiasts are involved in several aspects and push each aspect as though it alone is vitally important

Principles for the most appropriate use

- Alcohols can be use for transport. Hence they should be used not for stoves and heat applications or stationary electricity generation. They should be used essentially for transport vehicles (LMV) or chemical industry.
- Biodiesel should better be used similarly for heavy transport vehicles and not for industrial heat or stationary electricity generation.
- Solid biomass can be used for modern gasifier stoves, heat or gasifier based stationary electricity generation.

The resource base

- Plantation harvest and bioresidues
- Agro-residues
- Urban solid waste

Plantation output

Country	Plantation Area	Bioresidue MillT/y (Est)	Total Forest MHa
Argentina	0.83 MHa	8.0	34.0
Bolivia	20000 Ha	0.12	48.3
Brazil	4.8 MHa	72.0	551.1
Chile	1.75 MHa	11.0	7.9
Colombia	0.3 MHa	2.0	53.0
Costa Rica	0.13 MHa	0.8	1.2
Cuba	0.47 MHa	4.0	1.8
Dominican R	20000 Ha	0.12	1.6
Ecuador	0.12 MHa	1.0	11.1
El Salvador	8000 Ha	0.05	0.1
Guatemala	0.07 MHa	0.4	3.8
Haiti	12000 Ha	0.07	0.02
Honduras	40000 Ha	0.24	4.1
Jamaica	6200 Ha	0.04	0.17
Nicaragua	23000 Ha	0.14	5.6
Panama	16200 Ha	0.1	2.8
Paraguay	18000 Ha	0.13	11.5
Peru	0.35 MHa	2.1	67.6
Trinidad+ Tobago	18000 Ha	0.11	0.16
Uruguay	0.35 MHa	2.1	0.81
Venezuela	0.59 MHa	0.35	44,0

For productivity (dry tonnes per hectare per year), it is taken as 15 for Brazil due to its demonstrated experience in growing plantations, 10 for Argentina, and 6 for other countries. Those countries following Brazil can perhaps double the plantation output.

MT = Million tonnes

Country	Maize stalk & cobs. MT	Wheat residues, MT	Soybean stalks, MT	Coconut shell, & fronds MT	Sugar cane Trash, MT	Paddy straw, husk, MT	Population Million, Rural fractn, %
Argentina	30, 7.5	21,, 13			0.97		40.0, 10 %
Bolivia	1.4, 0.3	0.17, 0.1			0.24	0.4, 0.1	9.0, 37 %
Brazil	84, 21.9	8.6, 5.2	84.6	0.5, 2,2	20.1	20.0, 2.0	188, 17 %
Chile	2.6, 0.66	2.9, 1.7				0.2, 0.02	16.1, 13%
Columbia	2.8, 0.7				2.0	4.0, 0.54	43.6, 24 %
Costa Rica					0.19	0.4, 0.05	4.07, 39 %
Cuba				0.1, 0.1	1.2		11.4, 25 %
Dominican R				0.1, 0.1	0.28	0.8, 0.12	9.18, 41 %
Ecuador	2.7, 0.37		8.98		0.33	0.2, 0.27	13.5, 38 %
El Salvador	1.3, 0.33			0.1, 0.1	0.26		6.82, 40 %

Notes: **Maize cobs and coconut shells have low ash content and are just equivalent to wood in terms of cal value.** Maize cobs do not need to be processed. They can be used directly. Coconut shells need to be broken, and used. Both of them are extensively available in Latin America. Soybean stock is used as fodder in some countries. The remaining amount is dried, pulverized and briquetted before use.

