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Solar energy, windpower, heat pumps

Research and demonstrations at JYU

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Energy solution of ABC Viitasaari

- **Target:** 97 % of the heat and electricity from renewable sources. Also demonstration of renewable energy technology to public.
- **Means of realization:** Distributed heat and power production using biomass, solar and wind energy, and heat from Lake Keitele.
- **Funding:** Ministry of Trade and Industry, Keskimaa Osk., City of Viitasaari, the European Social Fund and the European Regional Development Fund, State Provincial Office of Western Finland

63.07°N
25.86°E

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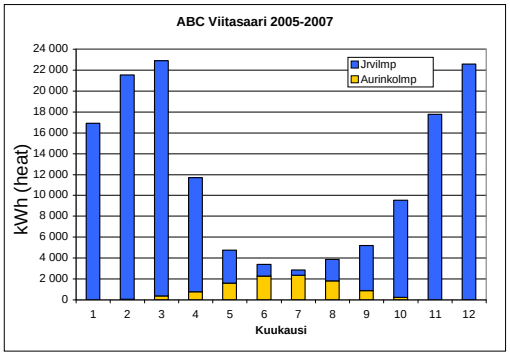
LÄMPÖPUMPUN JA AURINKOLÄMPÖKERÄINTEN TUOTANTOLUKUJA



Lämpöpumpun tuotto 133 MWh/v, n 60% kiinteistön lämmöntarpeesta, kuoletus 10 - 15v
Aurinkolämpökeräinten tuotto 10 MWh/v, kuoletus n. 20v (sähkö 100€/MWh)

Tasokeräimet 32 kW_p,
$TiNO_x$ päällyste Kallistus 35°
Kokonaisala 38 m^2 Suuntaus etelä

Järvilämpöpumppu 290 kW ,
7,5 km putkea Keiteleessä

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Saarijärvi PV system demonstrates the feasibility of new PV technology in cold climate.

HIT (*Heterojunction with Intrinsic Thin layer*) PV technology was chosen as it has shown top-level efficiencies in mass produced solar cells; possibly exceeding 20 %.

Cell and module efficiencies are 18,4 % and 16,5 %, respectively.

Source: SANYO/HIT Photovoltaic Module

Photo: Tuukka Rönkkö, 2005

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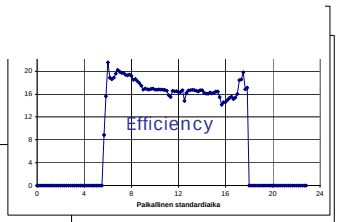
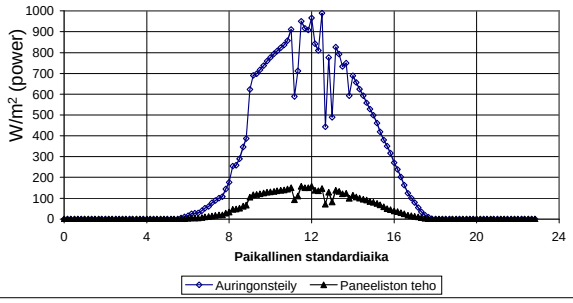
SUNNY DAY

FRI 21ST MARCH 2008



Saarijrven aurinkoshkpaneelisto



POWER 5996 W AT 12.00
POWER > 4000 W 9.00 - 14.20

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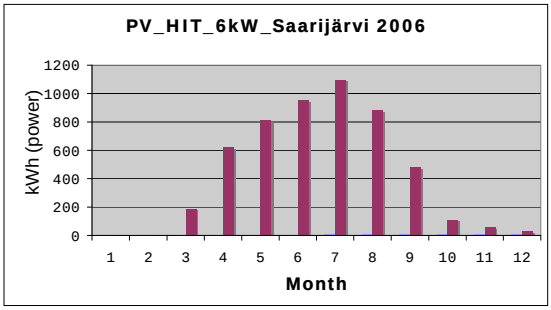
PRODUCTION BY MONTH IN 2006



