ECN

Energy research Centre of the Netherlands

2nd generation biofuels from imported biomass

Large scale production of Fischer-Tropsch diesel and/or Synthetic Natural Gas

Robin Zwart, Bram van der Drift
Energy research Centre of the Netherlands (ECN)

Contents

- Introduction
- EU directives, proposals & consequences
  à large scale production of FT diesel and/or SNG
- Technology options
  à syngas conversion versus product gas upgrading
- Technology challenges
  à biomass pre-treatment versus gas cleaning
- Conclusions

ECN: Energy research Centre of the Netherlands

ECN mission

Development of high-quality knowledge and technology for the transition to a sustainable energy supply, and bringing this to the market

~70 M€/y turnover
~530 employees

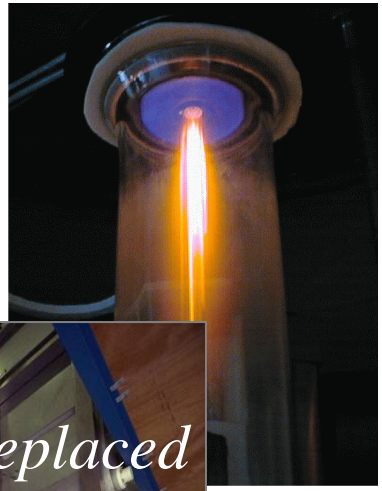
ECN biomass activities

ECN biomass activities

Fischer-Tropsch reactor

wet ESP

entrained flow simulator



OLGA: oil based gas cleaning

100 kg/h CFB gasifier

5 kg/h indirect gasifier

gas compressor

etc….

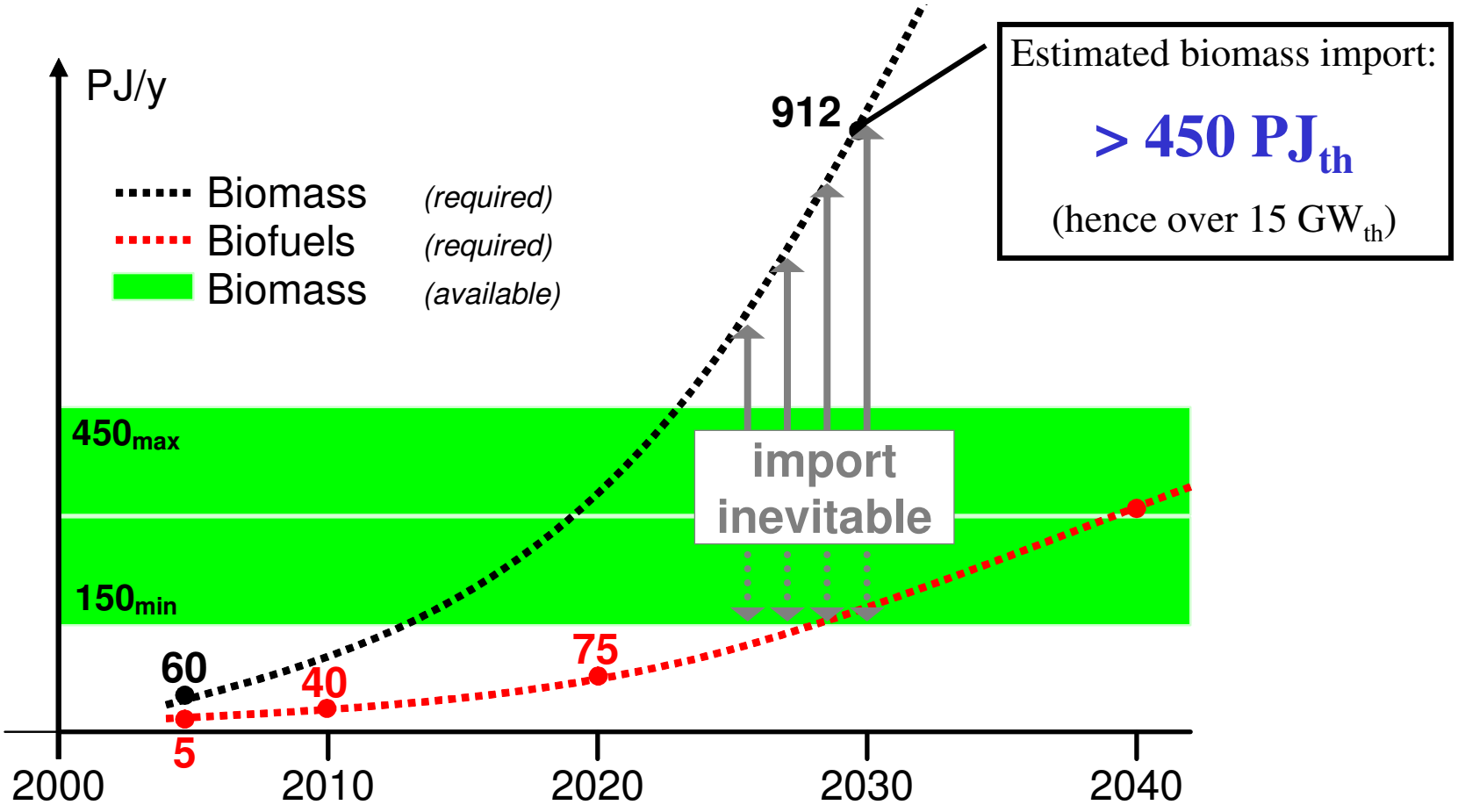
EU "biofuels" Directives and Proposals

The driving force for Fischer-Tropsch diesel production

	2005	2010	2015	2020	new proposal 2020
biofuels	2%	5.75%	7%	8%	15%
natural gas		2%	5%	10%	10%
LPG					5%
H_2		-	2%	5%	a few %
Total	2%	7.75%	14%	23%	> 30%

