

Waste Gasification

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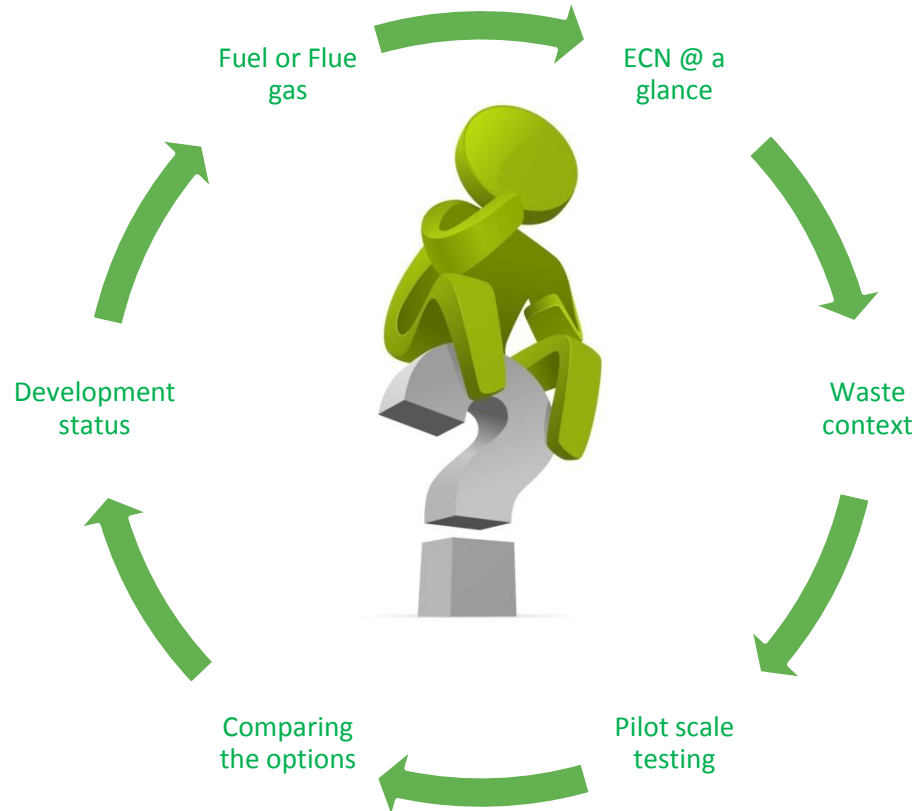


Waste gasification

Turning waste into fuel gas or flue gas?

Berend Vreugdenhil
March 16th 2017
Helsinki

Waste and what to do with it...



ECN acts as a bridge between science and ECN corporate innovation

Mission

We develop knowledge and technologies that enable a transition to a sustainable energy system



Not-for-profit research institute

Founded in **1955**

5 Commercial licensing deals / year

500 Employees

+/-20 patents a year

€ 80 M annual turnover



ECN R&D



**Policy
Studies**



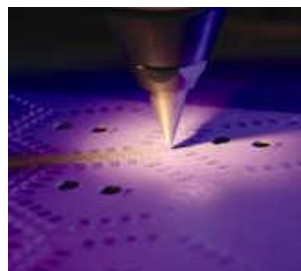
Solar Energy



Wind Energy



**Biomass and
waste**



**Energy
Engineering**

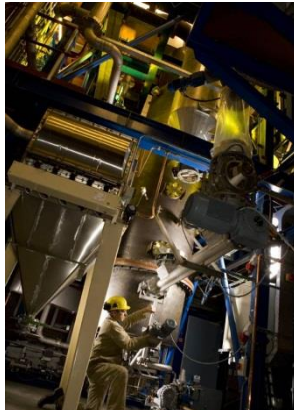


Environment



**Energy
Efficiency**

BIOMASS/WASTE R&D



Gasification



Combustion

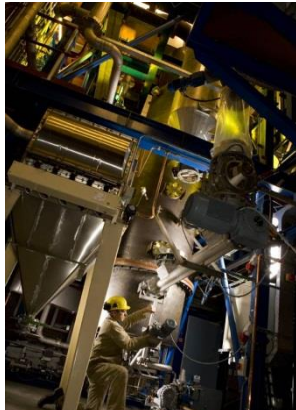


Torrefaction



Biorefinery

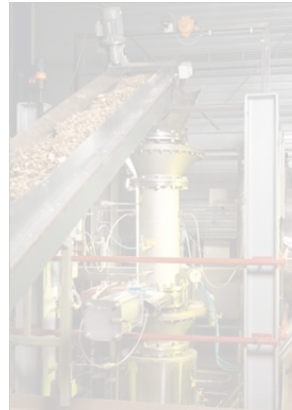
BIOMASS/WASTE R&D



Gasification



Combustion



Torrefaction



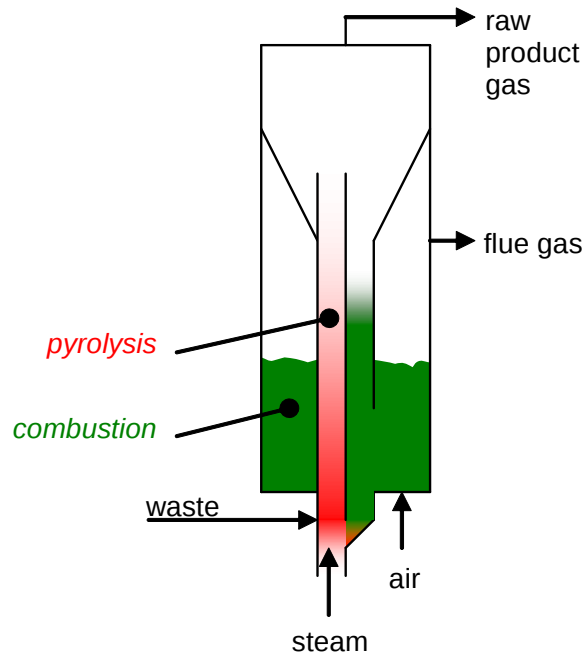
Biorefinery





Waste gasification – test results

Indirect gasification (MILENA)