Max. output 6,2 kW
Total output 5220 kWh
Total area 38 m²
Investment 29,8 k€

Price/kWh 22 cn

25 years, 6% interest rate, 7% annual increase in electricity price

Observe beneficial production in spring time, no leafs, reflection from snow

850 kWh/y in Berlin for 1 kW_p panel
870 kWh/y in Saarijärvi for 1 kW_p panel
1600 -1800 kWh/y in sunny regions of the planet

http://80.246.169.132/ya/keli/valikko/default.asp
http://www.jyu.fi/science/laitokset/kemia/muut%20yksikot/ue/tutkimus/demonstraatiot/sjarvi/aurinkopaneelisto

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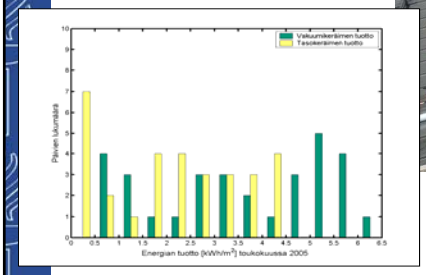
VAAJAKOSKI LABORATORY

Solar heat collectors

Testing site
for 6-10 m^2
collectors



-$TiNO_x$ plate
-vacuum
-black heat exchange solution
-pressed collectors (rubber)

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Hydrogen production from the solar- and windpower electricity system at the University of Jyväskylä

- Storing power from solar and wind energy as hydrogen.
- Hydrogen storage is a part of the energy system

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Bioenergy and waste-related research at the University of Jyväskylä

Jukka Konttinen
University of Jyväskylä
Department of Chemistry
www.jyu.fi/renewableenergy

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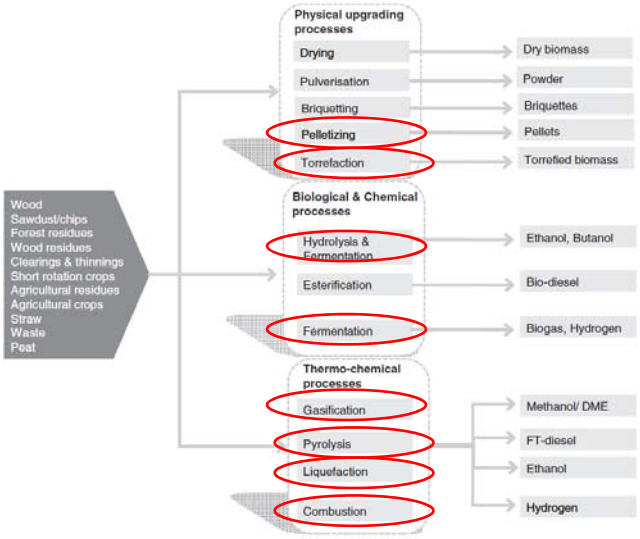
Producing fuels from biomass



Source: Louhelainen J., University of Jyväskylä 2010

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Thermochemical conversion of solid biomass (and waste)

Research and demonstrations at JYU

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Research in thermochemical conversion of waste

- Project OSER (Advanced energy production know-how in Central Finland), 2010 - 2013
  - Thermochemical conversion of metals in waste plastics
  - Elimination of PCDD/F compounds from co-combustion of biomass and waste
  - Partners: VTT, JYU Faculty of Information technology, Metso Power Oy, Foster Wheeler Oy
- Suitability of waste fuels for a gasification-based CHP plant (Year 2010 - 2011)
  - Partners: Lahti Energia Oy

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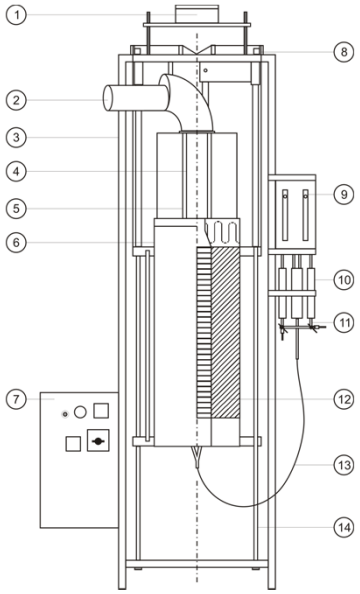
Thermobalance (cooperation with VTT)

