The potential of gasification of biomass/MSW to reduce GHG emissions in Indonesia

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- Development, planning and realization of turnkey biomass/ MSW gasification plants
- Based in Switzerland / Germany
- Holder of patents incl. “Basura” / “Promotheus” gasifiers and of MSW “Universial Plant” for Energy and Material Recovery
- 67,000 hours of R&D and operational experience with biomass/waste gasification plants
- Gasification technology certified to meet design specifications and pollution standards by independent research institutes

What is Gasification ?

- **Gasification** = conversion of carbon-containing materials (petroleum, coal, gas, biomass, waste) to a gaseous fuel (synthesis gas = syngas)

- **Syngas** to be used for
  - electric and thermal power production
  - raw material for the production of chemicals, fertilizers, hydrogen and transportation fuels

- 70% growth of gasification capacity projected until 2015
- High growth rates in Asia, especially China
- 2 % of global syngas production derived from biomass / MSW

History and current status of Biomass/MSW Gasification Industry

- Gasification of biomass/MSW

Main drivers in: Europe

- EU landfill legislation (increased cost of landfilling waste)
- EU biowaste legislation (targets to reduce landfilling of organic waste)
- Reduction of GHG emissions
- Incentives to produce power from non-fossil fuels

Asia

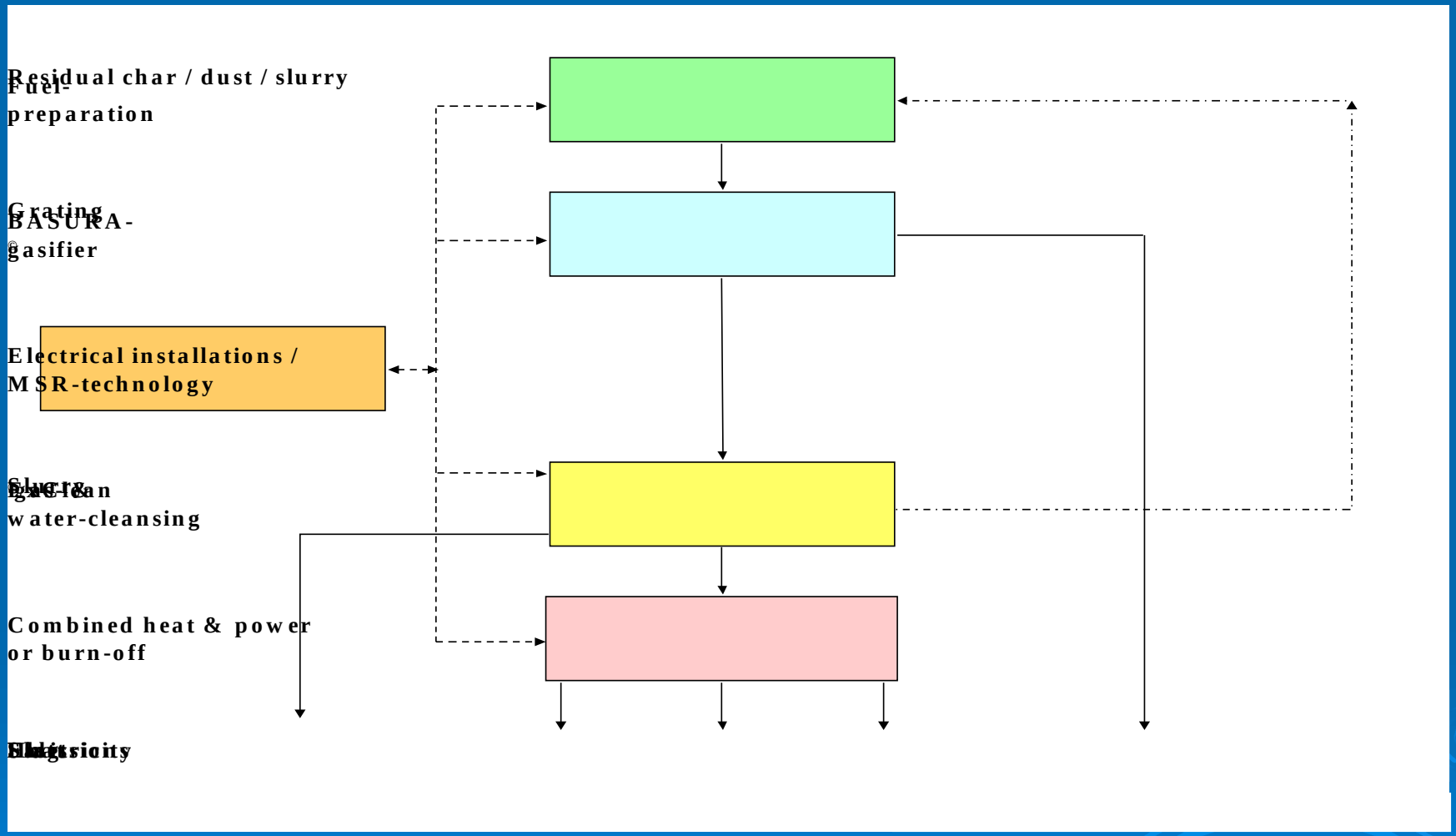
- Lack of landfill space due to rapid urbanisation
- Dislike of incineration technology (e.g. Korea, Japan)
- Established knowledge base in small-scale (e.g. India)