- 2001: EU directive proposal for "alternative transportation fuels"
- 2003: EU directive 2003/30/EC for period 2005-2010 for biofuels, not mandatory, deviations should be motivated, if unjustified: mandatory targets
- EU Alternative Fuels Contact Group proposal for period beyond 2010
- discussions on mandatory shares for biofuels ongoing, in some countries already projected

Biomass availability and targets in the Netherlands



912 PJ in 2030 from "Rabou, Deurwaarder, Elbersen, Scott: Biomass in the Dutch Energy Infrastructure in 2030, January 2006"

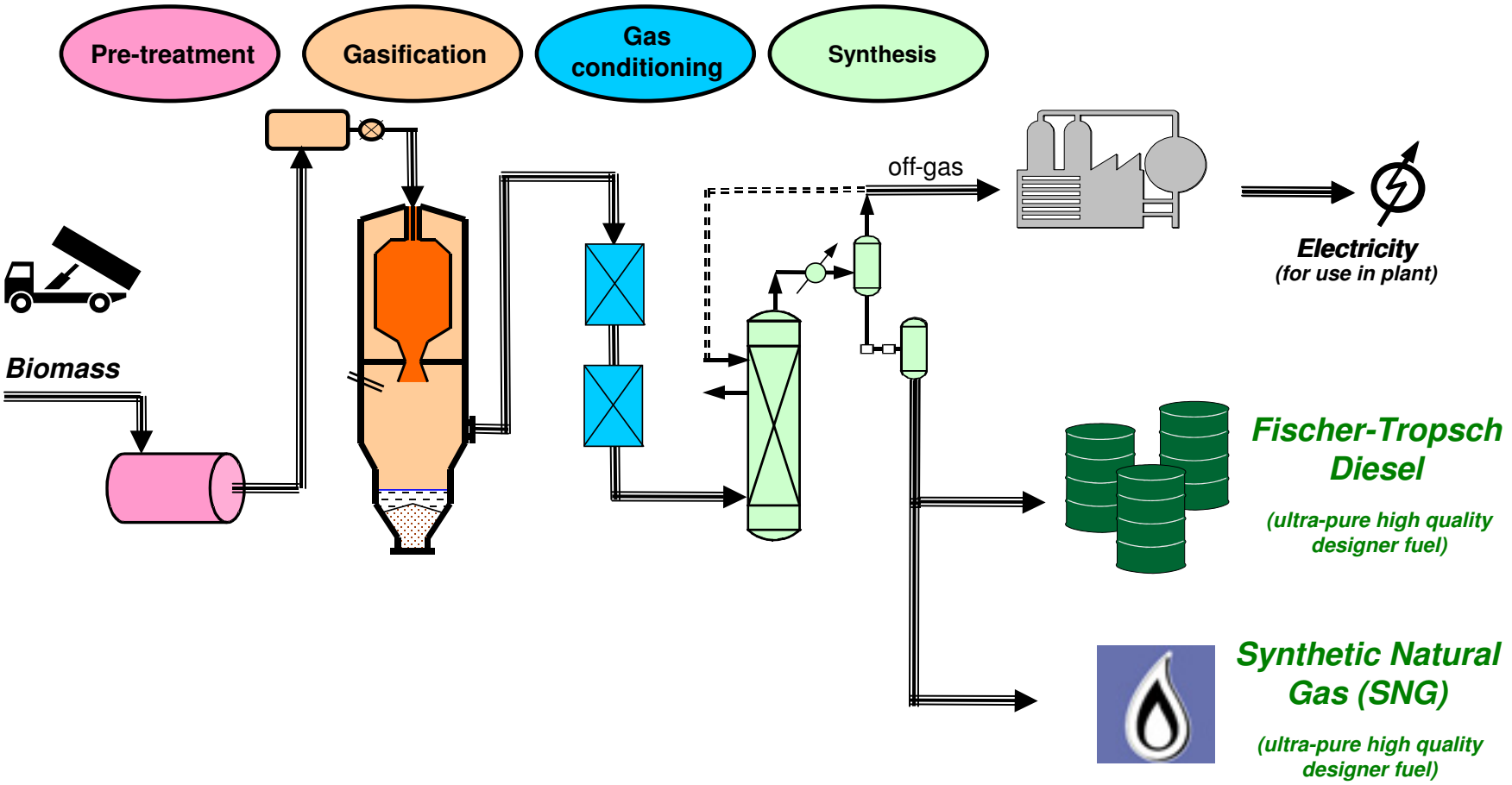
16 GW of biomass?!?

- 50 MW_{th} plants
  (commercial CFB, Choren β-plant)
- 600 MW_{th} plants
  (commercial IGCC, planned Choren plant)
- 8 GW_{th} plants
  (commercial GtL and CtL plants)