Main components of the specialised thermo balance:

(1) electronic balance
(2) flue gas tube
(3) supporting frame
(4) quartz tube
(5) tube of thermally resistant glass
(6) cylindrical furnace
(7) power supply for heating element
(8) hoisting system
(9) gas flow meters
(10) in-line silica gel drying cells
(11) gas mixing connections
(12) 3 kW heating element
(13) gas line to furnace base
(14) guide for vertical motion.



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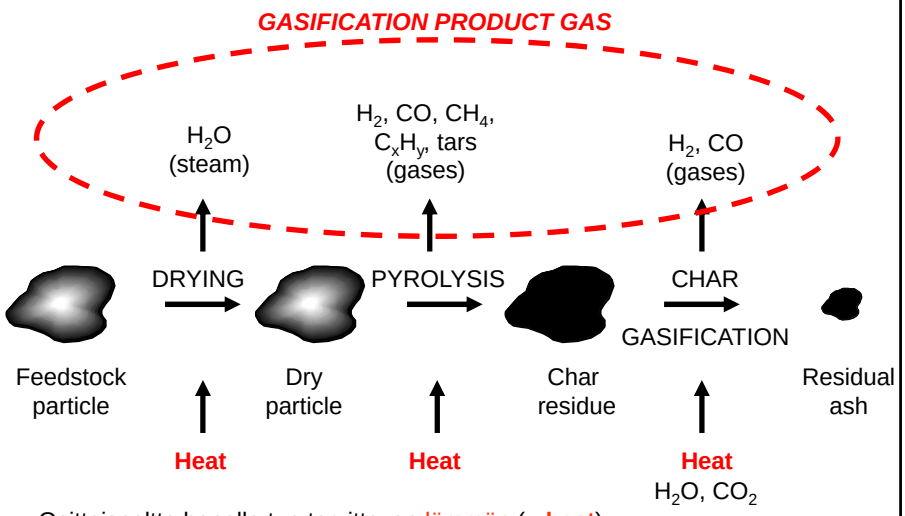
What happens in gasification?



Osittaispoltto hapella tuo tarvittavan lämmön (= **heat**)

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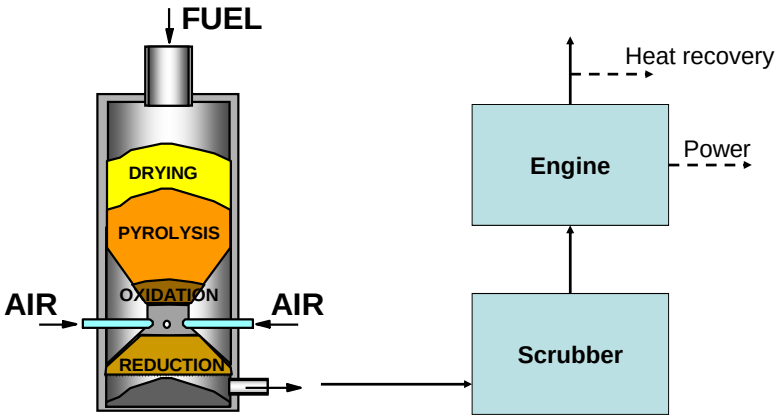
Micro-CHP based on gasification

- Downdraft gasifier + gas cleaning + gas engine



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Micro-CHP based on gasification

