

Gasification of Solid Fuels:

Challenges and Opportunities for Clean Environment

22nd March, 2016 | Dr. Dobrin Toporov (presenter)
Jens Pöpperling, Ralf Abraham
thyssenkrupp Industrial Solutions

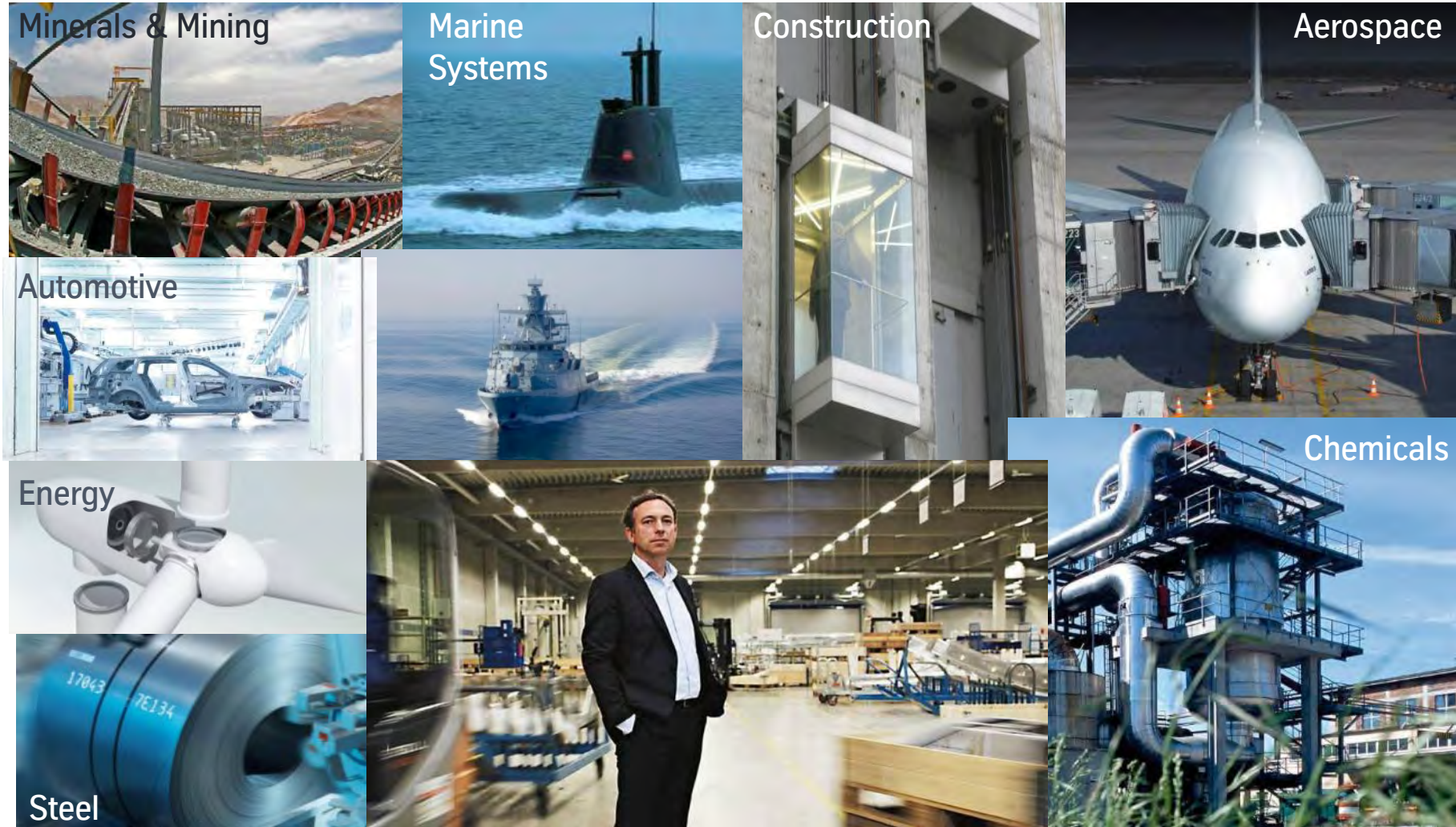
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Working for our customers

Sector examples – Mastering challenges together



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What is Gasification?