- Considerable investment in R&D to advance gasification technology
- Between 1990 – 2005 installation of numerous pilot and demonstration plants
- Today proven technology for different type of biomass/MSW feedstocks

Case Study: Siebenlehn district heating plant

- Biomass gasification plant with combined heat-and-power (co-generation) facility
- Aim: Pilot and demonstration plant to proof technical feasibility of wood gasification
- Operational: 04/2000
- Feedstock: forestry residues, wood industry waste
- Capacity: 20,000 tons/yr
- Output: 2,3 MW_e and 2,0 MW_{th}

Biomass gasification plant flow chart



1. Biomass processing 2. Fuel delivery 3. Gasification 4. Syngas purification 5. Electricity Generation 6. Heat Recovery 7. Slag disposal

Siebenlehn: Basura© gasification unit

Design

- Counter-current gasifier with fixed bed
- Ceramic hearth lining
- Temperature of 2000 C° in oxidation zone

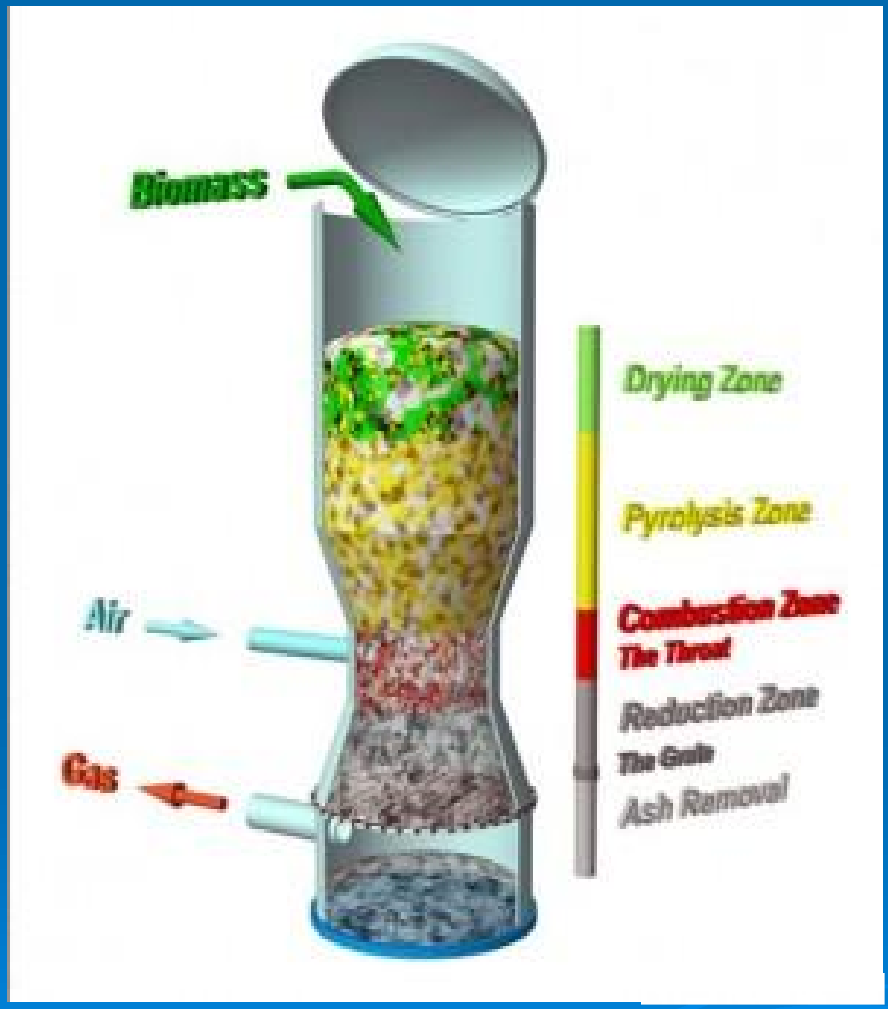
Process

- Conversion from homogenised wood pellets into gaseous fuel (syn-gas)
- Achieved by partial combustion (limited air supply)

Features

- Most simple and robust gasifier type
- optimal temperature profile and flow balance
- Destruction of toxic pollutants

Syngas production



- Drying ~ 200°C (Moisture content 20%)
- Pyrolysis ~400-800°C = woody material turned into gaseous components
- Oxidation ~800-2000°C

Addition of oxidation agent (air)

$$C + \tfrac{1}{2}O_2 \rightarrow CO$$

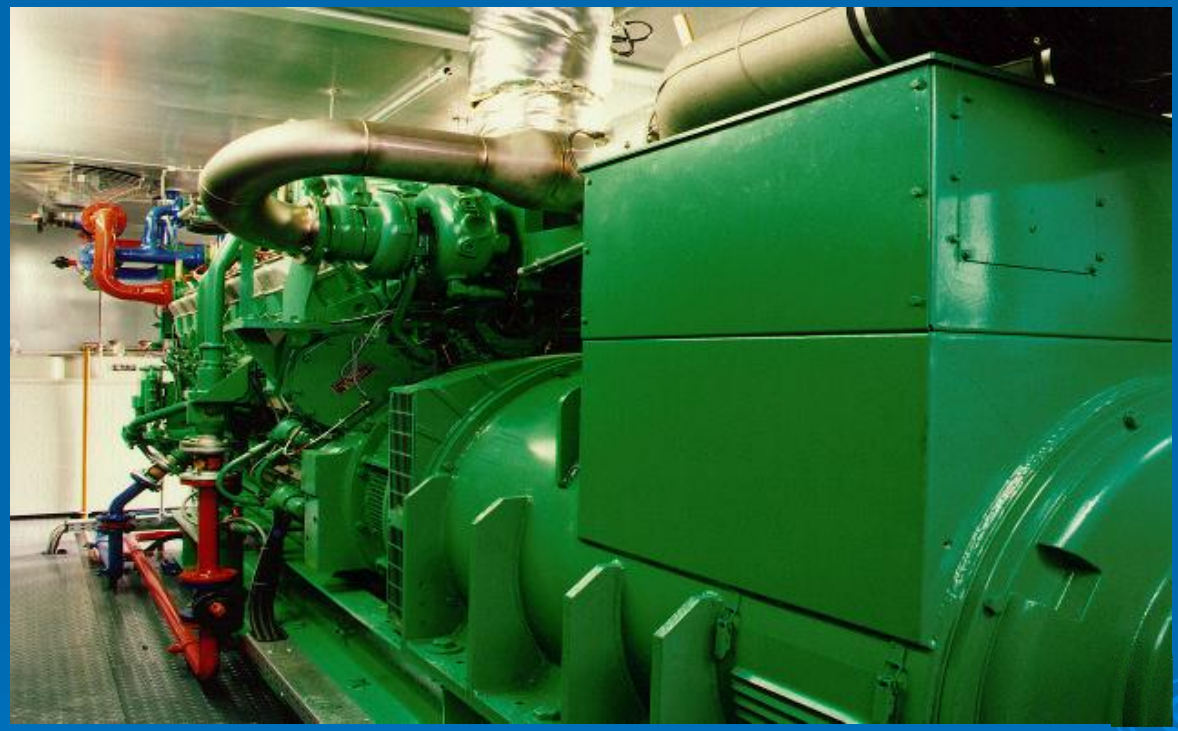
- Syngas (~12-20% CO, 15-35% H_2, 10-15% CO_2, 2-5% CH_4, 40-50%N),
- Calorific Value 4.8 – 6.4%
- Metal/mineral residues → inert glazed mass