- Downdraft gasifier + gas cleaning + gas engine
  - Capacity 100 – 1000 kW_{th}
  - Power production about 30 % of the thermal energy
  - Overall efficiency > 70 %
- Private companies in Central and Northern Finland – technology development and commercialization
  - Gasek Oy (www.gasek.fi), CCM-Power Oy (www.ccm-power.fi), Entimos Oy (www.entimos.fi), HT Enerco Oy (www.htenerco.fi)
- DEMONSTRATION OF GASIFICATION & STIRLING ENGINE IN REISJÄRVI
- Challenges:
  - Gasifier – tars
    - Improvements in the design, to minimize tars
  - Long-term availability of the plants

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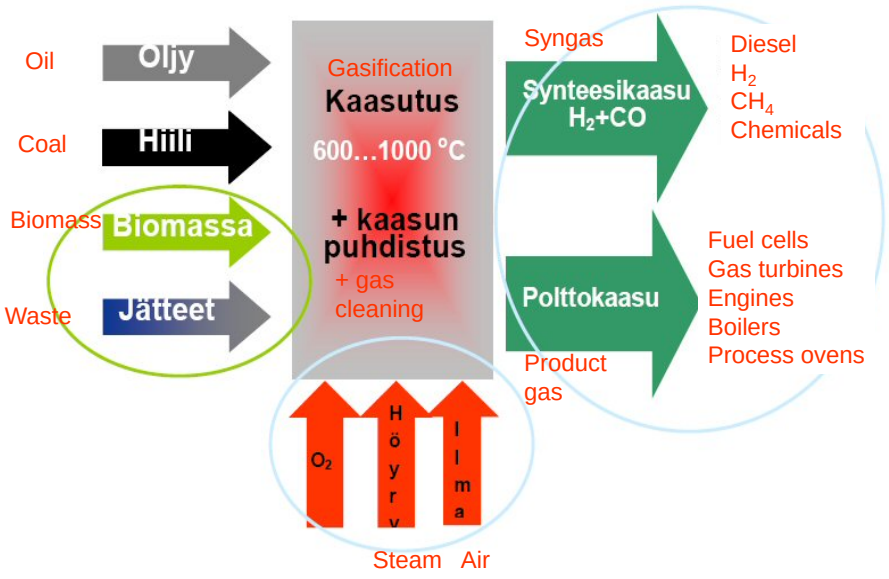
BIOMASSAN KAASUTUSTEKNIIKAN SOVELLUKSET
APPLICATIONS OF BIOMASS GASIFICATION



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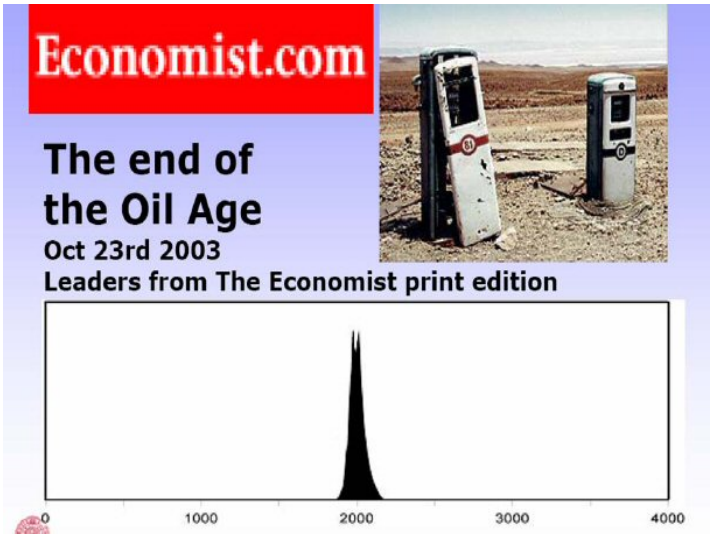
The end of oil age!?