- **gasification**, any process of converting coal into gas for use in illuminating and heating.

Encyclopaedia Britannica



- **gasification** is a process that converts organic or fossil based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide.

Carbon Fuel + (Steam, Carbon Dioxide) + Heat →
Carbon Monoxide + Hydrogen + etc

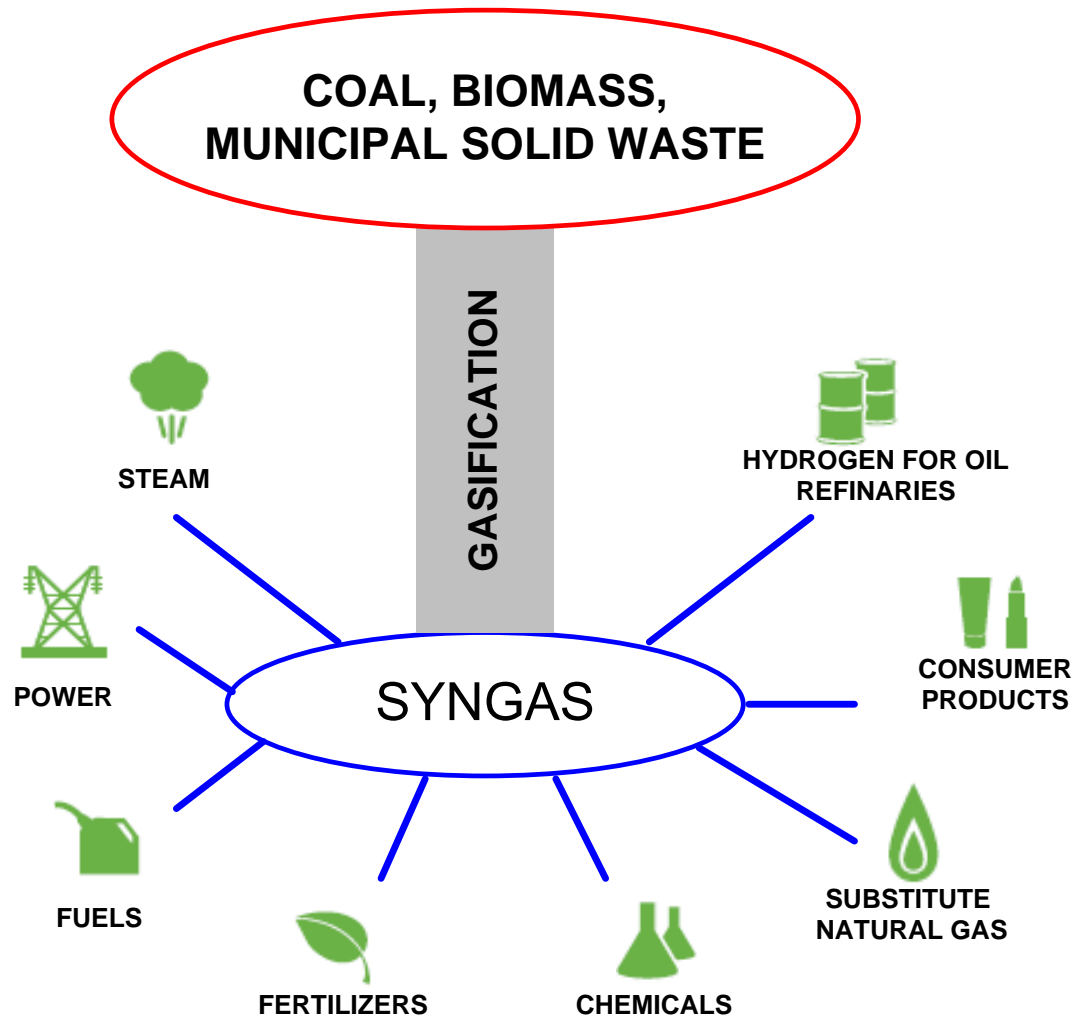
Syngas

$\lambda < 1$