LARGE SCALE CONVERSION OF IMPORTED BIOMASS

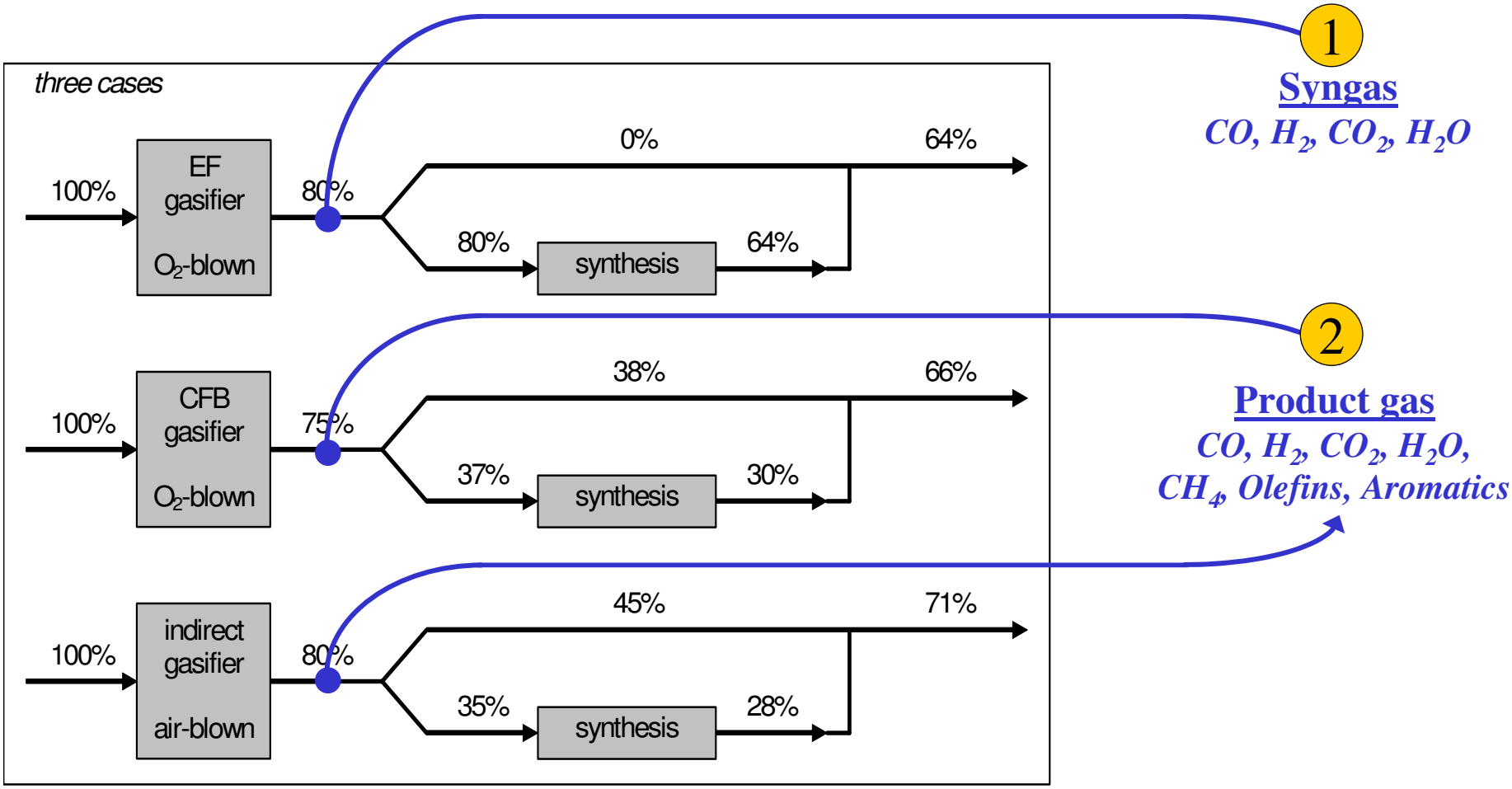
Biomass to liquids

General system line-up of 2nd generation biofuels production



Choice of gasifier

Syngas conversion versus product gas upgrading



Choice of gasifier

Syngas conversion versus product gas upgrading

1

Syngas

CO, H_2, CO_2, H_2O

2

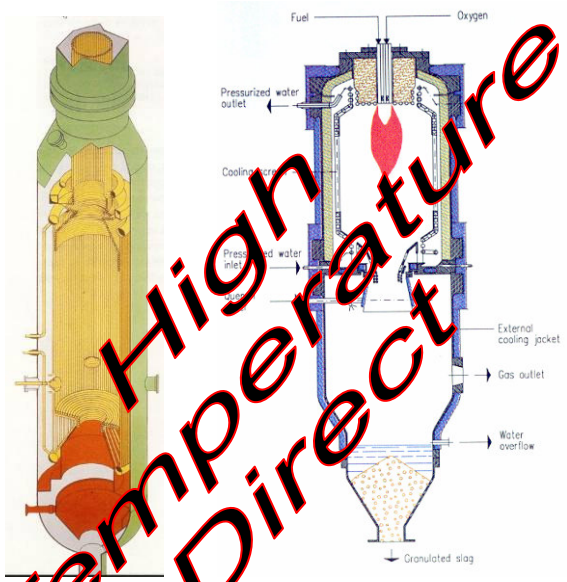
Product gas

CO, H_2, CO_2, H_2O, CH_4, Olefins, Aromatics

&

TAR

1

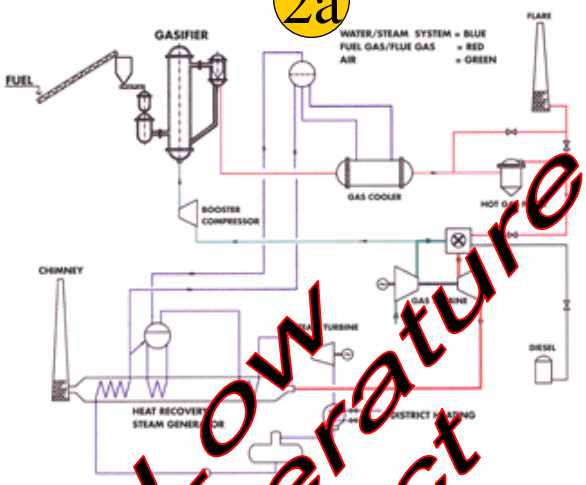


High Temperature Direct

Shell *Buggenum, Magnum*

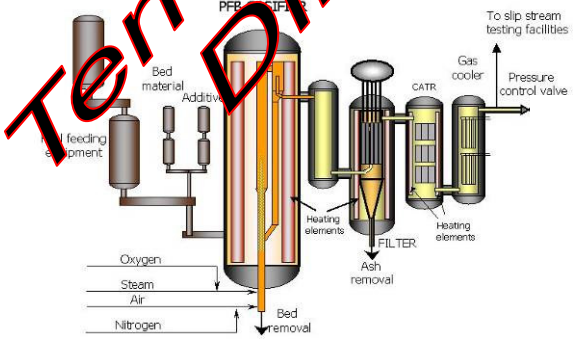
Siemens *Schwarze Pumpe, China*

