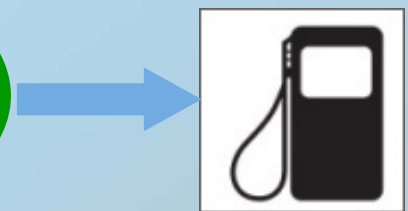


An update on the BioTfuel Project and other activities of TKIS-PT in the area of biomass gasification

Workshop „Liquid Biofuels“

Ralf Abraham and Norbert Ullrich
Gas Technologies



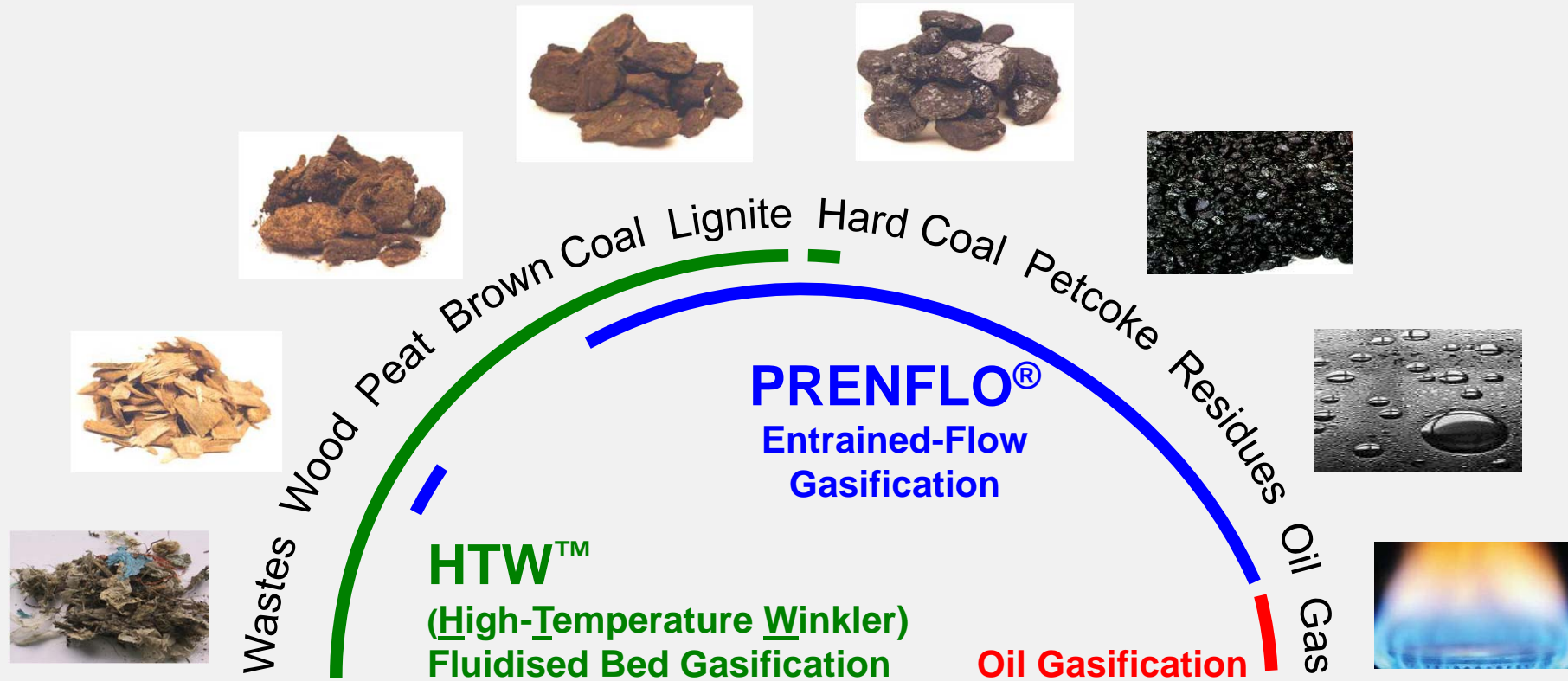
ThyssenKrupp
Industrial Solutions



ThyssenKrupp

Gasification Portfolio

Different feedstocks require different gasification technologies

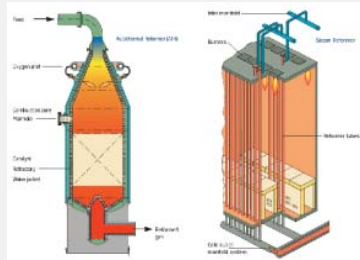


TKIS fuel and product flexibility for syngas product routes

Feedstock	TKIS Gasification Technologies	Products
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High fuel flexibility