MT = Million tonnes

Country	Maize stalk & cobs. MT	Wheat residues, MT	Soybean stalks, MT	Coconut shell, & fronds MT	Sugar cane Trash, MT	Paddy straw, husk, MT	Population Million, Rural fractn, %
Guatemala	2.1, 0.54				0.9		12.3, 54 %
Haiti	0.18,0.70				0.05	0.1, 0.01	8.31, 63 %
Honduros	1.0, 0.50				0.27		7.30, 54 %
Jamaica				0.1, 0.1	0.11		2.76, 45 %
Mexico	43, 10.8	3.5, 2.09	0.22		2.42	0.4, 0.06	107, 22%
Nicaragua	0.9, 0.22				0.2	0.3, 0.05	557, 43 %
Panama	0.2, 0.04				0.02	0.5, 0.06	3.19, 43 %
Paraguay	2.2, 0.56	1.1, 0.65	6.09		0.18	0.2, 0.03	6.51, 43 %
Peru	2.4, 0.59				0.48	2.7, 0.36	28.3, 26 %
Trinidad+Tbg					0.03		1.06, 22%
Uruguay	0.4, 0.11	0.8, 0.48	0.65		0.01	1.9, 0.25	3.43, 7 %
Venezuala	4.3, 1.09			0.1, 0.1	0.44	1.4, 0.19	25.7, 12 %

Here again, Maize cobs are a significant residue in most countries and paddy husk is another significant residue

Issues on Liquid fuel - Alcohol

- Much has been done on ethyl alcohol from sugarcane in Brazil for over 30 years.
- Many problems experienced over a period of time have been overcome.
- One of the most important developments is the Fuel-flex vehicle that uses new technology to enable switching from alcohol to gasoline or a mix
- Free market forces are operating in the production and distribution of the fuel and vehicles.
- For light motor vehicles, Brazil's experience provides world leadership.

Issues on Liquid fuel – Biodiesel (1)

- Much that has been learnt in Europe is in part being transferred under cooperative arrangements to countries like Nicaragua.
- Jatropha has been identified as one important fuel in countries like Nicaragua.
- Brazil has taken a leadership role in the last several years
- It is looking at Soybean oil as an alternative
- Of course, there are several possibilities.

Issues on Liquid fuel – Biodiesel (2)

All values in thousand tonnes

Country / year	2002	2003	2004	2005 e	2006 (est.)
Mexico	—	—	—	—	—
North America	51	70	86	292	412
Czech Rep.			60		
France	366	357	348		
Italy	210	273	320		
Germany	450	715	1035		
Spain	0	6	13		
UK	3	9	9		
Australia	27	27	29	36	187
Japan	2	2	3	3	3
China	-	20	45	64	150
Brazil	-	-	6	176	238
Phillipines	-	-	29	29	50

Note that Germany is a leader in Liquid bio-fuels generating about 1 million Tonnes of rapeseed oil. Brazil in LA has made very impressive start

Issues on Liquid fuel – Biodiesel (3)

Crop species	Output oil* tonnes /Ha
Palm oil	5.0
Coconut	2.2
Brazil nuts	2.0
Jatropha	1.6
Jojoba	1.5
Rapeseed	1.0
Groundnut	0.9
Sunflower	0.8
Pongemia	0.8
Soybean	0.4

The productivities of various oils in terms of tonnes per hectare shows that even if one needs to take of all aspects of production, the differences in productivity are very significant. Europe, Germany in particular is a leader in rapeseed oil.

Issues on Liquid fuel – Biodiesel (4)

- **The most important action taken by Brazil** is the creation of a new Law, under which *ANP* (National Petroleum Agency) became the National Petroleum, Natural Gas and Biofuel Agency.
- The Agency has defined biodiesel and its production, distribution and marketing chain structure specifications, and has also acquired authority over the activities of biofuel producers.
- Eighteen of the Agency's regulations on the national supply of fuels were revised as a result of the inclusion of biodiesel. Fuel distributors are allowed generally to carry out the addition of biodiesel to diesel oil.

Issues on Liquid fuel – Biodiesel (5)

- But refineries are also authorized to do so.
- The legislation permits, in certain cases, the use of mixture ratios greater than that established by the government, provided it has *ANP* authority.
- The Agency is also responsible for authorizing the production of biodiesel by companies.
- Furthermore, these producers and distributors must certify the quality of the product to the dealers, guaranteeing, via laboratory analysis, that it meets all technical specifications.
- All the above aspects of law are very important for progressing the field. They need to be emulated for greater progress on finding biofuels for heavy transport.