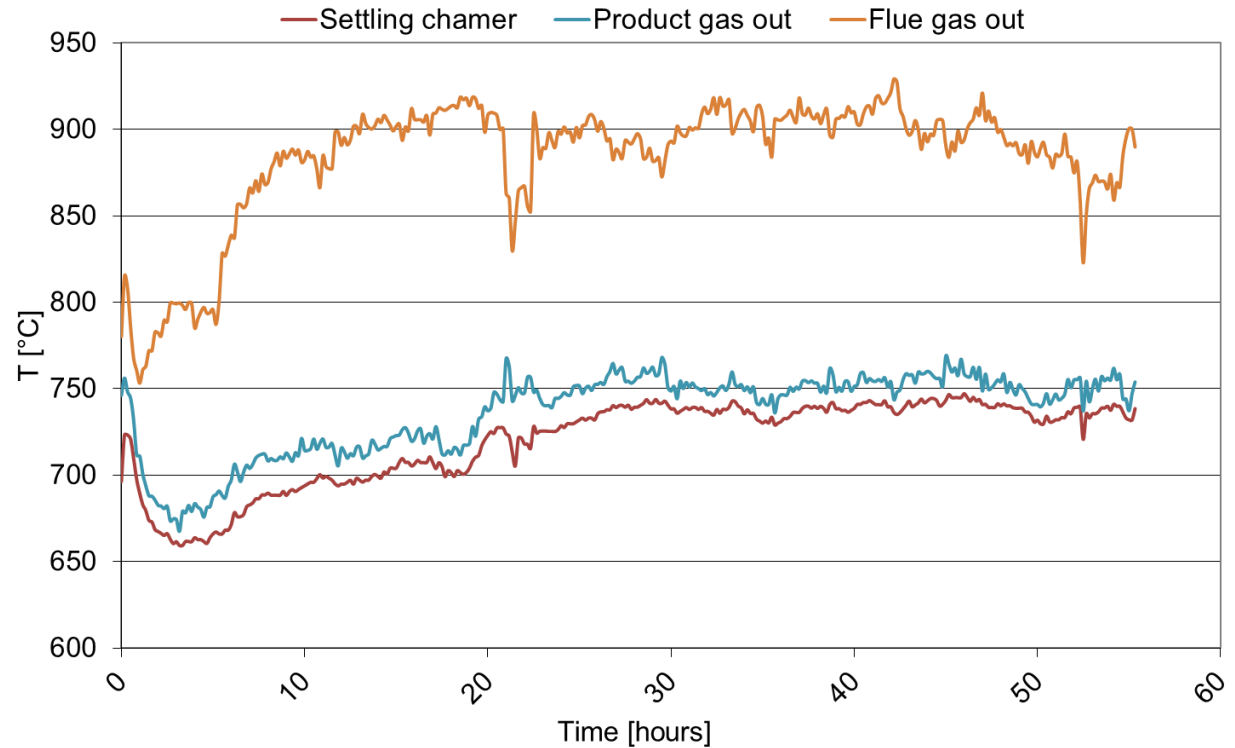
Key Features

- I. Heat consumption and heat production separated
- II. Complete conversion even at low temperatures
- III. Possible to use air without diluting the product gas
- IV. No design compromises to obtain “clean” product gas
- V. Highly flexible towards feedstock