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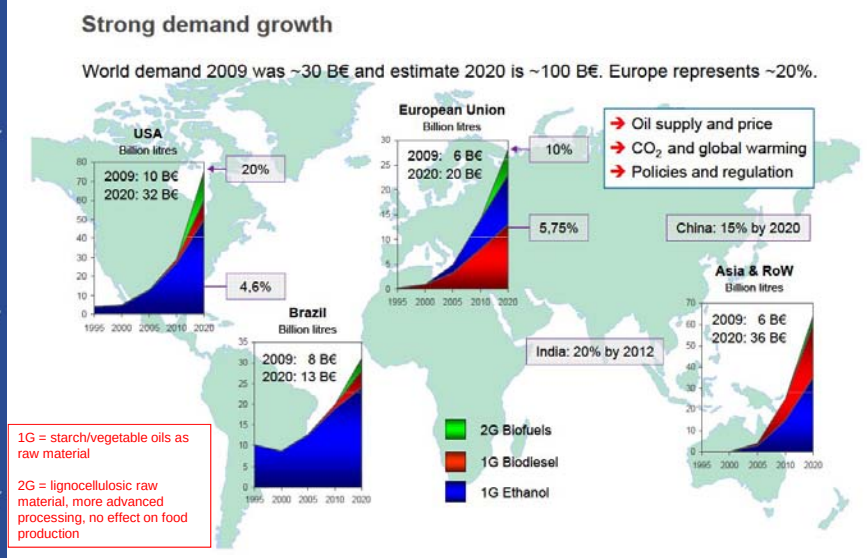
Demand of liquid biofuels



Source: UPM/Sohlström H., FOREST BIOENERGY Conference, September 2010

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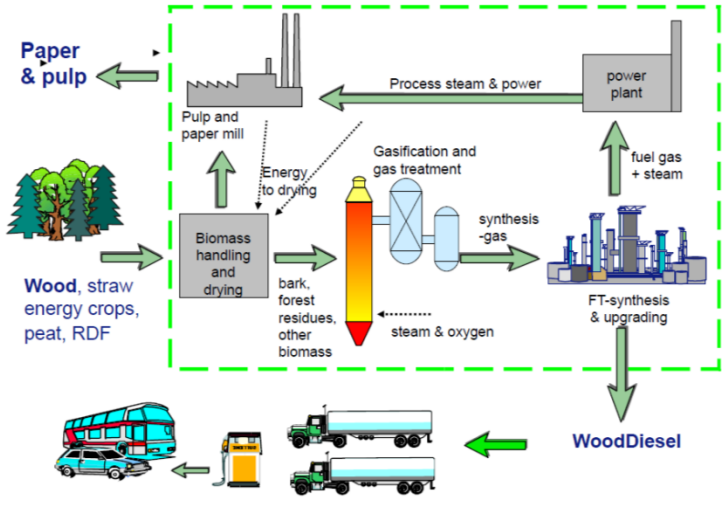
Finnish approach: Integration of renewable diesel-oil production to pulp and paper mills



Source: VTT/Mäkinen T., AEBIOM European Bioenergy Conference 2010

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BIOFUEL GASIFIER FEEDSTOCK REACTIVITY – EXPLAINING THE DIFFERENCES AND CREATING PREDICTION MODELS

- In the project, a method is generated to predict the gasification behavior of biomass fuels in a gasification reactor
  - The method should be based on reasonable cost and effort
- The results of the project will help to understand the differences in the gasification behavior of biomass fuels.
  - An essential hypothesis in the project is that the decrease of the catalysis properties of biomass ash will decrease biomass char gasification reactivity and thus the final carbon conversion
- Partners University of Jyväskylä, VTT and Åbo Akademi University

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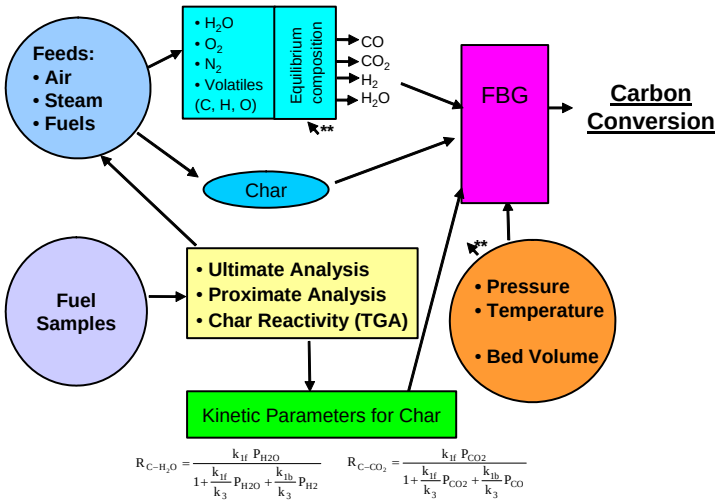
Research in gasification "CARBON CONVERSION PREDICTOR"