Siebenlehn: Syngas and Wastewater Purification Unit

- Gas cooling in a quench washer
- Tar removal in gas washing unit
- wastewater purification
- filter slurry and dust will be fed back into gasification unit for destruction
- wastewater combusted through powering up flare

Siebenlehn: Co-generation Unit

High temperature flare



Co-generation plant (gas turbine)

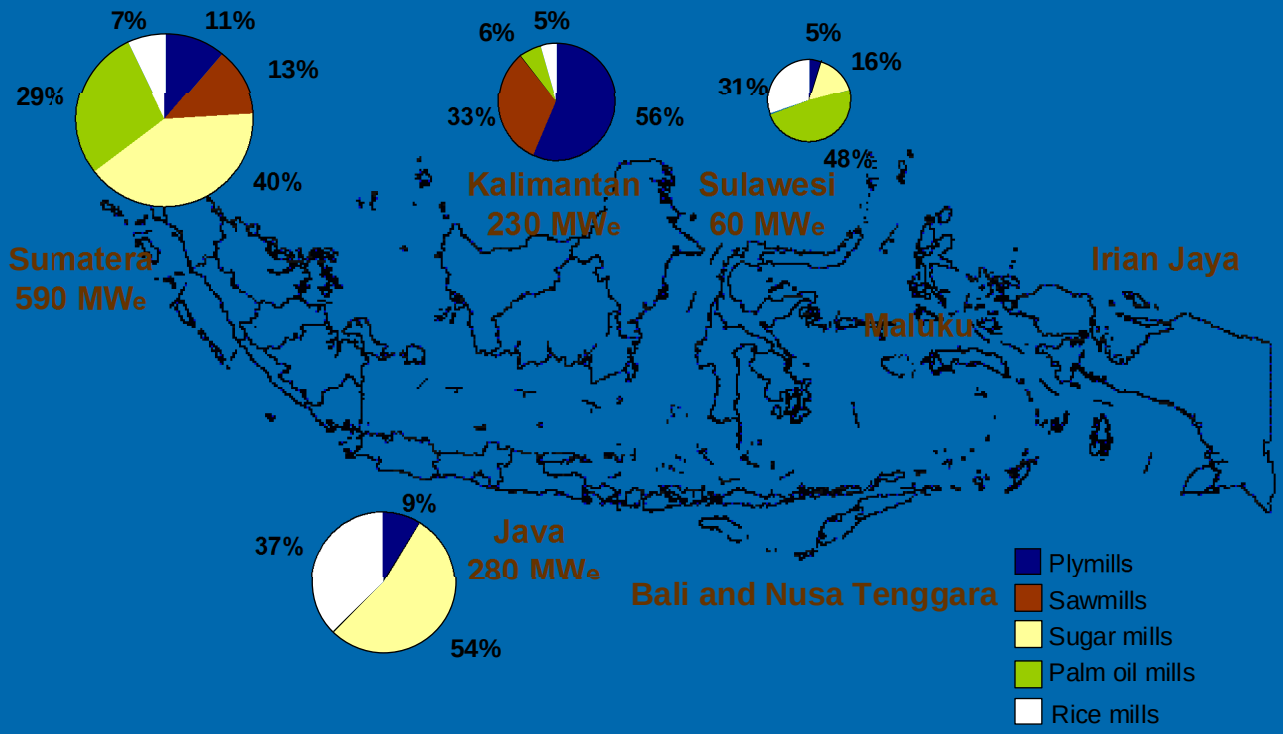
Combined Heat & Power production

Key features Wood Gasisification

- significantly higher energy efficiency compared to combustion
- convenient process control
- elimination of environmental pollution
- proven technology
- GHG reduction
- most components are commercially available in Indonesia
- Gasifiers are eligible for Carbon Credits under the CDM

How can the advantages be used in Indonesia?

Biomass Energy potential in Indonesia



146.7 million tons of biomass per year

Energy potential
~ 470 GJ/y (~ 50 GW)

Installed RE Biomass Capacity: 0,9 %

Biomass	Main region	Production (million tons/yr)	Energy potential (million GJ/yr)
Rubber wood (replanting)	Sumatra, Kalimantan, Java	41,0	120
Logging residues	Sumatra, Kalimantan	4,5	19
Sawn timber residues	Sumatra, Kalimantan	1,3	13
Plywood/veneer production residues	Kalimantan, Sumatra, Java, Papua, Maluku	1,5	16

Source: ZREU (2000)

Wood gasification potential in Indonesia

Type of industry	Mill size m^3/yr	Capacity CHP technology	Biomass potential for power generation