Gasification test

Goals

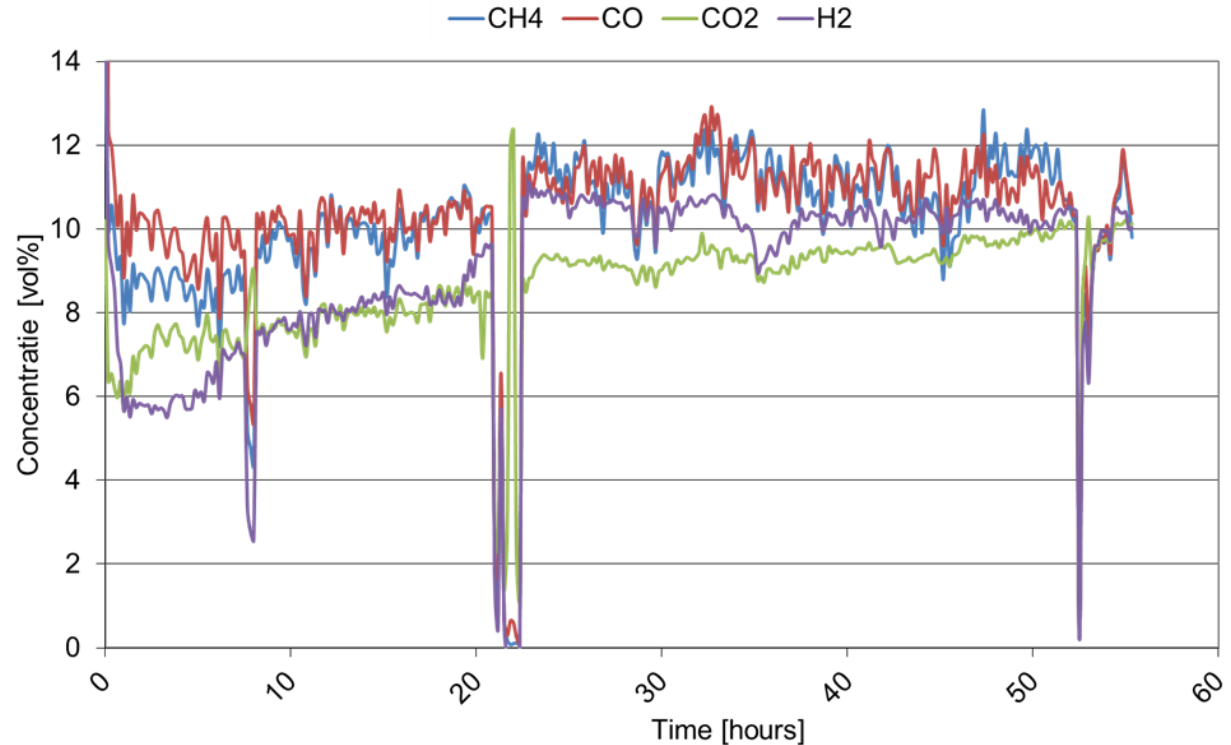
- I. Low temperature
- II. >50 hours operation
- III. Stable operation



Gasification test

Goals

- I. Low temperature
- II. >50 hours operation
- III. Stable operation
- IV. Obtain complete gas composition
- V. Determine fate of contaminants



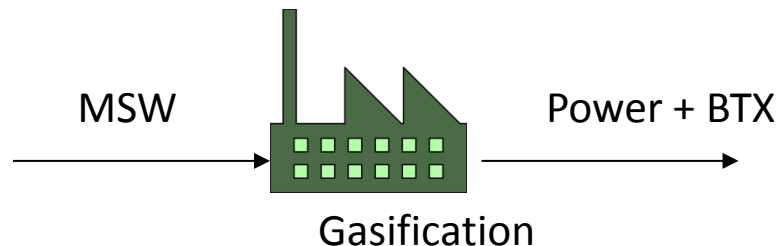
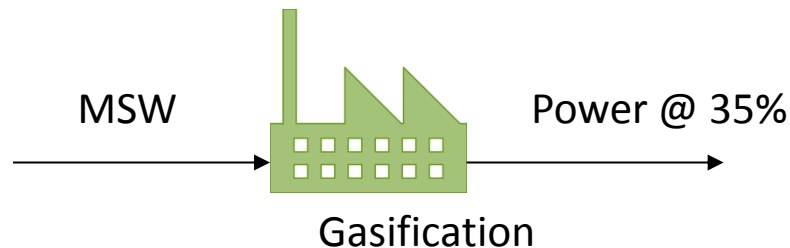
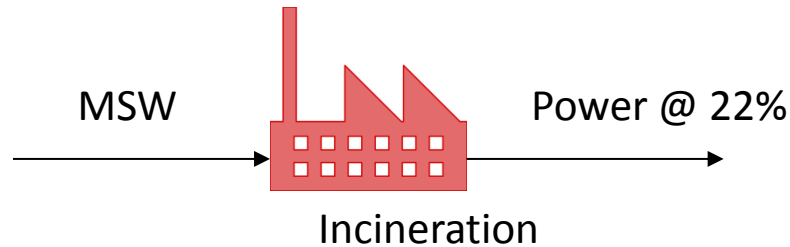
Gas composition

Product gas	CH ₄	CO	H ₂	CO ₂	Sum C ₂	Sum C ₃	Sum C ₄	H ₂ S	COS	BTX
	[vol.%]	[vol.%]	[vol.%]	[vol.%]	[vol.%]	[vol.%]	[vol.%]	[ppmV]	[ppmV]	[vol.%]
Pine wood	15.5	43.4	23.6	12.0	5.7	n.m.	n.m.	150	11	1.0
Icopower®	16.9	20.6	19.7	17.1	17	2.6	1.0	1653	49	3.2

- Methane increases when gasifying waste
- Total amount of syngas decreases
- Sum of larger hydrocarbons shoots up
- Sulphur components increase
- BTX volume increases