The Gasification Industry

200 years of experience

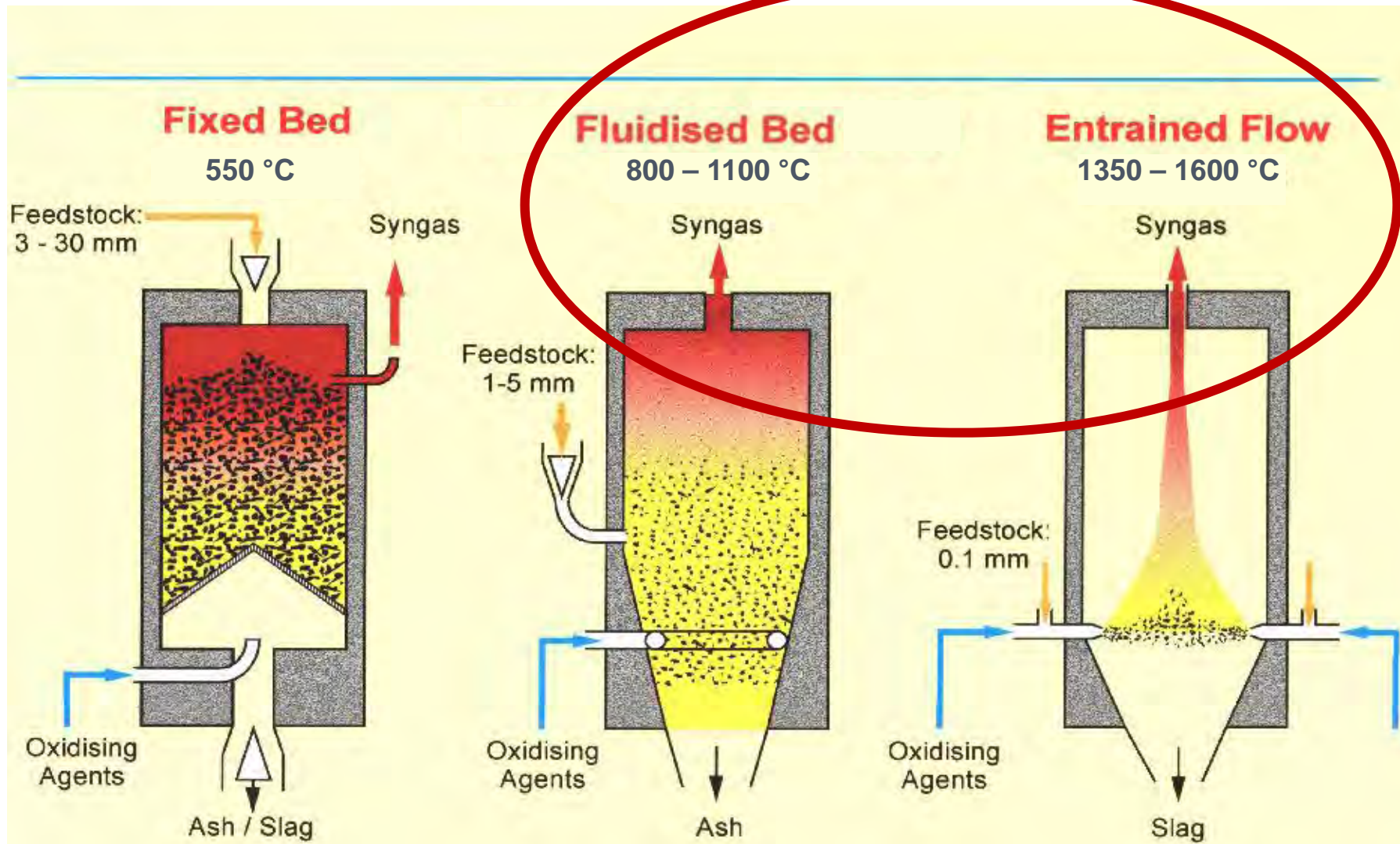


- 1814 – first commercial use of syngas, London
- Today syngas from coal still supplies about:
 - 25 % of world's NH_3 production
 - 30 % of world's MeOH production
- Currently there are:
 - 833 gasifiers in operation (148 GWth)
 - 324 under construction (97 GWth)
 - 664 planned (113 GWth)