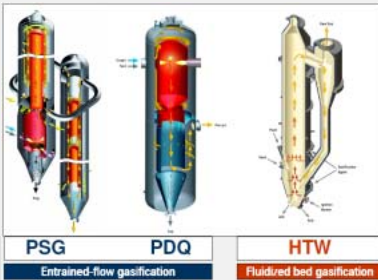
- Gas
- Naphtha
- Petcoke
- Hard Coal
- Biomass
- Lignite
- Wastes



TKIS
Steam Reformer

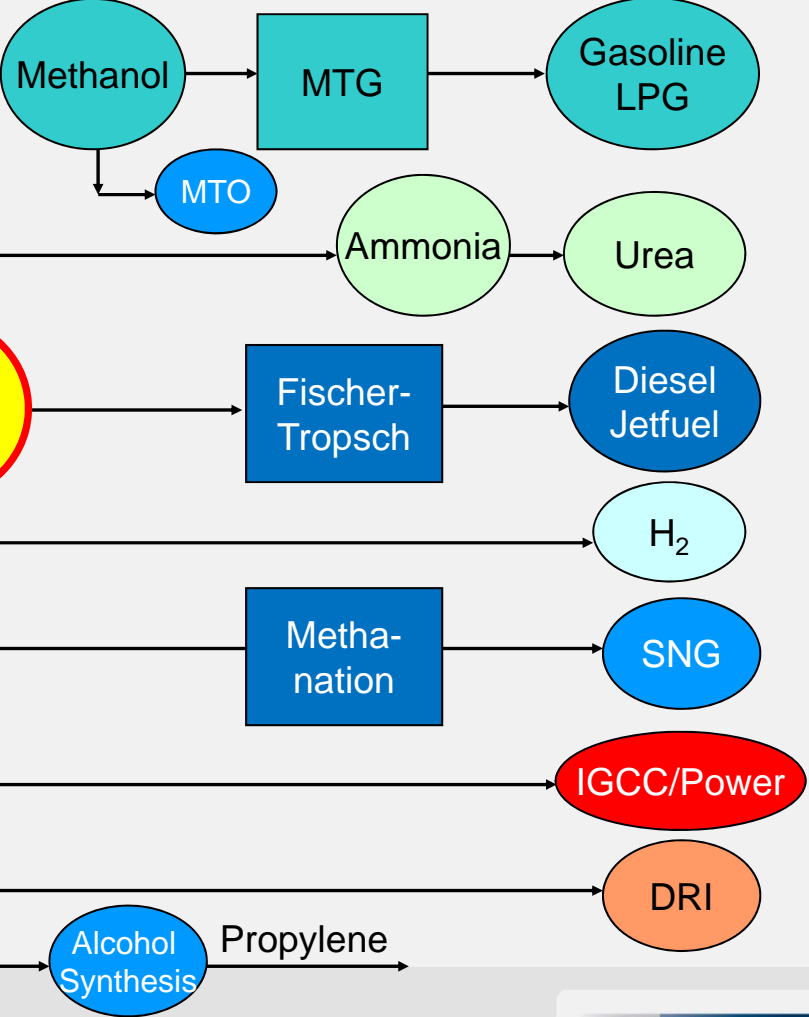
PRENFLO
Gasification

HTW
Gasification

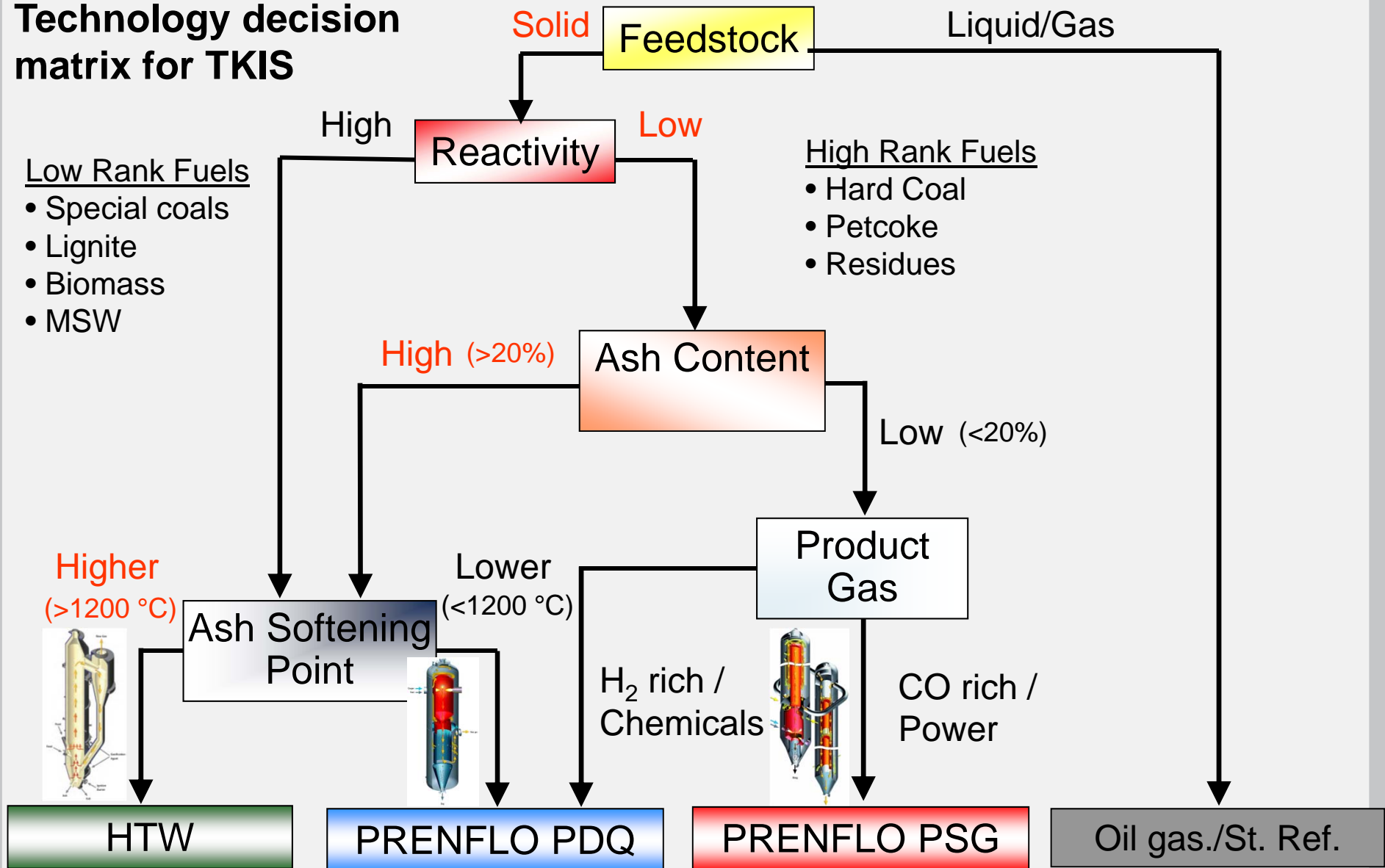


Syngas
(CO+H₂)