Issues on Solid biofuels (1)

- **It is important to note** that solid fuels are more difficult to handle compared to liquid or gaseous fuels. Additional features are that they have various shapes, sizes, density and are affected by moisture.
- Solid biofuels can be contemplated for use as domestic cooking fuels
- Modern forced convection stoves can be introduced for better use of solid fuels
- Solid biofuels can be used as fossil fuel replacement through the gasification route for high grade heat or electricity in industries or for distributed power generation (also, rural electrification).
- These options are particularly very important for countries importing fossil fuels

Issues on Solid biofuels (2)

- Gasification of biofuels has been tried out in several parts of the world.
- Two by World bank assessments have appeared.
- Experts have mixed feelings on the reliability and operability of gasification systems
- These are due to inadequate understanding and incomplete documentation on the subject by previous researchers and system developers
- Much has happened in India in the last ten years and dissemination of this knowledge has occurred through workshops and training programs.
- Brazil and Costa rica have been involved in these workshops.

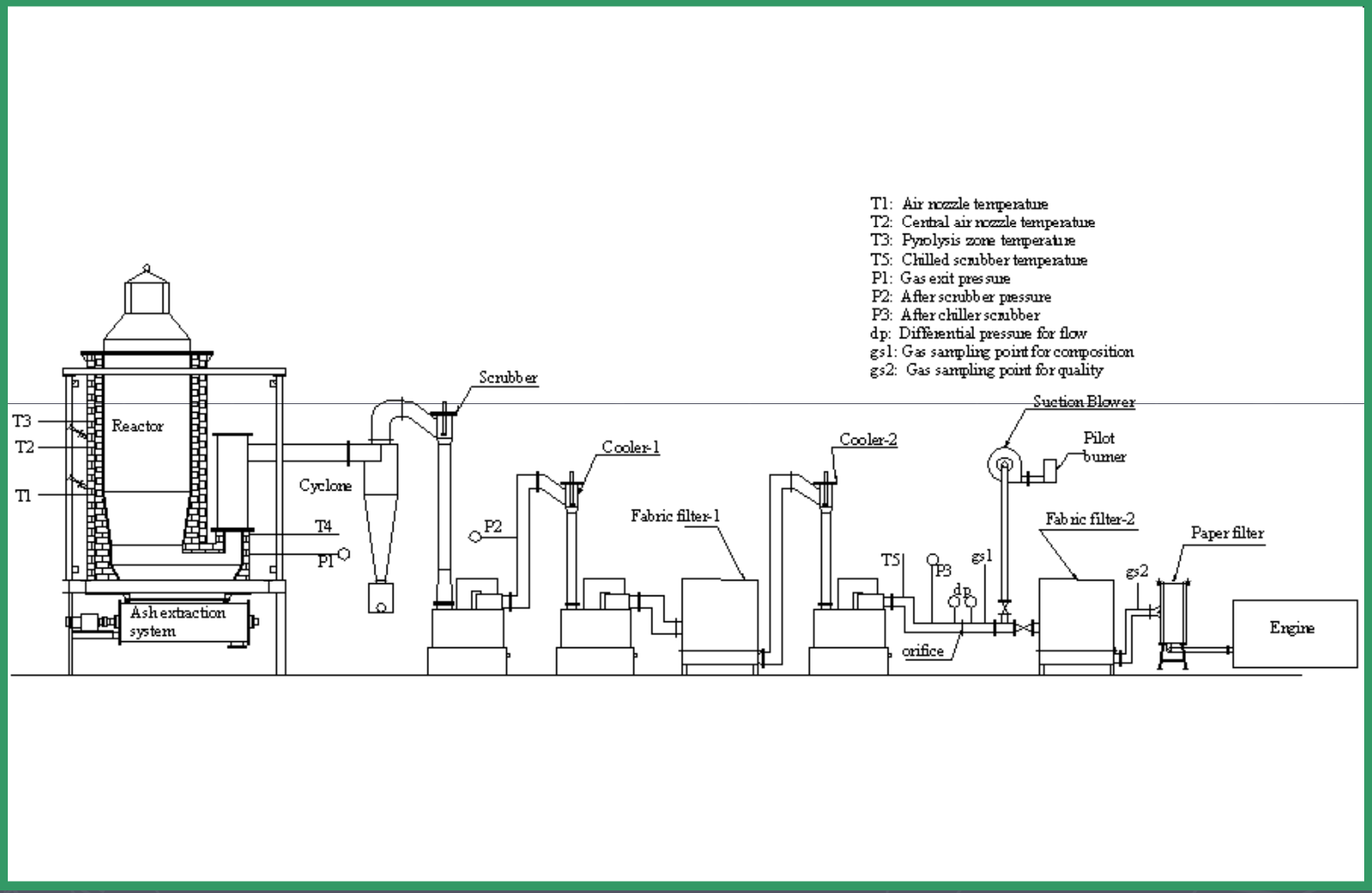
The Technology

- All biomass must be made into the form – of dry solid pieces, if it is tree branch or stalk or coconut frond, pieces of coconut shell, briquettes, if rice husk, sugarcane tops and leaves or similar fine material
- Typical sizes - 10 to 100 mm
- Use these in a gasifier to get a clean and cold gas.
- This gas is used in a reciprocating gas engine – alternator to get electric power.

Issues on Solid biofuels (3)

- The key problem in gasification technology with reference to use in power generation equipment is the “cleanliness” of the gas.