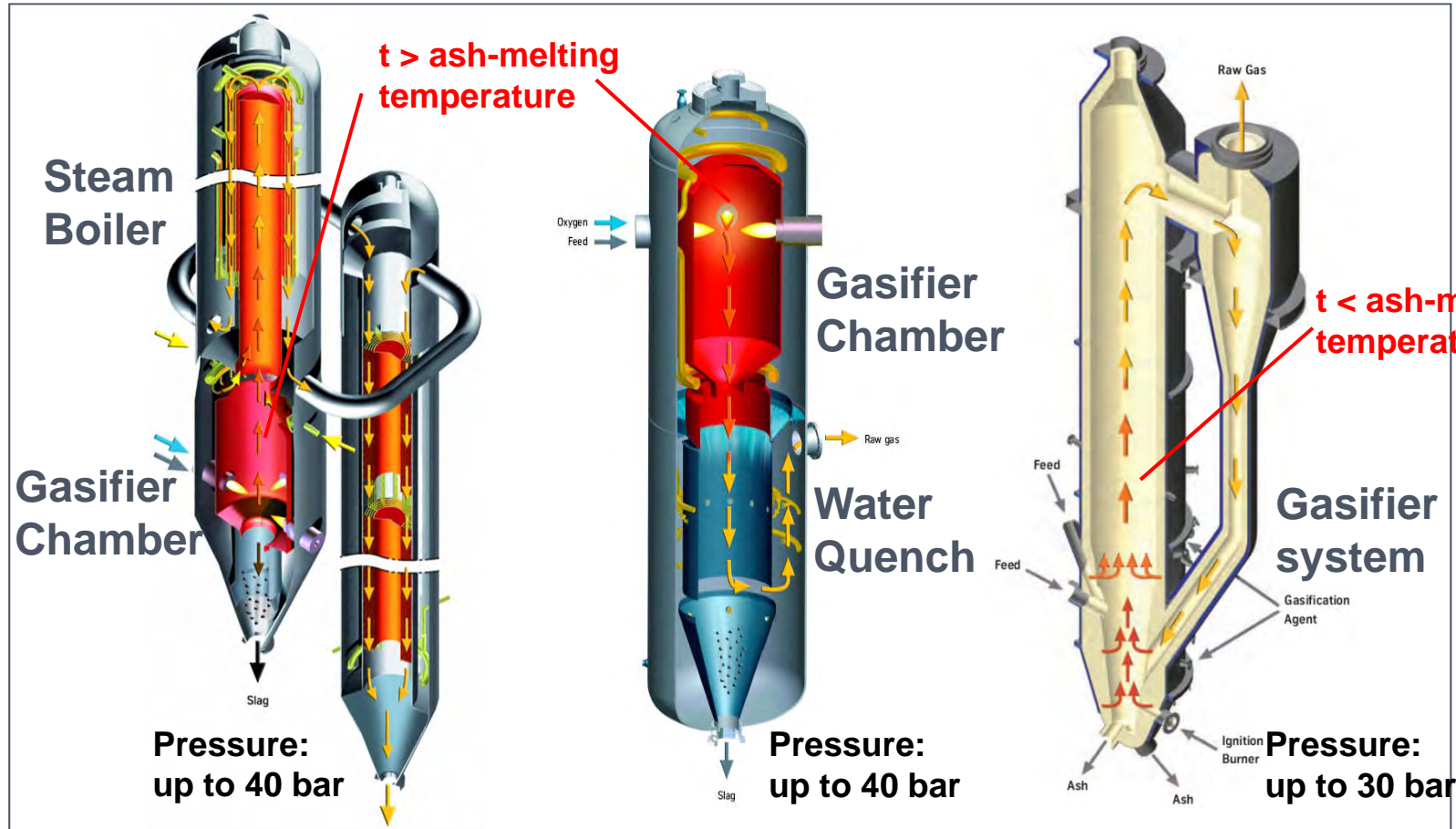


Gasification Technologies

Technologies from ThyssenKrupp



tkIS Proprietary Gasification Technologies



PSG

PDQ

HTW™

PRENFLO Entrained-Flow

Fluidised Bed



Concepts & Projects/Plants - Overview

„Site“-Seeing: 6 Examples for tkIS Gasification Plants

PRENFLO IGCC
Puertollano, Spain
petcoke / coal-to-power



PRENFLO biomass gasification