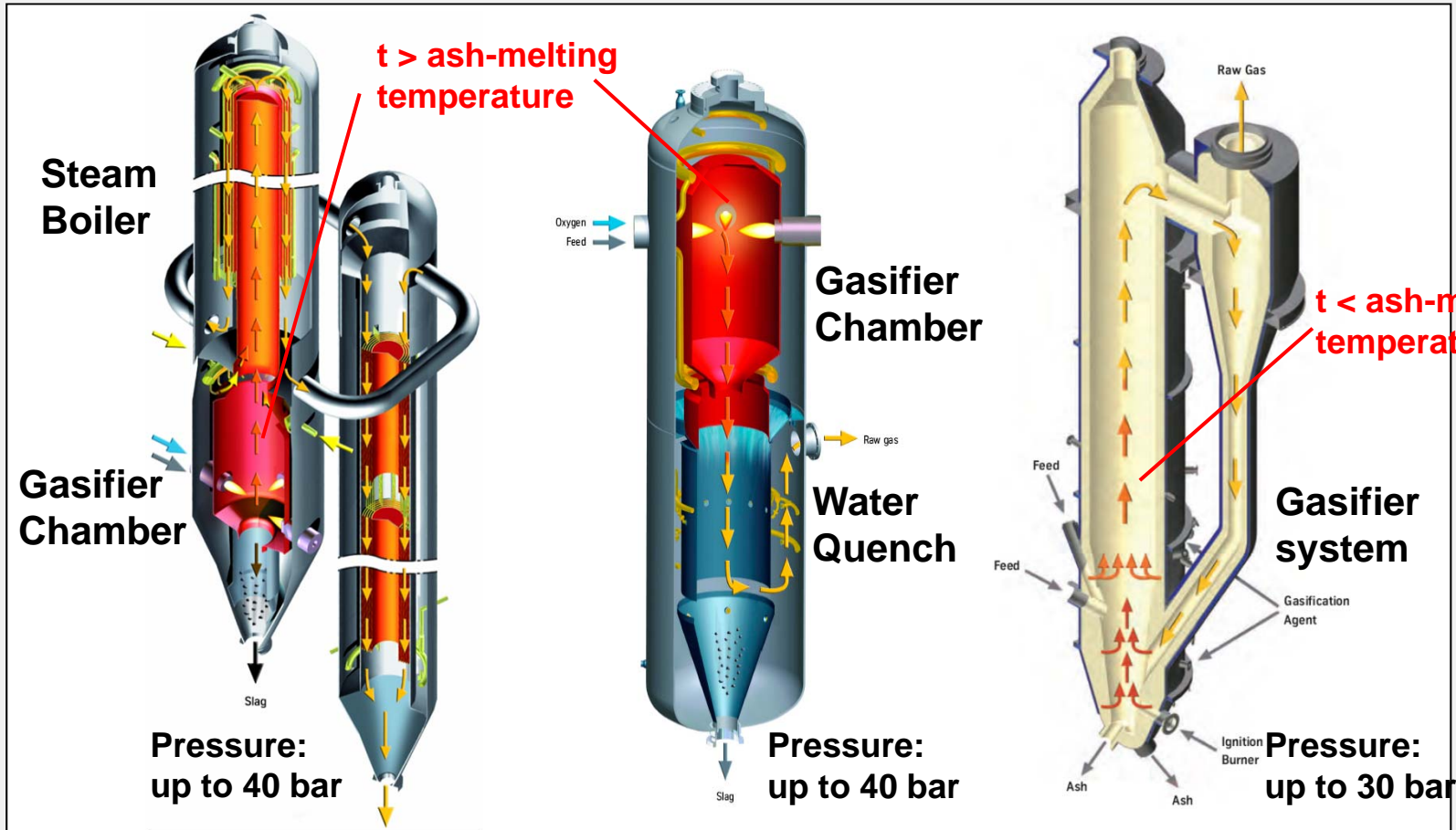
High product flexibility



Technology decision matrix for TKIS



TKIS Proprietary Gasification Technologies



PSG

PDQ

HTW™

PRENFLO Entrained-Flow

Fluidised Bed

Gasification Portfolio

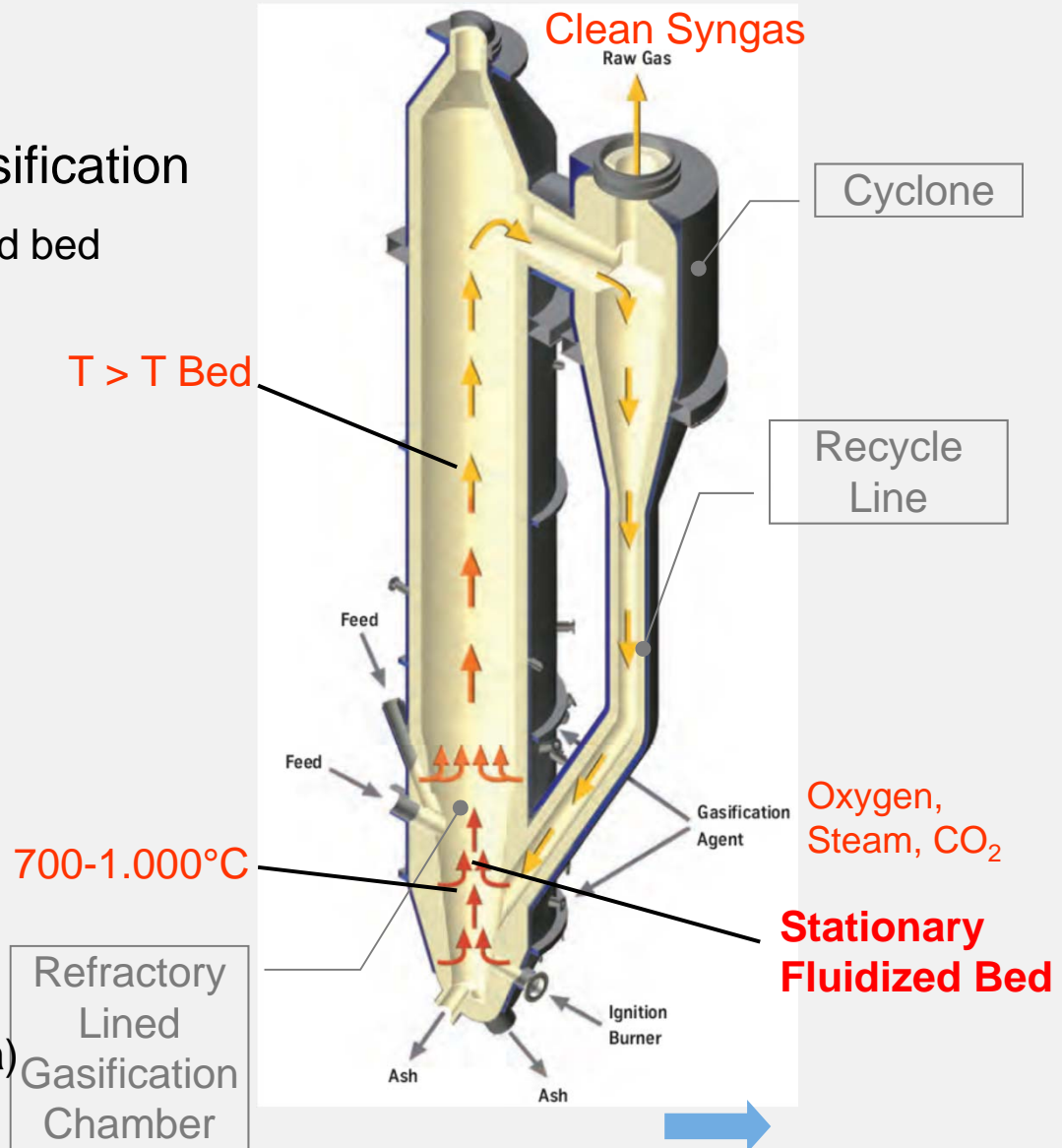