**More valuable components
when gasifying waste**

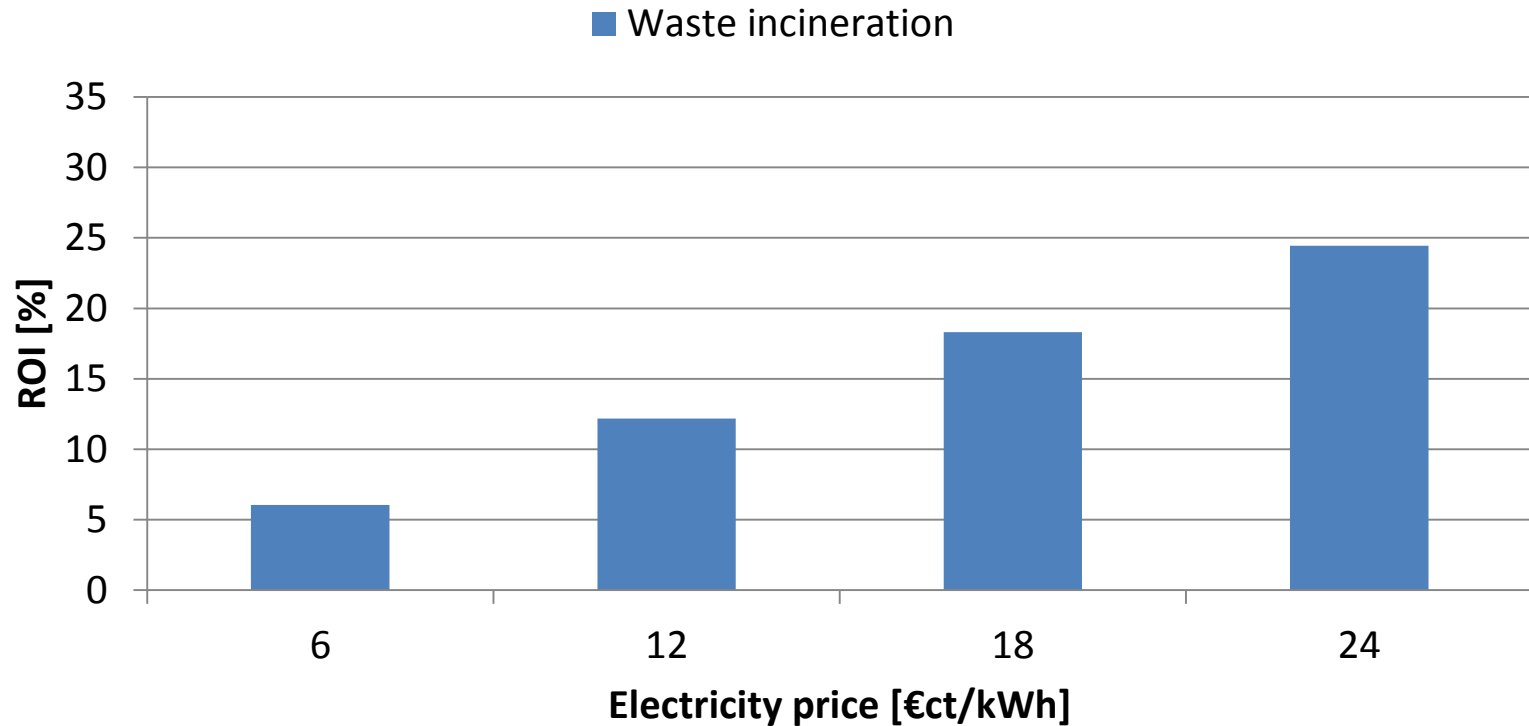
Economic comparison of three cases



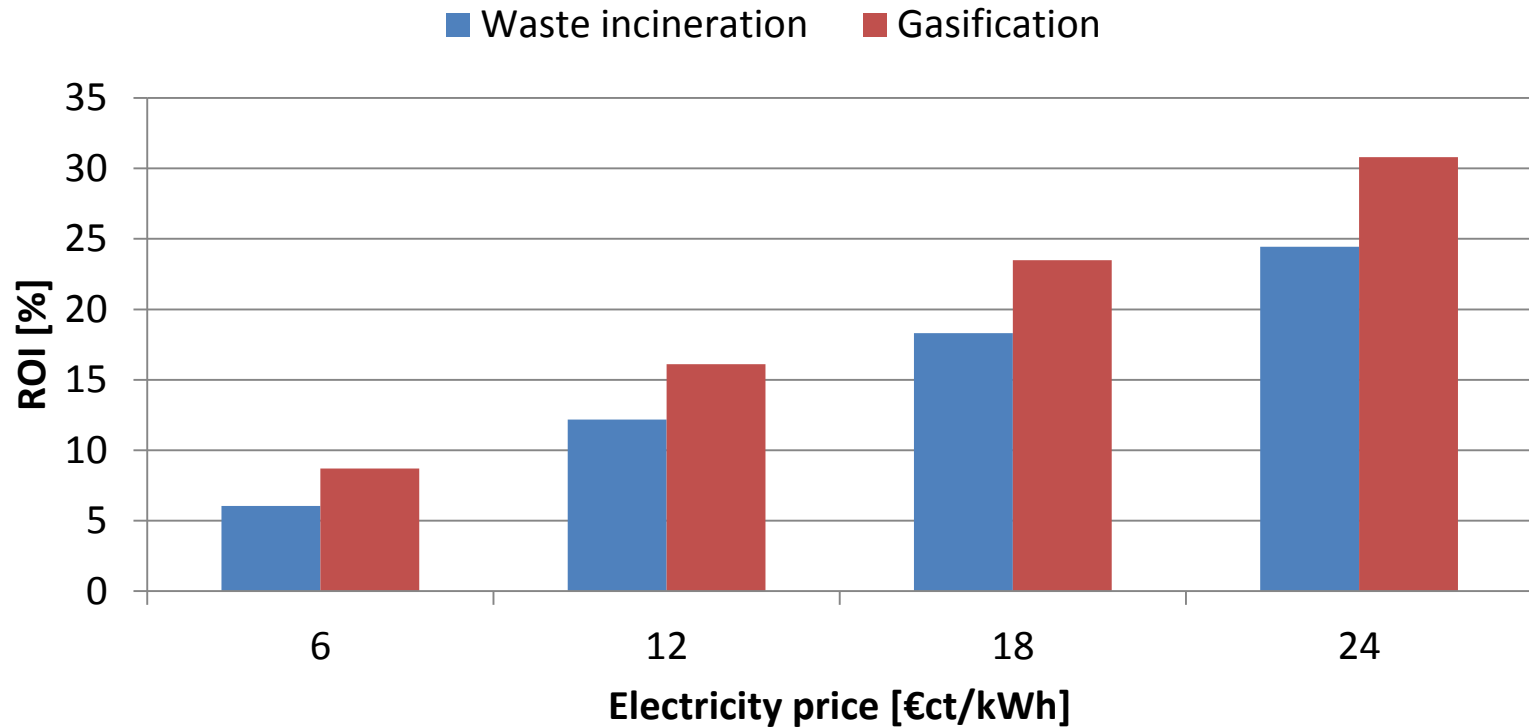
- ROI of 6% for incineration
- Electricity at 6 €/kWh
- MSW at -60 €/ton
- MRF included
- Gasification based on ETI data^{*}
- Scaled to 90 MWth
- BTX case based on lab/pilot data
- BTX separation adds 2% CAPEX
- Power island is reduced with 15%
- BTX price is 14.7 €/GJ