Dunkerque, France
Biomass-to-Clean Jet Fuel



HTW coal gasification
Berrenrath, Germany
lignite-to-methanol



HTW Syngas Plant, Oulu/Finland



HTW biomass gasification
Oulu, Finland
biomass-to-hydrogen / ammonia



HTW biomass gasification
Värmlands, Sweden
Biomass-to-methanol



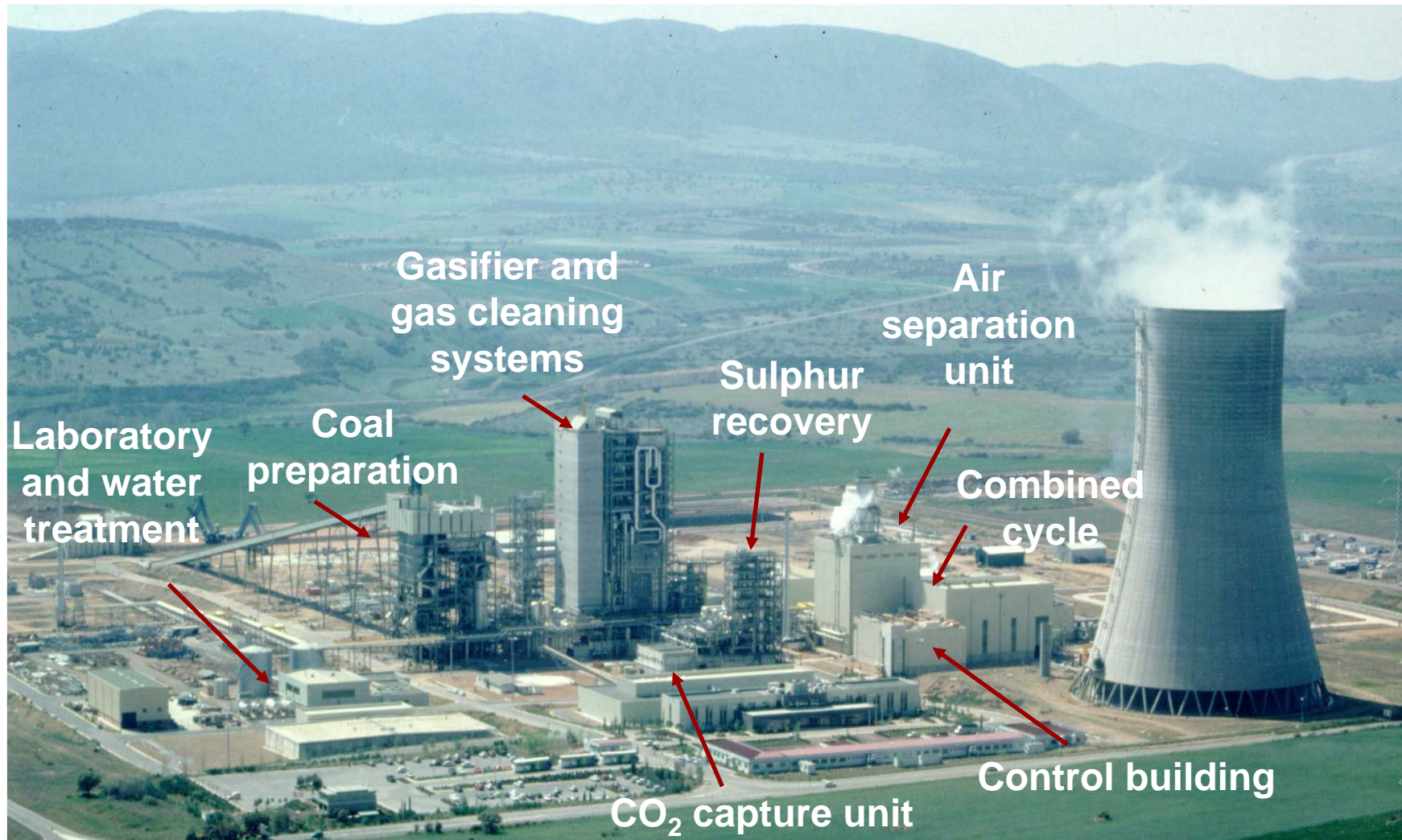
HTW MSW gasification
Niihama, Japan
waste-to-energy