The HTW™ Gasifier

High Temperature Winkler Gasification

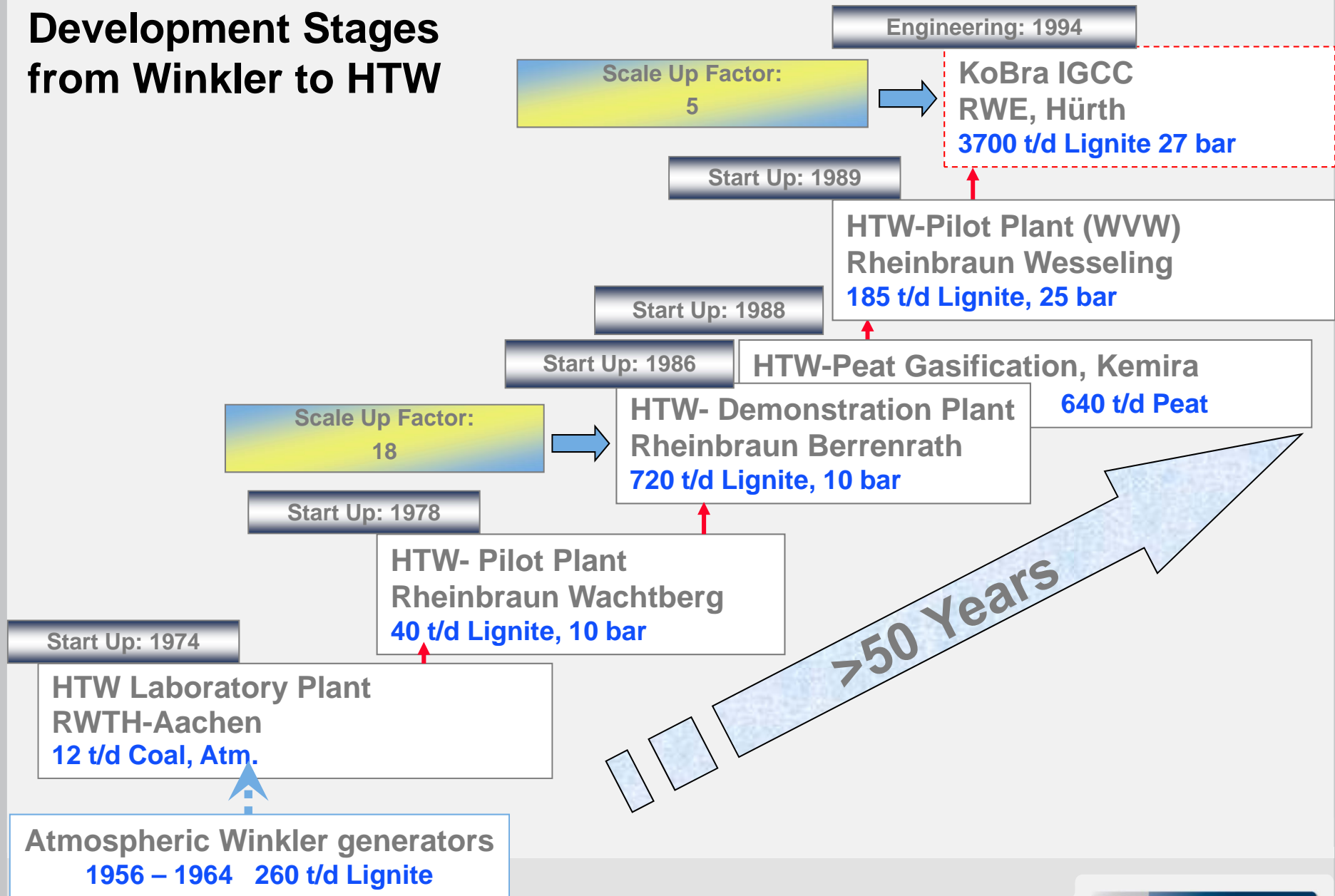
- Oxygen-blown stationary fluidised bed
- Gasification temperature: 700 – 1,100 °C
- Pressure: up to 30 bar
- Co-Feed with biomass and/or waste realised
- HTW operates below the ash melting point

resulting in low oxygen consumption

Strong advantages for feeds with high ash content, higher ash softening point (China and India) and Biomass



Development Stages from Winkler to HTW



Gasification Portfolio (Fluidized Bed)