2a



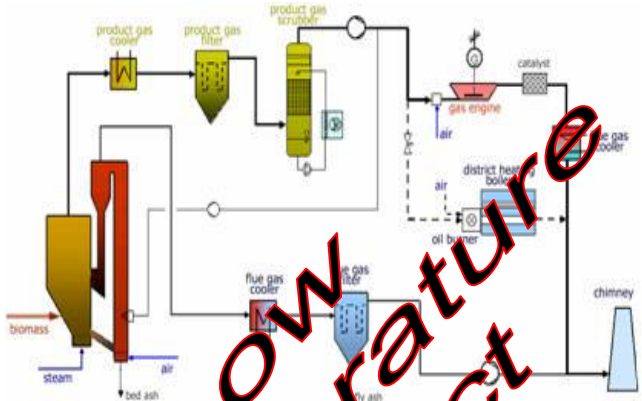
Low Temperature Direct

Värnamo *demo plant*



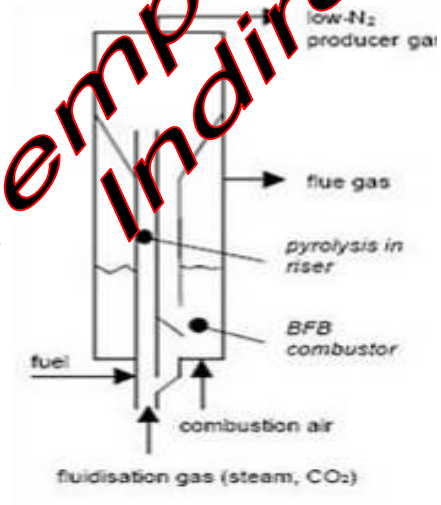
VTT *pilot plant*

2b



Repotec *Güssing*

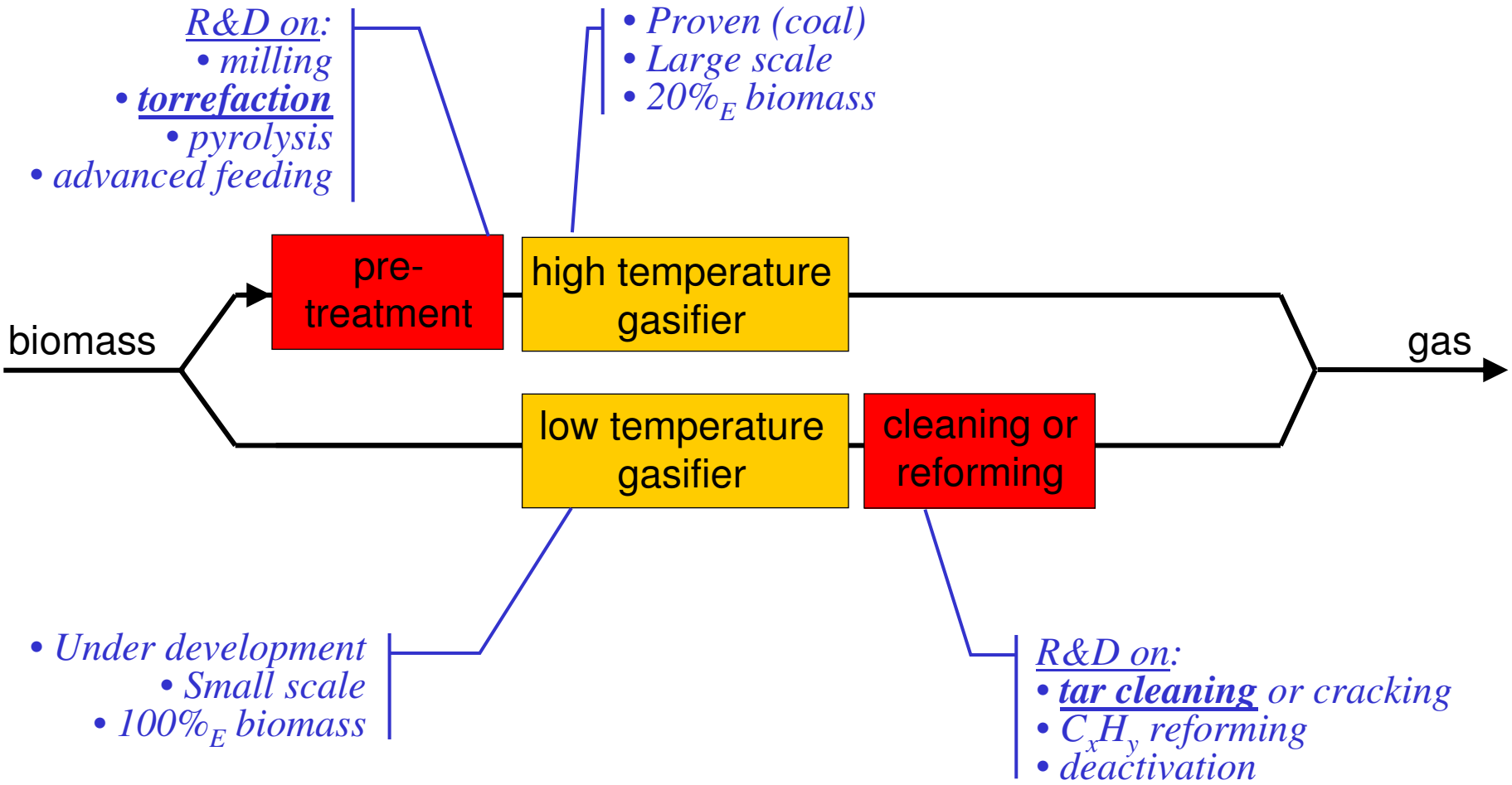
Low Temperature Indirect



ECN *pilot plant*

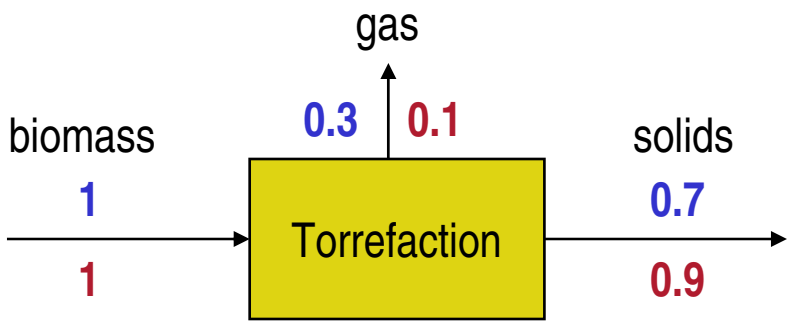
Options summary

Biomass pre-treatment versus gas cleaning



Biomass pre-treatment

General torrefaction process description



- Temperature: 200-300 °C
- Pressure: near atmospheric
- Absence of oxygen
- Product: solid phase (energy)
- Particle size < 4 cm thickness
- Residence time 30 to 90 min
- Heating rate: <50 °C/min

Biomass pre-treatment

Product quality of torrefied biomass

Green biomass

Waste

Demolition wood

Tough and fibrous
Hygroscopic, Hydrophilic
Vulnerable to biodegradation
Contaminated
Heterogeneous
10 to 18 MJ/kg (LHV, ar)
< 5 GJ/m^3

Torrefaction and pulverisation

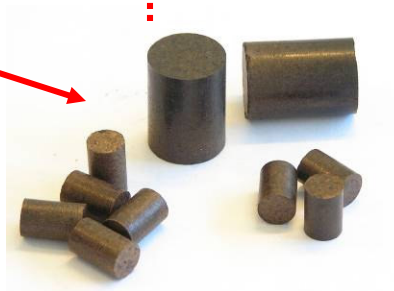
Friable and less fibrous
Hydrophobic
Preserved
Reduced contaminations
Homogeneous
19 to 22 MJ/kg (LHV, ar)
< 5 GJ/m^3

TOP fuel powder

Size reduction
Combustion / Gasification
Logistic operations (transport)
Feedstock bandwidth
Biofuel standardisation