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Current projects – BIOMASS AND WASTE THERMAL CONVERSION

Project	Timetable	Budget total, k€	Budget JYU/RE, k€	Partners	Funding
GASIFREACT	2011 - 2014		220	VTT, Åbo Akademi University	Academy of Finland
OSER – advanced energy production in Central Finland	2010-2014		225	VTT (coordinator), JYU Information technology, Metso Power, Foster Wheeler, Renewa	ERDF (EAKR), private companies
HighBio2	2011-2013		130	Kokkola Chydenius Centre (coord.) Luleå University of Technology, Centria polytechnic	EU INTERREG Nord, private companies

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Current projects – OTHER PROJECTS AND PROGRAMMES

Project	Timetable	Budget total, k€	Budget JYU/RE, k€	Partners	Funding
Doctoral Program in Energy Efficiency and Systems (EES)	2012 - 2015		N.A.	Aalto (Coord.), UH, TUT, LUT, UV, OU, ÅAU	Academy of Finland
Drop in the sea (Hybrid energy production systems)	2011 - 2013		200	Vaasa University (coord.), VAMK, Novia	ELY-centres Central Finland & South Ostrobothnia
DESY Research (Distributed energy systems)	2012 - 2014		170	VTT (coord.), LUT, TUT, UV, MTT	TEKES, private companies
DI/FM -from Barchelor's to Master's	2010-2012		250	JYU/IT (coordinator), JYU/KEM, TTY	ESF (ESR), Ministry of education

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COMPLETED PROJECTS

Project	Timetable	Budget total, k€	Budget JYU/RE, k€	Partners	Funding
BioNano – nanotechnology applications for bioenergy	Dec 2010 – May 2011		Conf.	Benet Oy (coord.)	OSKE Centre of Expertise programme
Fuel characterization for waste gasification	Jan 2011 – Jun 2011		Conf.	Lahti Energia Oy	Lahti Energia Oy
Advanced production of steam and power in ships	Oct. 2010 – June 2011		25	CleanGas Ltd. (coord.), PAC Solutions, HT Enerco, Naava Energy	ERDF (EAKR), Ålands teknikkluster r.f., private companies
Micro-CHP roadmap	Sep. 2010 – Jun. 2011		15	JY (coord.), private companies	OSKE Centre of Expertise programme
Preparation of international research consortium	Oct 2010 – Dec 2010		19	JY (coord.)., Chydenius-Centre Kokkola	Academy of Finland

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Production of biogas (anaerobic digestion of organic matter)

Research and demonstrations at JYU

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BIOGAS

- Is formed when organic matter decomposes at anaerobic conditions
- Is formed in dumps/landfills, can be produced from wastewater treatment sludges, biowaste, agriculture manures, energy plants, side products from food industry…

Gas source	CH_4 (%)	CO_2 (%)	N_2 (%)	H_2S (ppm)
Wastewater treatment	55-65	35-45	<1	10-40
Landfill	45-55	30-40	5-15	50-300

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UTILIZATION OF BIOGAS

- Heat and steam production
- Power and heat production (CHP)
- Traffic fuel
- Fuel cells
- Feeding to natural gas grid
- Chemicals

- The most optimum utilization is depending on many factors, such as location, local conditions, distribution network, legistlation, side products etc.
- Different requirements for gas purity in different applications

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BIOGAS
– FROM LABORATORY TO PRACTICE