TKIS acquired HTW™ Gasification Technology

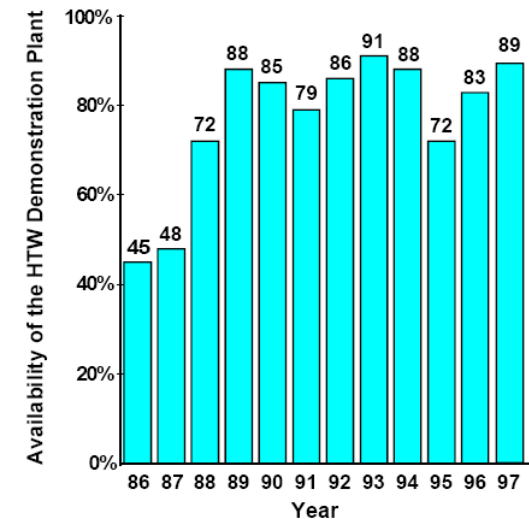
- HTW™ goes back to 1926 (Winkler Gasification)
- HTW™ was previously owned by RWE
- TKIS acquired the HTW™ technology with all IP rights and know-how from RWE in **December 2010**
- **Main target:**



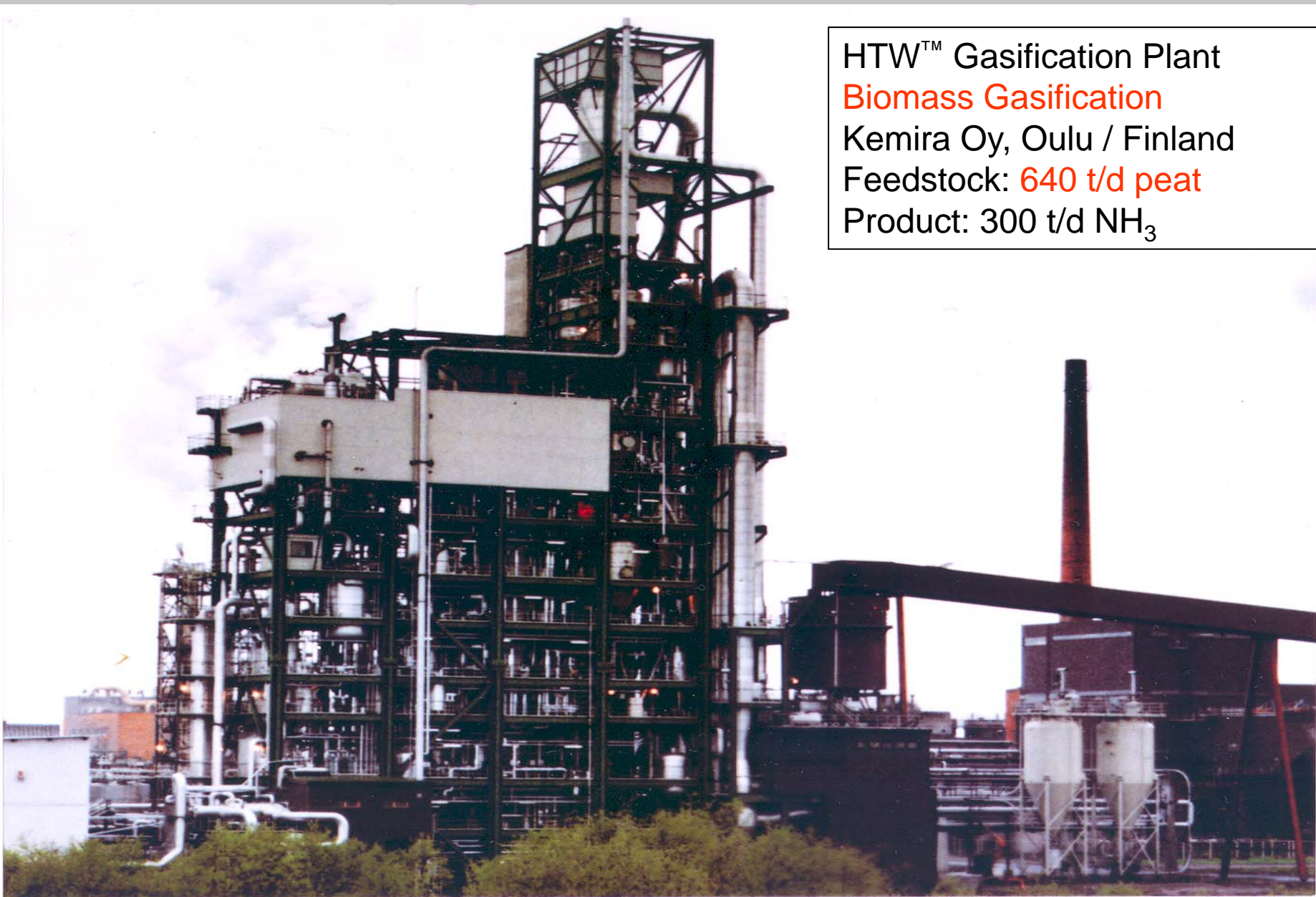
- 1) Lower-rank feedstocks
 - lignite, peat
 - coals with high ash content
- 2) Biomasses and wastes