^{*} Identifying Likely Late-stage WTE Gasification Candidates, Chris Cothran, Gasification Analyst at Stratas Advisors, Presented at TCBIomass 2015

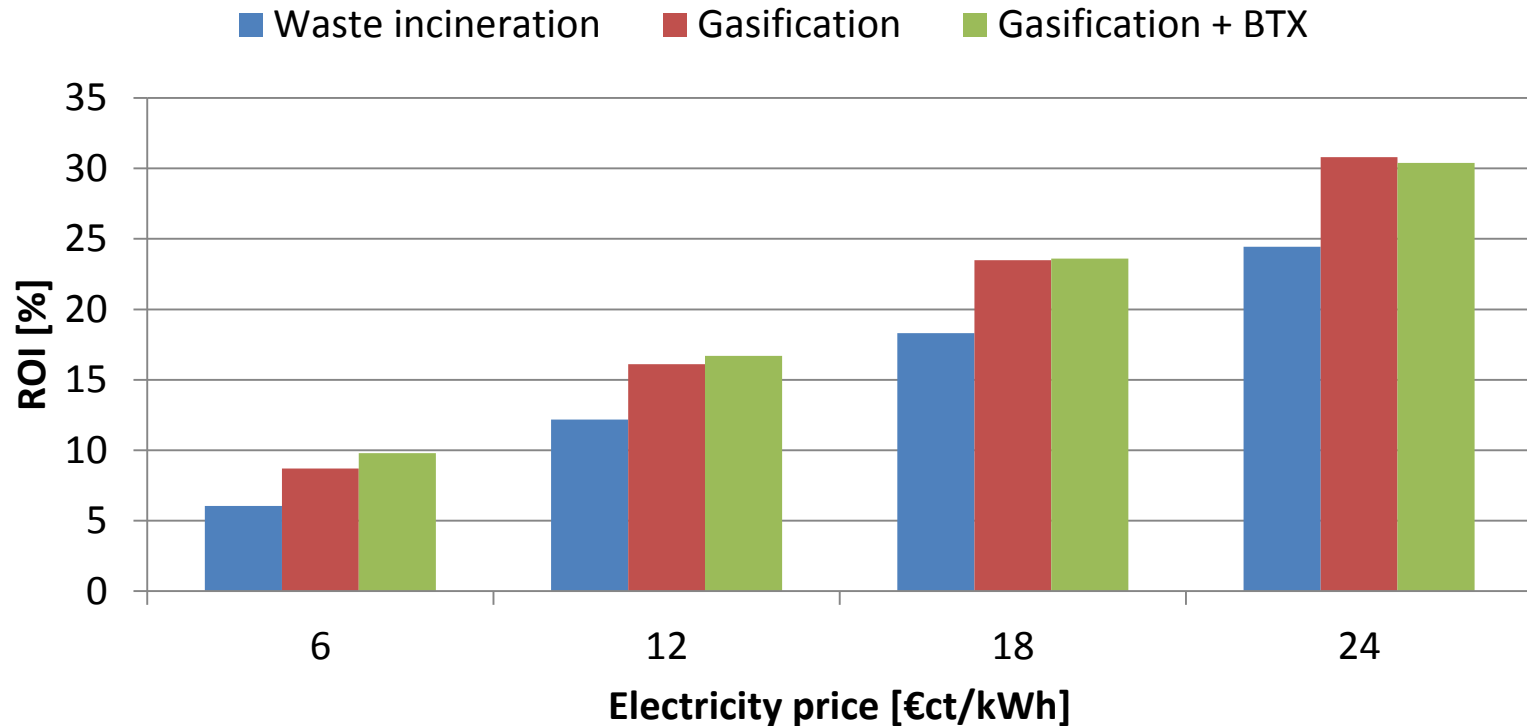
Standard solution



Gasification

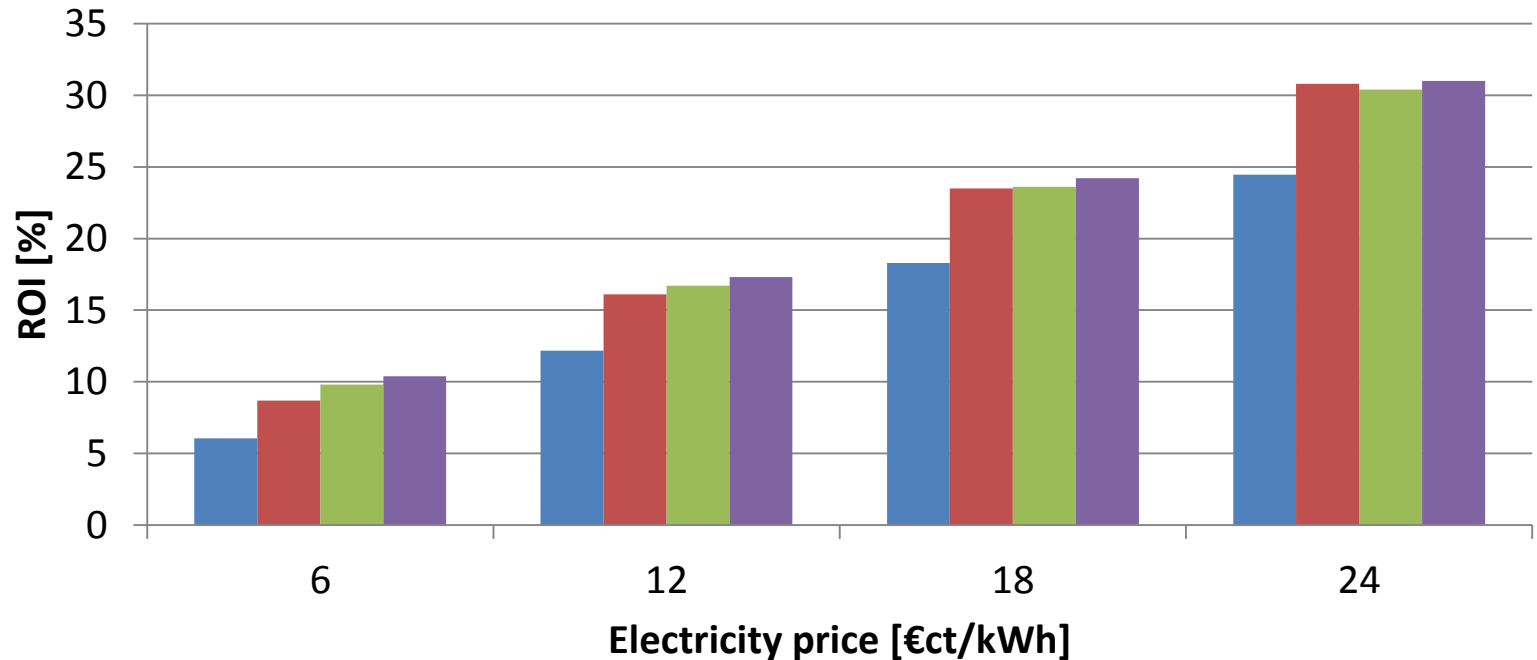


Co-production via gasification



Adding a premium to BTX (900 \$/ton)

■ Waste incineration ■ Gasification ■ Gasification + BTX ■ Gasification + premiumBTX



Conclusions

- Gasification adds value to MSW
- Removing the valuable components before power production adds more value
- Gasification based system much more flexible towards electricity prices
- BTX recovery works better with a concentrated gas
- Indirect gasification (MILENA) and tar removal (OLGA) make this possible
- COG currently is processed in a similar fashion

Where do we stand and where
do we go?

- WtE projects
- BTX harvesting
- Increasing BTX yields

We offer an integrated, modular end-to-end solution—from MRF to IGCC . . .