Concepts & Projects/Plants

Example 1: Entrained Flow PRENFLO PSG

World largest single-train IGCC (300 MWe), Puertollano Power Plant, Spain



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Concepts & Projects/Plants

Example 1: Entrained Flow PRENFLO PSG

World largest single-train IGCC (300 MWe), Puertollano Power Plant, Spain



Feed: **high ash (41%) bituminous coal + petcoke**

103 t/h

Operating pressure:

24 bar

Syngas production:

153,000 Nm³/h

Plant net efficiency:

42.2 %

In operation:

since 1998

Emissions (mg/Nm³ at 6% Oxygen - dry):

SO₂: **20** (EU Directive 2010/75/EEC – max. 200)

NO_x: **111** (EU - max. 300)

Particulate: **0.4** (EU - max. 20)



Source: Elcogas, 2013

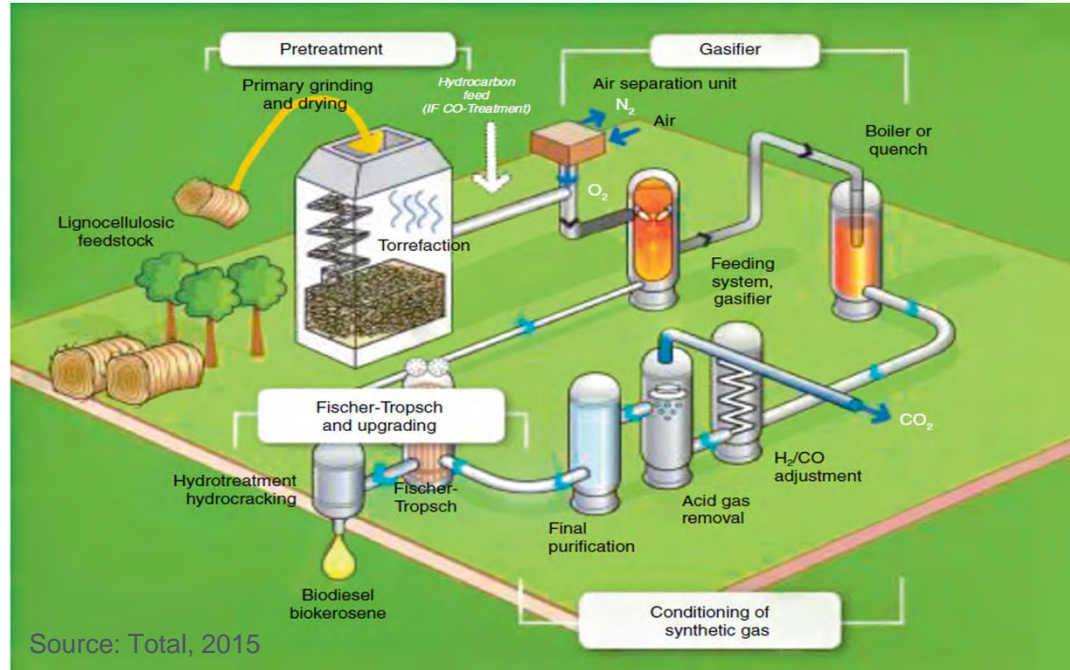
The Cleanest and among the most Efficient Coal-Based Power Plants in Europe!



Concepts & Projects/Plants

Example 2: Entrained Flow PRENFLO PDQ

Demo Project for Production of 2nd Generation Bio-Fuels, Dunkerque, France



Feed: Lignocellulose Biomass (straw, forest waste, energy crops)
Products: Bio-Fuels (biodiesel / bio-jet fuel / bio-naphtha)
Commissioning: starts in 2017

Efficient Conversion of Plant Waste into High Quality Clean Bio-Fuel !