HTW™ Gasification Plant
Berrenrath, Germany
Feedstock: **720 t/d lignite**
Pressure: **10 bar**
Product: 300 t/d methanol



Operating hours gasification
> 60,000



HTW™ Gasification Plant
Biomass Gasification
Kemira Oy, Oulu / Finland
Feedstock: 640 t/d peat
Product: 300 t/d NH₃

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Workshop Liquid Biofuels
04.11.2014
Ralf Abraham
Norbert Ullrich





HTW™ Waste Gasification
Sumitomo Heavy Industries Ltd.
Niihama / Japan
Feedstock:
20 t/d Household Waste

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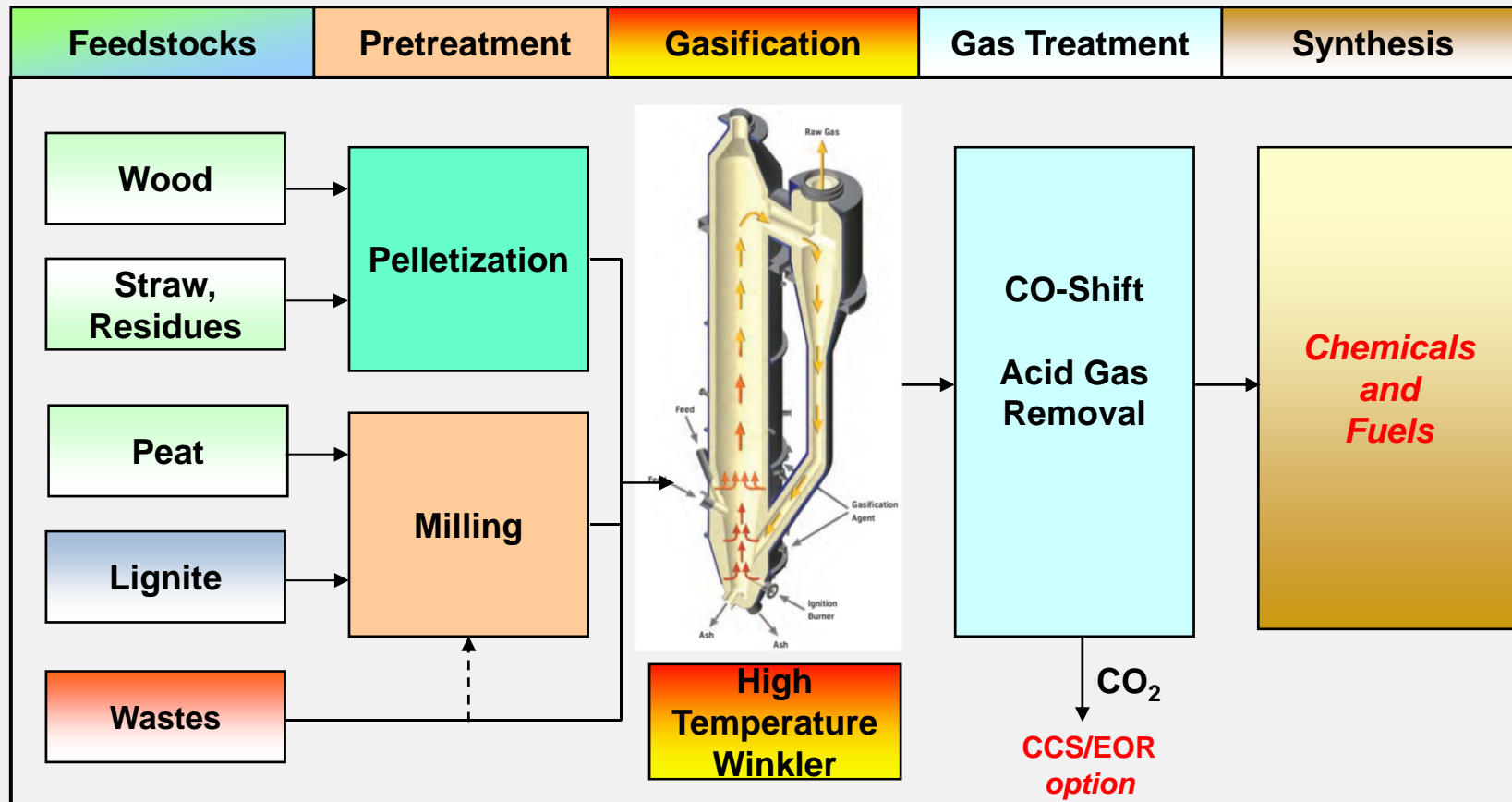
ThyssenKrupp
Industrial Solutions