Saw mills	1,000-3,000	40-100 kWel	0.6 m^3 wood waste/m^3 sawn timber ~ 130 kWh/m^3 sawn timber
Plywood mills	40K-120K	1,5 –3 MWel	0.8 m^3 wood waste/m^3 plywood ~ 200kWh/m^3 plywood

Source: ZREU (2000)

Possible plant configurations:

1. **Decentralised power generation** in remote or rural areas (e.g. use of rubber wood and forestry residues in Kalimantan, Sumatra) – local grid supply
2. **Decentralised power generation** in Central-Java (feedstock supply from multiple saw mills located in close vicinity) – Smallholder Independent Power producer (ESCO)
3. **Island solutions** e.g. plywood mills with delivery of excess power to local grid (PSK-Tersebar)

ADB - Research of wood gasification (Central Java) in 2006
PREGA (Promotion of RE, energy efficiency and GHG Abatement)

- ~ 3,000 wood industries (~300 large-scale)
- ~ Output wood waste: ~ 250,000 tons/yr

Findings:

- Potential for biomass gasification & co-generation
- Wood processing industries could use BMG to satisfy its own energy and heat demand and supply excess electricity to local grid
- Example Wood Working Mill:

Wel Consumption: 43,200 kWh/d	Wel pot: 74,000 kWh/d
Wth Consumption: 245,000kWh/d	Wth pot: 111,000 kWh/d
Substitution of ~3,3 Mio. liters fuel	Saving of ~10,000 tons CO_2

- Substancial GHG emissions reductions (replacement of fossil fuels, efficiency)
- Potential to meet CDM elegibility criteria
- Central-Java would benefit from pilot plant installation