- Both “particulate and tar” in the gas must be brought down to parts per billion level with a technology that is not expensive.
- Some European developments involving electrostatic precipitator are very expensive
- The breakthrough has occurred in India as demonstrated by more than ten thousand hours of field operation and getting on board an engine company “Cummins- India” to market producer gas engines.

Technology elements



Salient features – Well insulated reactor

- Ceramics – to stand high temperature and meet industrial standards
- No metal would stand the oxidizing and reducing environment

• Necessary cooling and cleaning system - to meet the end use requirements

Typical applications serviced

- Electricity generation
  - Village electrification
  - Captive power generation
  - Grid linked power generation
  - Energy Service Company - ESCO
- Thermal application
  - Low temperature (drying, etc.,)
  - High temperature (furnaces, kilns, etc.,)

Typical Biomass used

Coconut shells

Sawmill waste

Solid stock

Bamboo

Grass, Pine needles

Marigold pellets

Pulverized peanut shells

Arashi Hi-tech Biopower Pvt Ltd

GASIFIER

Producer gas

PRIME MOVER

EMISSION ~ Qualifies for CDM Benefits

GRID LINKAGE

Flue gas

Overall efficiency > 25%

FEED STOCK

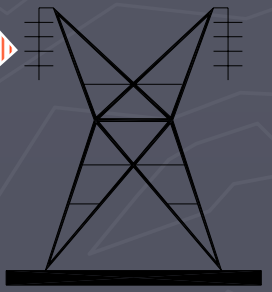
DRIER

PROCESSOR

EFFLUENT TREATMENT

Recycled water

440 V to 11 kV



POWER EXPORT

Arashi Hi-tech bio power system

Salient features of the plant

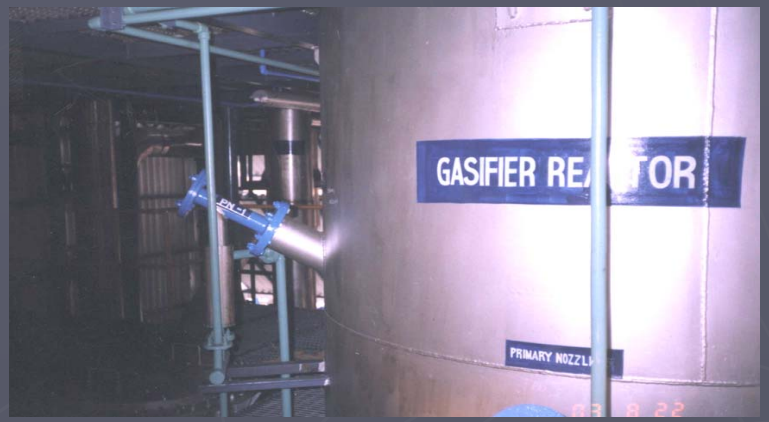
- 5 engines of nominal rating of 250 kW installed
- Gas engine being grid linked for the first time in the country.
- Total hours of operation > 12000 hrs
- Gas quality acceptable for engines
- **Performance**
  - Biomass 1.1 ± 0.10 kg/kWh
  - Continuous mode of operation possible
  - Engine maintenance comparable to natural gas engine
- Cummins India Limited provides guarantee on the power and performance of the engine