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Concepts & Projects/Plants

Example 3: Fluidised Bed HTW

Demonstration Plant for Production of Methanol, Berrenrath, Germany



Feed: **lignite**, pre-dried: 27 t/h
Operating pressure: 10 bar
Syngas production: 35,000 Nm³/h
Cold gas efficiency: 84.7 %
In operation: 1986-1997
Methanol Production: 300 tpd
Co-gasification: lignite & waste
 lignite & biomass
 (60:40)



HTW Demonstration Plant Berrenrath, Germany
Production Rates: 300 t /d methanol

Commercially Proven Efficient Conversion of Low Quality Coal into Methanol !



Concepts & Projects/Plants

Example 4: Fluidised Bed HTW

Commercial Plant for Peat-based Production of Ammonia, Oulu, Finland

Feed: Peat , pre-dried:	20 t/h
Operating pressure:	10 bar
Syngas production:	20,000 Nm ³ /h
Cold gas efficiency:	80 %
In operation:	1988
Ammonia Production:	230-270 tpd



HTW Syngas Plant, Oulu/Finland



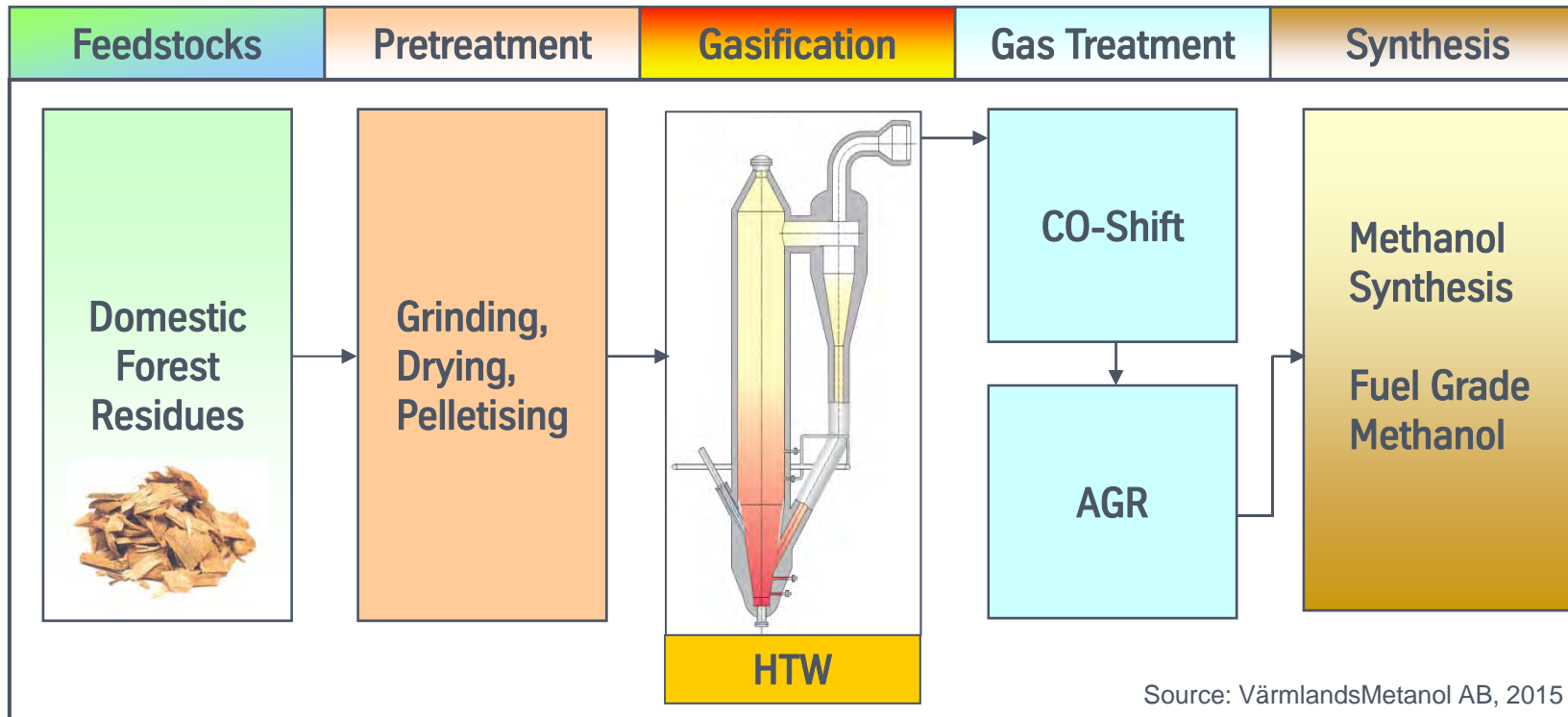
Commercially Proven Efficient Conversion of Biomass into Hydrogen / Ammonia !