MSW, industrial waste, biomass



Proven MRF

Hundreds of successful systems worldwide



Proven Gasifier

Track record of operating successfully on RDF/Biomass



Proprietary OLGA Gas Cleaning

Oil scrubbers proven at countless petro plants



Caterpillar Solar Gas Turbine

Thousands operating reliably around the world

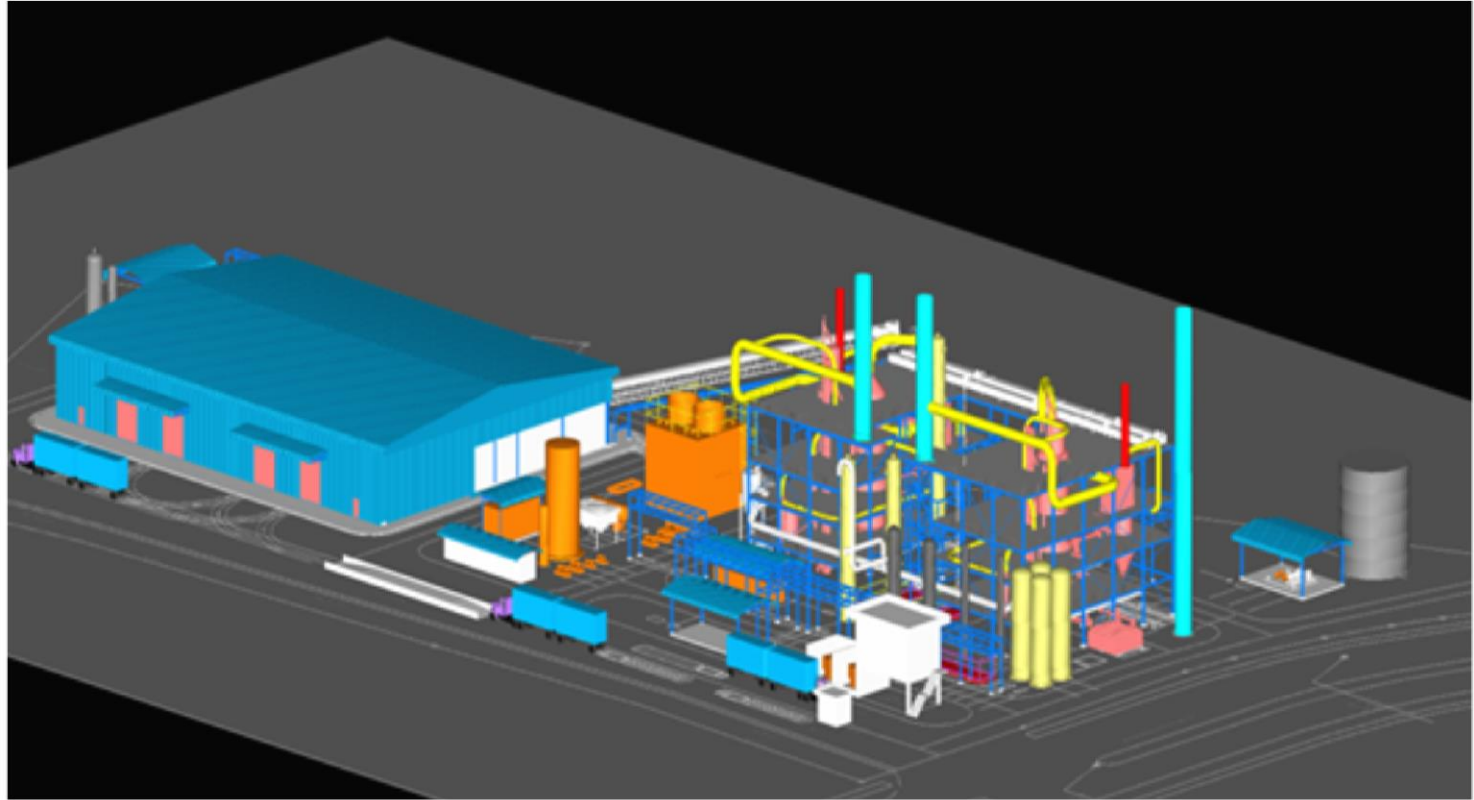


Substitute for natural gas or feedstock for liquid fuels

Power