Industrial Thermal

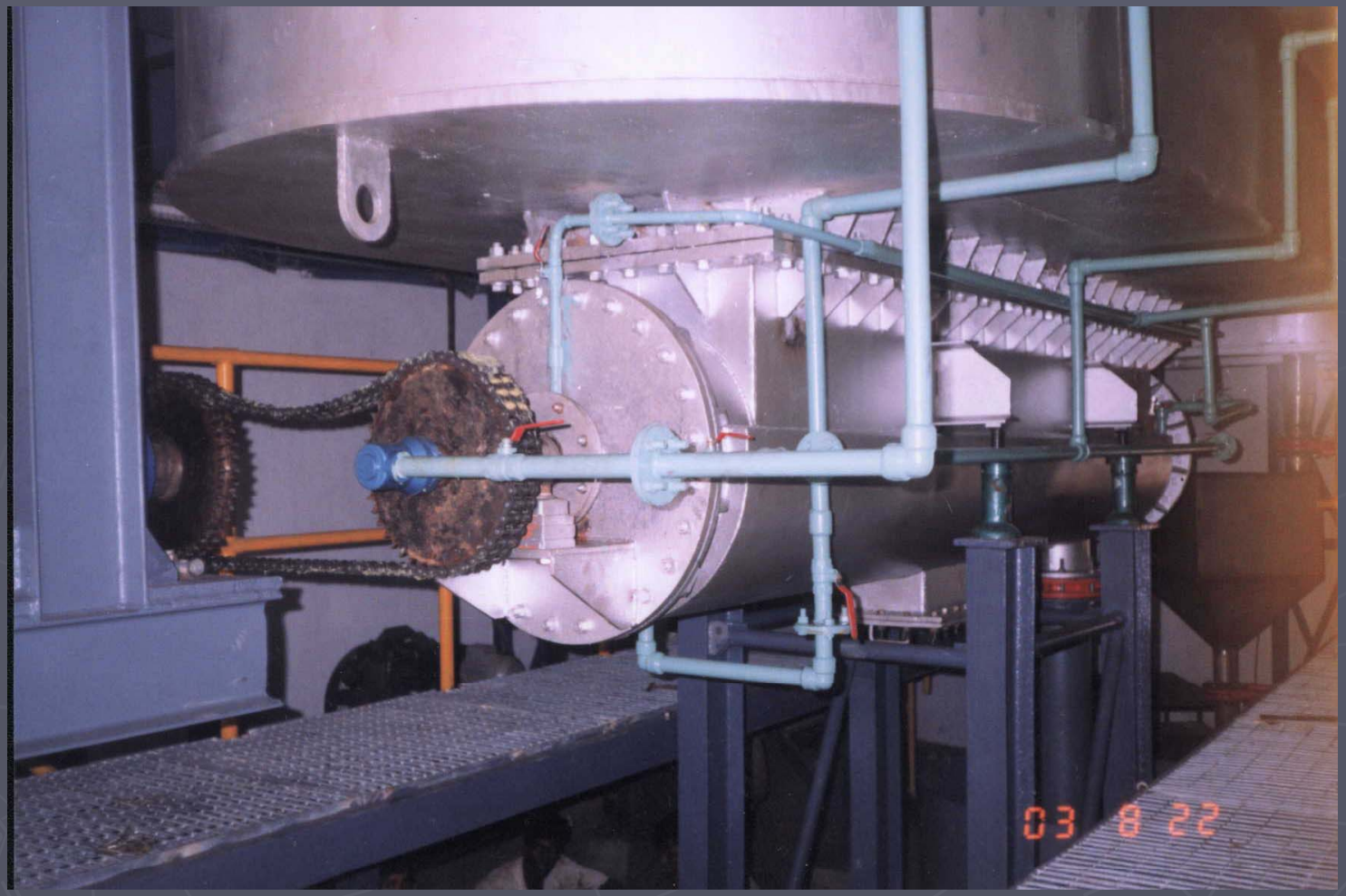
TANFAC, TN, India

- Objective
  - To substitute about 280 lts per hour of furnace oil by producer gas
- A 5 MW th (1100 kg/hr) biomass gasifier designed and commissioned to meet the above requirement
- Single largest capacity plant on downdraft configuration
- System configured to have
  - Industrial standards
    - Fuel feed, ash extraction, water treatment, automation and necessary accessories
  - To handle various biomass
  - To generate gas of high quality to meet the commercial burner requirements (Wessman)

Tanfac – Reactor



Tanfac – Ash Extraction system



Tanfac - Water Treatment Plant

Tanfac -PLC Control Panel

Performance

- Fuel used ~ eucalyptus, coconut shells, prosopis
- Hours operated of operation ~ 25000
- Continuous operation ~ 2500 hrs
- Total Biomass Consumed ~ 27300 T
- Total Fuel Oil replaced ~ 6800 kL
- 8 % activated char extraction with iodine no ~ 600 as by product

Current status – gas engines

- Gas engines
  - Over **50,000 hours** of operational experience in the field
  - About 4 MW power pack installed and 3.5 MW being installed
- Producer gas engines from Cummins India Ltd
  - 25 to 250 kWe

Overall performance

- No major issue on the engine wear (based on the inputs from CIL)
- Engine capable of handling varying loads
- SFC ~ 1 ± 0.1 kg/kWh
  - Efficiency (Wood to electricity) ~ 25 %
  - Efficiency (Gas to electricity) ~ 29 %
- O & M costs on Gasifier + power pack
  - 0.02 USD per kWh (~ 100 kWe)
  - 0.01 USD per kWh (1 MWe)

Operating performance

SYSTEM	ESTBLD	CAPA-CITY,	FUEL	HRS PER YEAR (OPERATD)	PLANT AVAI-LABILE?
ARASHI HI-TECH BIOPOWER	2002 (D-F) 2004 (GAS)	1 MWe	Julifora Prosopis, Coconut shell	6500	>85 %