Concepts & Projects/Plants

Example 5: Fluidised Bed HTW

Commercial Plant for Production of 2nd Generation BioFuels, Värmlands, Sweden



Feed: 20 t/h dry **wood** (111 MWth)

Products: 300 tpd methanol (74MWth) + 15 MWth district heat export

Efficient Conversion of Forest Residues into Fuel Grade Bio-Methanol !



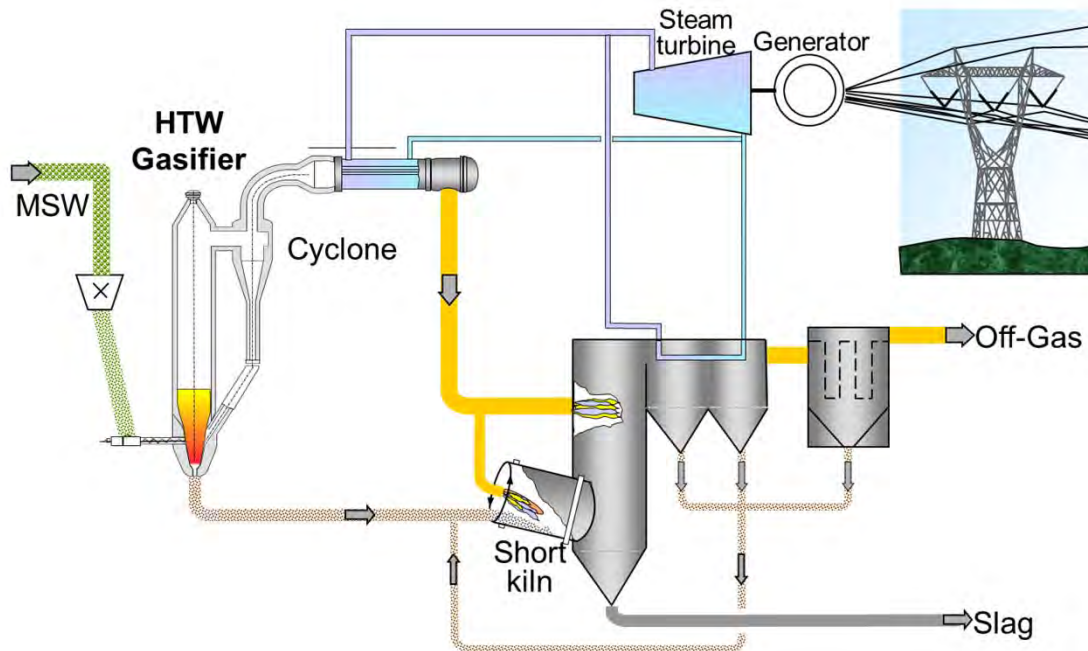
Concepts & Projects/Plants

Example 6: Fluidised Bed HTW

Commercial Plant for MSW, Niihama, Shikoku, Japan



Sumitomo Heavy Industries
Material Handling Systems Co.,Ltd.



Feed: 20 tpd **municipal solid waste**
Products: electricity and slag
In operation: 1999

Industrially Proven Concept for Clean and Efficient Conversion of MSW into Power !

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Summary

- ◆ Gasification is a **proven technology**, a vast number of gasifiers are operating since decades successfully on commercial basis
- ◆ Gasification allows **flexibility** in feedstock and polygeneration of products, even for biomass and waste projects
- ◆ Gasification is an **environmental friendly** technology
- ◆ TK Industrial Solutions has more than **70** years of experience in gasification based on different gasification technologies
- ◆ ... received more than **100** contract awards for gasifiers
- ◆ ... has built **world's largest** solid fuel based, single train **IGCC**
- ◆ ... has built several **biomass-** and **waste-based** gasifiers
- ◆ ... is a process oriented EPC contractor and **not only licensor**
- ◆ ... has built more than **2,000 chemical plants** worldwide