Currently developing a large WtE plant in Thailand based on MILENA OLGA technology supplied by Royal Dahlman



► Aromatics production

A Shared Research Centre of TNO, VITO & ECN at the Green Chemistry Campus

World Class in Bio Aromatics Technology

Our mission: To **enable commercial production** of bio-aromatics by 2025

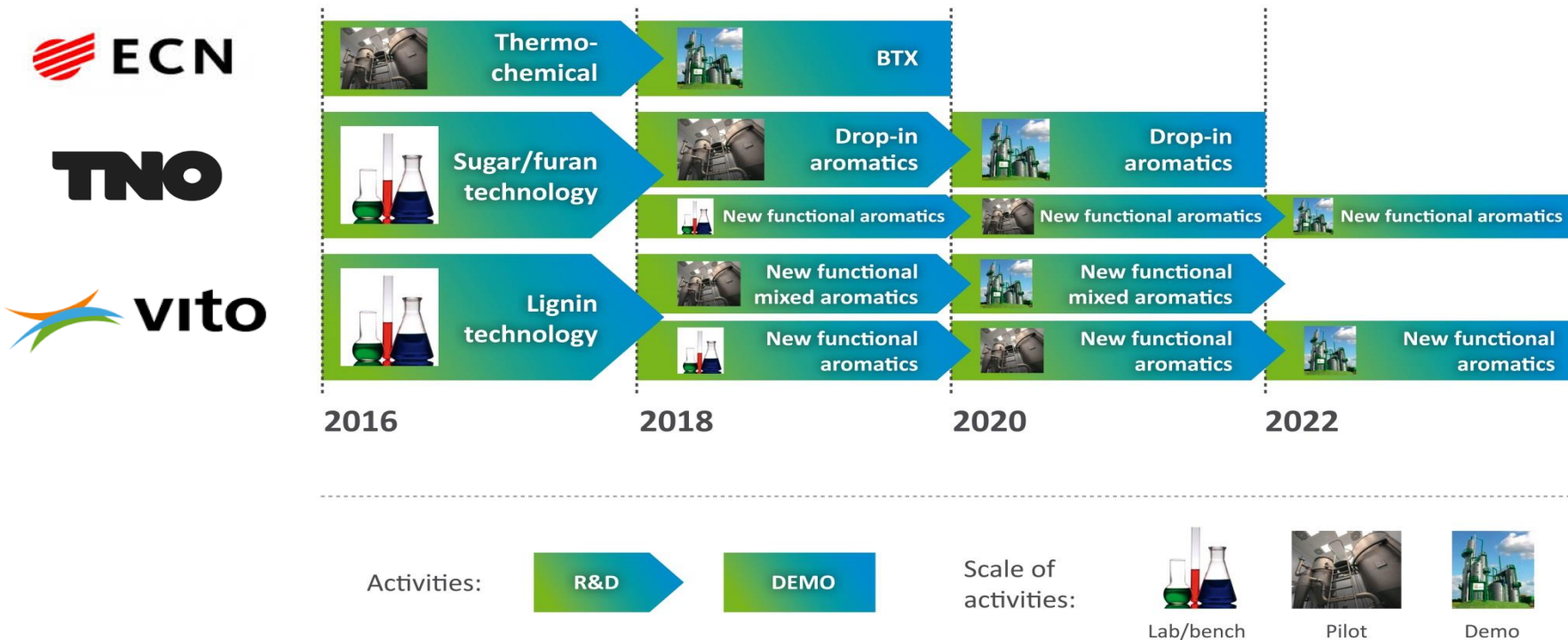


Collaboration with critical mass, focused on renewable **functionalized** aromatic compounds