HINDUSTAN PENCILS	2003 (D-F) 2005 (GAS)	200 kWe	Sawdust briquette	5500	> 95%
TANFAC	2003	1100 kg/hr	Juliflora Prosopis, Forest waste	7500	>95%
TAHAFET	2001	300 kg/hr	Juliflora Prosopis	7000	>95%
CRUMB RUBBER (1)	2002	80 kg/hr	Wood, Coconut shell	7000	>97%

Summary of issues - 1

- Liquid fuels in terms of production and distribution are better understood compared to solid bio-fuels
- In some countries in Europe and LA (Brazil, Nicaragua) greater awareness exists and there is infrastructure and a legal regime in support of these fuels.
- One needs to learn from others' experiences
- These can be undertaken within LA

Summary of issues - 2

- Solid biofuels need greater emphasis than what is provided till now.
- Specifically, all stakeholders – technical groups, users, financing agencies, decision makers in the government must all be at the same wave length in terms of the current status of capabilities and strategies for commercializing the use of solid fuels in their own countries.
- Benefits of CDM in individual countries are yet to be capitalized upon.
- For oil importing countries, these should be urgently undertaken, as also the number of active groups in such countries is still limited.

Recommendations on solid fuels

- It is suggested that formal linkages be developed between academic institutions in LA and India to enhance technical cooperation.
- Immediate action to create awareness through short and long term visits be undertaken
- Focused workshops to discuss the opportunities in specific countries in LA in sufficient detail, strategies for implementation of meaningful projects in adequate size to ensure demonstrative significance be worked out.


Thank you