Pelletisation

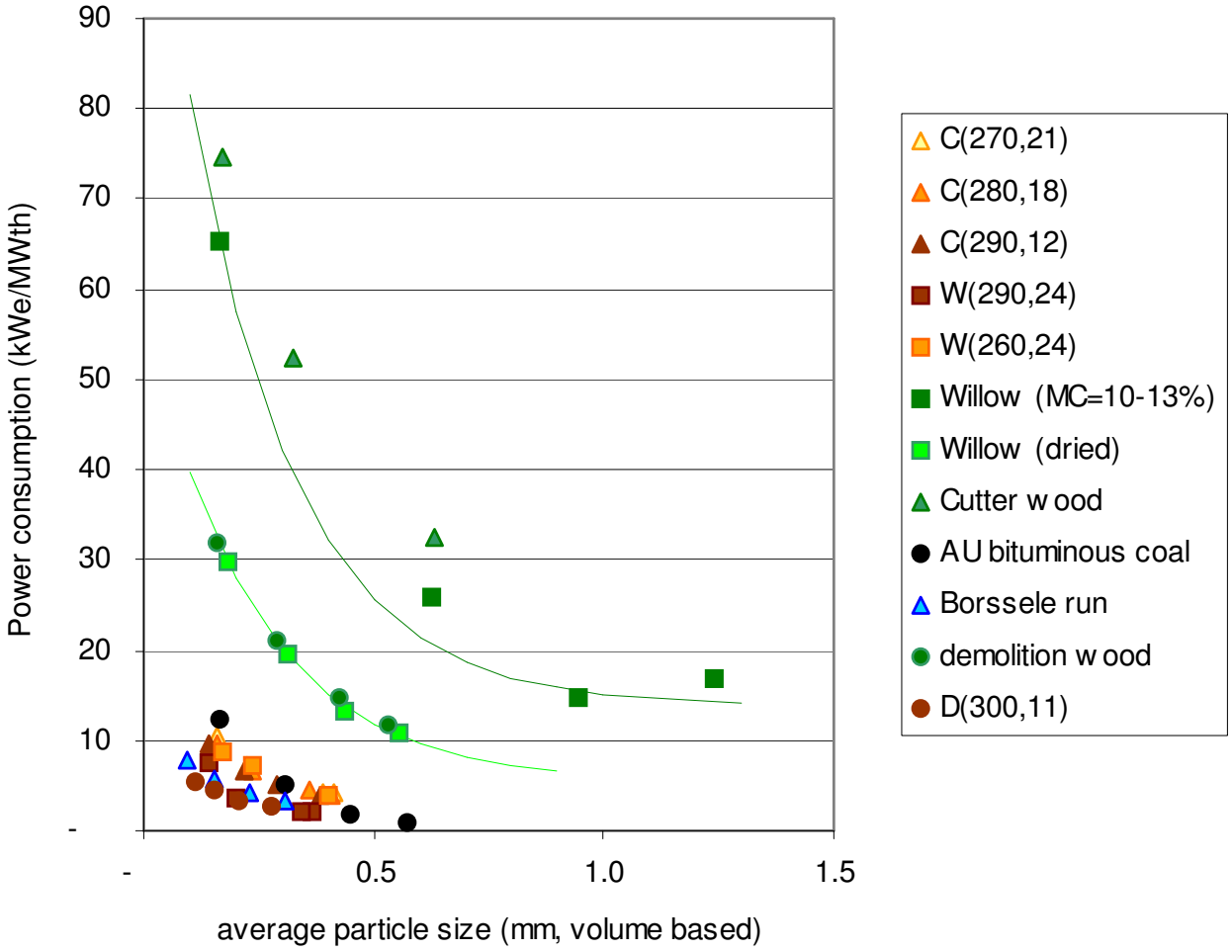
750-850 kg/m^3
15-20 GJ/m^3



TOP fuel pellets

Biomass pre-treatment

Grindability of (torrefied) biomass compared to coal

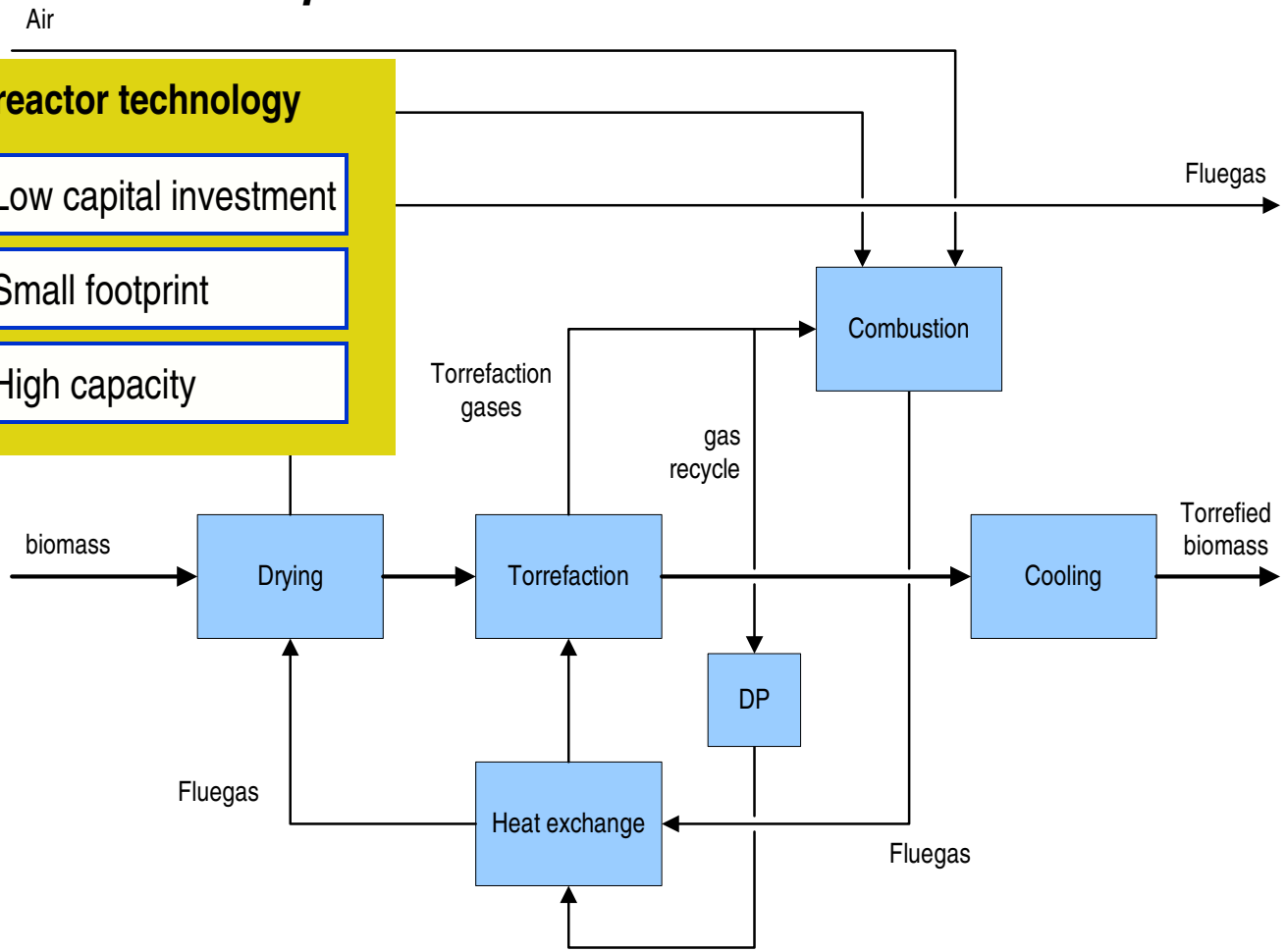


Biomass pre-treatment

ECN directly heated torrefaction process

Moving bed based reactor technology

Compact reactor	Low capital investment
Accurate T-control	Small footprint
Feedstock flexibility	High capacity



Gas treatment
Motivation for OLGA

Avoid tar related problems…….