Decentralised wood gasification co-generation plants

- Contribute to local/regional energy supply and increase energy security
- Increase of overall energy & resource efficiency
- Contribute to GoI 5% renewable energy target
- Provision of island solutions
- Techno-economically viable alternative to fossil fuels
- GHG emissions reduction
- Scalability to local demand: 0,5MW_e - 10MW_e output
- Most plant parts can be sourced locally (appropriate technology)
- ESCO – PSK Tersebar opportunities

Barriers

- Investment barriers
  - high initial investment and pre-investment costs
- Institutional and policy barriers
  - Owners of wood processing industries have no knowledge or experience to become an electricity supplier
  - lack of policy incentives and detrimental policies (low feed-in tariffs/energy subsidies)
- Financial barriers
  - Difficult to obtain credit from banks (lack of experience from banks)
- Technology efficiency and reliability barriers
  - Lack of demonstration facility
  - Bad perception due to previous experience with 1st generation gasifiers
- Feedstock barriers
  - Wood processing industry may encounter resource shortages in future
- Environmental barriers
  - Regulations (e.g. AMDAL)

MSW gasification potential in Indonesia

Context

- growing population
- Industrialisation
- Increasing living standard
- Rapid urbanisation

Increase in residential & commercial waste

More Landfill space

Increase of GHG emissions & environmental pollution

By 2020

CH_4 emissions 61.96 10^6 ton-equivalent CO_2 (BAU)

MSW 29 10^6 tons (15% recycling, 70% col.)

74% carbonaceous = ~ 56 10^6 tons crude oil

= ~ 2300 MWe

MSW gasification & gas utilisation

MSW

Pre-processed
MSW (Fuel)

BASURAplant©

Gas production & utilisation

Heat, Steam

Electricity

Vehicle fuel

Minerals **Metals** **Nitrogen** **Water**

Construction materials

Foundries

Fertiliser Detergents

Recycled Water

$C_xH_y + O_2 >$

$> CH_4O$

Methanol

Options of MSW treatment

Options / Requirements	BAU	End-of-Pipe Solutions		New Option
	Landfill	Sanitary Landfills CH_4 Capture	Incineration	MSW gasification Methanol production
Landfill Space	- - -	- - -	-	+
Pollution Control	- - -	+	+	+++
GHG Emissions	- - -	++	+	+++
Energy Recovery	- - -	+	+	++?
Resource Recovery	- - -	- -	- -	+++
Costs	- - -	- -	- - -	?
SD	- - -	- -	- -	++

Clean MSW treatment = „Leapfrogging“ end-of-the-pipe technology option

Incineration vs MSW gasification & gas utilisation

Comparison	Incineration (Singapore - real)	MSWG with Methanol (Jakarta - assumed)
Number of plants	5	7
Investment	2,2 billion US$	2,2 billion US$
Daily/annual capacity	10,000 t/d 3,65Mt	8,800 t/d 3,15 Mt
Electricity We/ Steam Wth	~ 110 MWe / ?	~ 210 MWe / ~ 280 MWth
Volume reduction of MSW	10%	1%
Ash to be landfilled	328,000 t/yr	31,500 t/yr
Scrap Metal Recovery	~33,000 t/yr	126,000 t/yr
Fertilizer	0	3,150 t/yr
Construction Materials	0	630,000 t/yr
Water	0	630,000 t/yr
Methanol	0	830,000 t/yr

Summary

Conference Objectives	Biomass gasification of wood waste	Gasification of MSW & syngas utilisation
Solutions for problems of energy and GHG emissions	√	√
Raise public awareness concerning the importance of reduction of GHG emissions in Indonesia and its economic benefits	√	√
Exploration of untapped potential of CDM projects	√	√
Capacity building and technology cooperation between Indonesia and the member states of the EU	?	?

We cannot afford more of the same timid politics when the future of our planet is at stake. Global warming is not a someday problem, it is now…

This is not the future I want for my daughters. It's not the future any of us want for our children. And if we act now and we act boldly, it doesn't have to be."
Barack Obama, Portsmouth, NH, 10/8/07