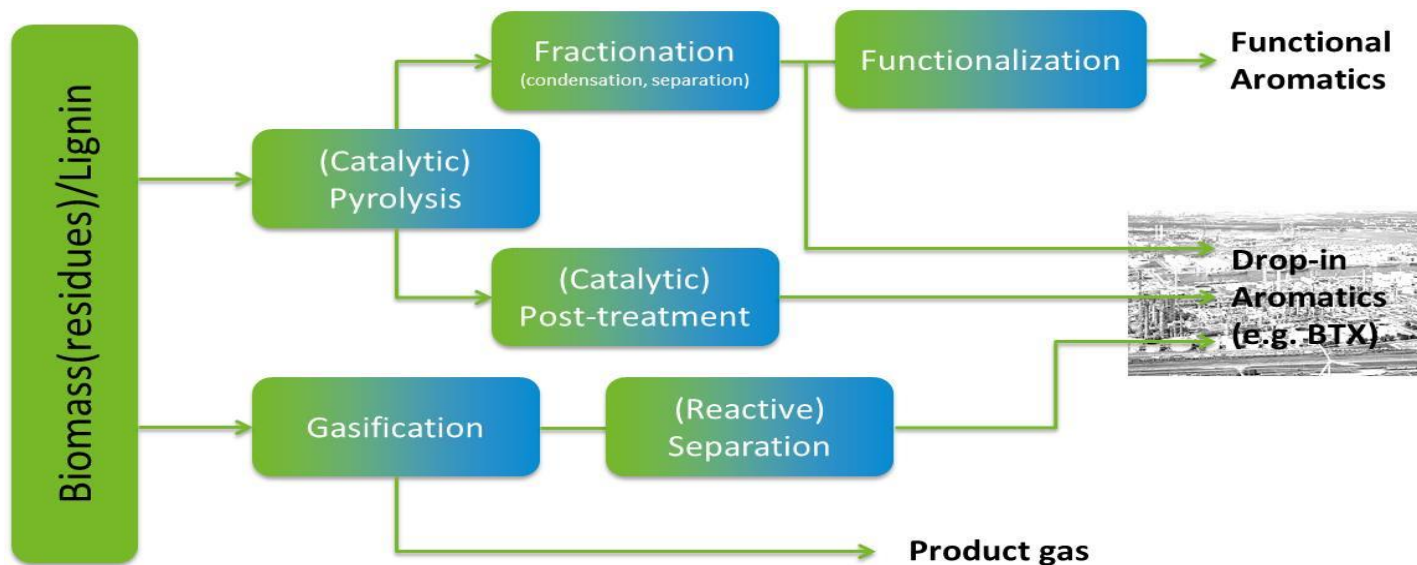


► Biorizon roadmap

Mission: to enable commercial production of bio-aromatics by 2025

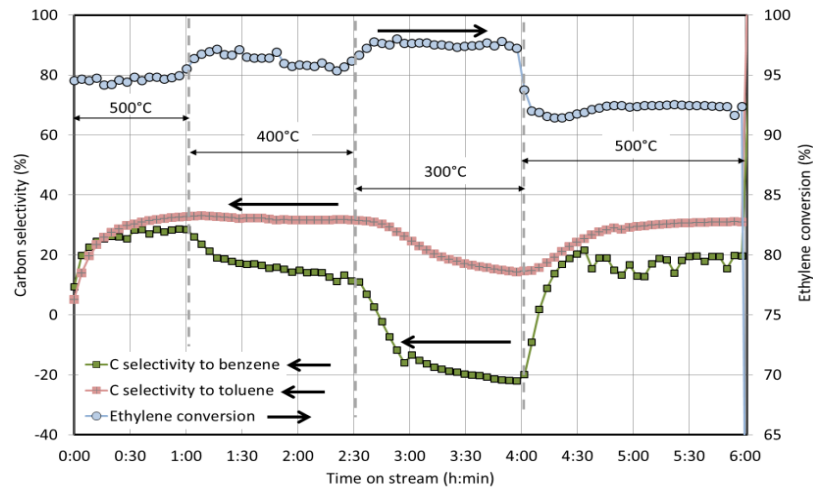


► Horizon 1 – Thermochemical processing



Boosting the aromatics yield

Ethylene conversion to aromatics



- High conversion of ethylene
- Steerable towards BTX or EB/styrene

Final statements

Gasification of waste produces a fuel gas with considerable value, which is a waste if turned into flue gas directly.

Co-production of BTX adds value to WtE processes, but also to other processes such as the production of Substitute Natural Gas (SNG).

Removing BTX from fuel gas is a new way of recycling plastics, second generation recycling!

This presentation was prepared with input from Royal Dahlman and Synova LLC

TURN WASTE INTO FUEL GAS!

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Publications: www.ecn.nl/publications

Fuel composition database: www.phyllis.nl

Tar dew point calculator: www.thersites.nl

IEA bioenergy/gasification: www.ieatask33.org

Milena indirect gasifier: www.milenatechnology.com

OLGA: www.olgatechnology.com / www.renewableenergy.nl

SNG: www.bioSNG.com / www.bioCNG.com

BTX: www.bioBTX.com



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