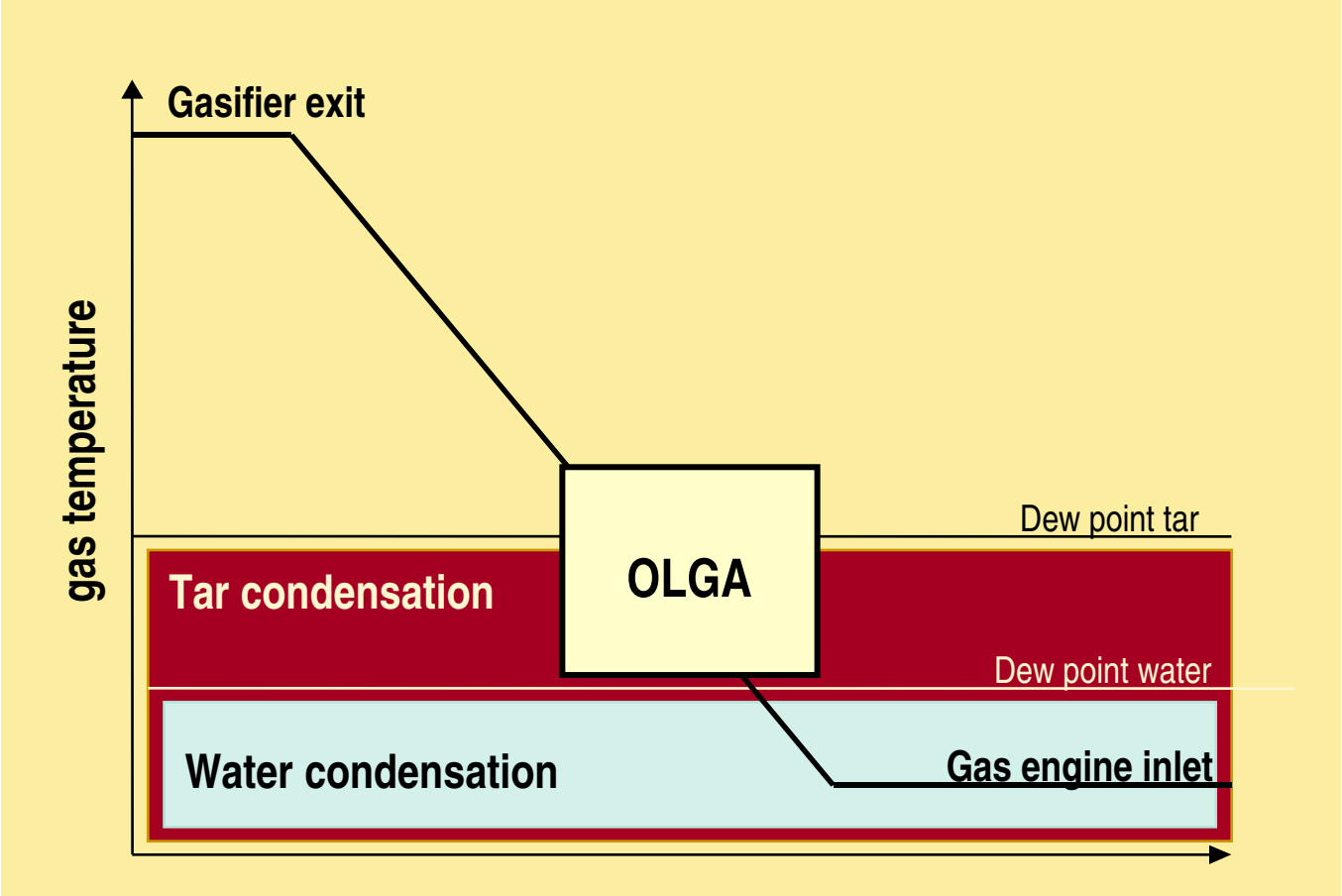
Deactivation of catalyst with soot (SNG)

Wastewater production (E)

Fouling of equipment (SNG & E)

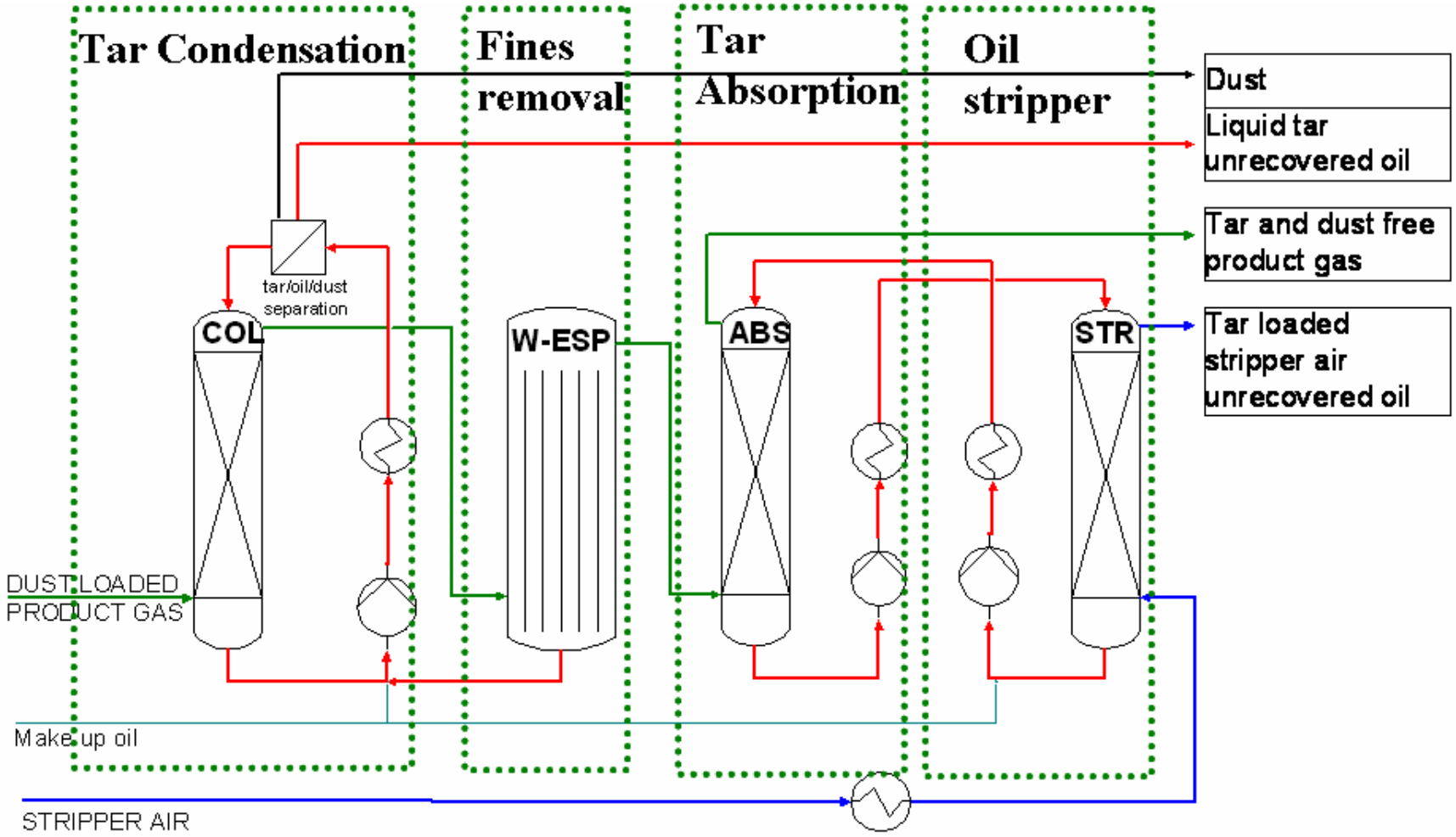
Gas treatment

Positioning of OLGA in the gas cleaning



Gas treatment

OLGA technology in a process flow diagram



Gas treatment

OLGA duration test January 15th to March 10th 2006

Duration test

- Duration: 677 hours
- 2 operators per shift
- Number of shifts = 3

Key data

- 59500 kg of biomass (pellets) used
- 1730 kg tar removed (3% of biomass)
- 25000 kWh_e produced

Partners

Dahlman	(OLGA)
Host	(Gasifier)
Lek Habo	(Gas engine)

Gas treatment

Demonstration OLGA installation

Project details

- Location: Moissannes in France
- Eneria is plant operator
- Dahlman is OLGA supplier
- ECN delivered design data for the plant and assists during start-up and operation.

Key process data

- 4 MW_{th} Fixed bed gasifier
- 1,1 MWe gas engine
- 2000 m_n^3/h of gas
- OLGA removes fine dust + tar
- 100 hours of OLGA operation
- Performance according design

Gas treatment
Demonstration OLGA installation

- Complete removal (>99.9%) of phenol
- Complete removal of heavy tars
- 350 à 10 mg/m_n^3 of light tar condensables
  (improves in time)
- Dust below detection limit
- No fouling of piping or gas engine
- Stable and fully automated operation

	Start-up Measurements	**Duration test** Measurements
Heavy tars	150 à 0	140 à 0
Phenol	200 à 0	200 à 2
Naphthalene	1000 à 10	3500 à 150
Condensables (@40°)	500 à 10	2500 à 60 (@40°)

Gas treatment

OLGA by night

Conclusions

On short term start implementing, on long term increase efficiency

- Large-scale implementation of 2nd generation biofuels required
- Import of (expensive) biomass inevitable
- High efficiencies required

- Pre-treatment required for existing high temperature EF gasifiers
- Torrefaction results so far very promising
- Construction of a pilot plant ongoing

- Gas cleaning required for developed low temperature gasifiers
- OLGA results so far very promising
- Technology commercialized by Dahlman
- Technology optimized by ECN

Further research

At the Energy research Centre of the Netherlands (ECN)

BioSNG

- Optimization Milena gasifier and OLGA
- Optimization gas cleaning
- Optimization CH_4 synthesis
- Construction of Pilot plant (800 kW_{th}, mid 2007)
- Formation of consortium for the Demo installation (10MW_{th})

Torrefaction

- Optimization torrefaction / TOP process
- Testing of fuel in entrained flow gasifiers
- Construction of Pilot plant (600 kW_{th}, mid 2007)
- Formation of consortium for the Demo installation (15MW_{th})

Thank you for your attention

For more information, please contact:

Ir. Robin Zwart
phone +31 224 56 4574
fax +31 224 56 8487
email zwart@ecn.nl

Ir. Bram van der Drift
phone +31 224 56 4515
fax +31 224 56 8487
email vanderdrift@ecn.nl

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"Thersites" – *internet model for tar dewpoint calculations: www.thersites.nl*

"BioSNG" – website providing information on Synthetic Natural Gas from biomass: www.biosng.com

"OLGA" – website providing information on the OLGA gas treatment: www.olgatechnology.com