ThyssenKrupp

HTW-Technology

Process Chain for Chemicals and Fuels



Co-feeding of lignite with biomass or waste has been demonstrated

HTW Demoplant Darmstadt

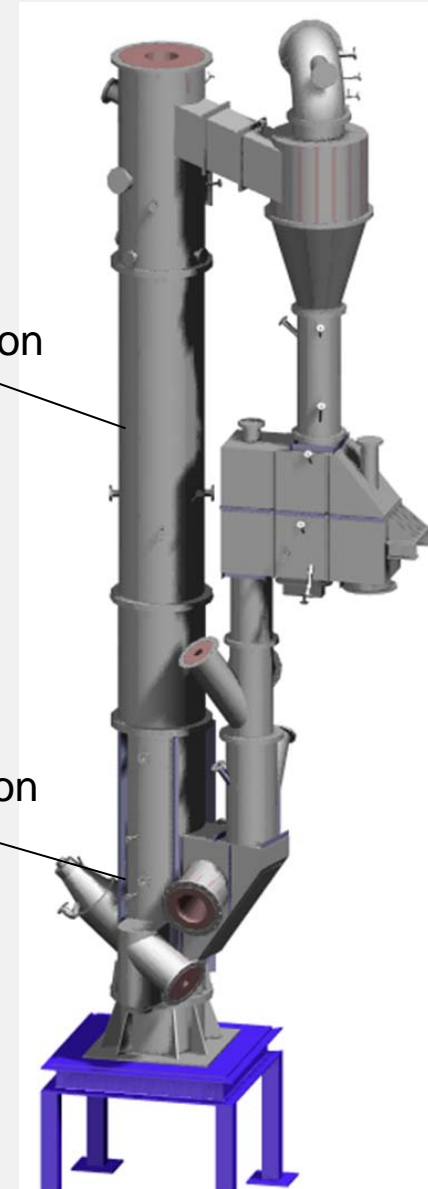
- Testplant already existing (former Test Gasifier from Foster Wheeler, Sweden, installed in Darmstadt for Carbonate and Chemical Looping)
- **Existing fluidized bed gasifier will be converted to HTW gasifier (stationary fluidized bed)**
- Capacity 100-200 kg/h (500 kW to 1 MW_{th})
- atm. pressure
- Scheduled Start up: Q1 2015

Will be used by TKIS for for gasification tests of different feed materials and different customers:

- Biomasses
- High ash brown coals
- Reactive hard coals with high ash melting point

Second gasification zone

Primary Gasification zone



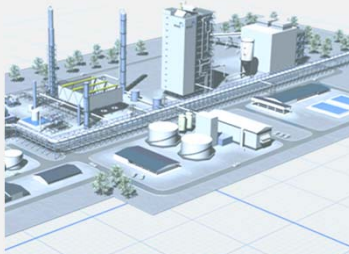
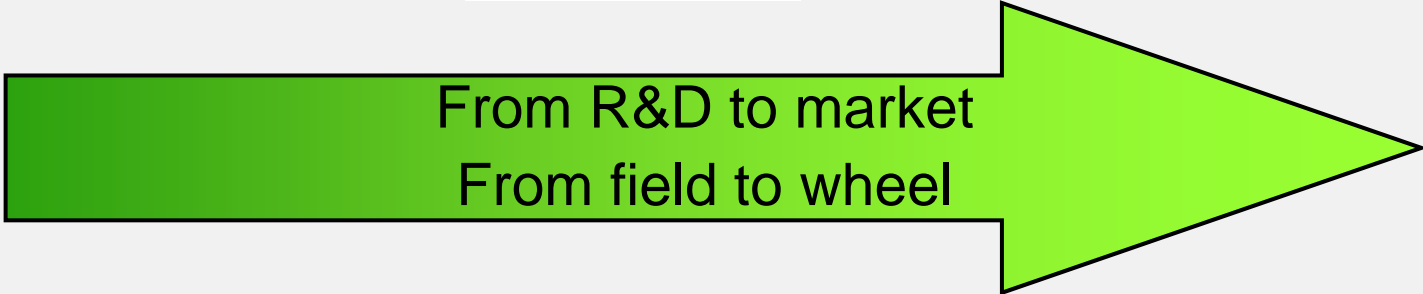
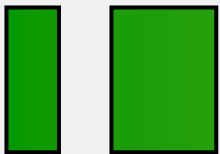
The B-XTL BioTfuel-Projekt

“Open innovation”: a consortium of partners with complementary core businesses

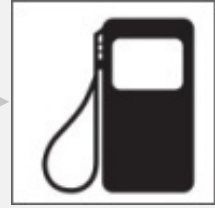
R&D

Technologies licensors

Fuels producers



Bio-diesel
Bio-jetfuel



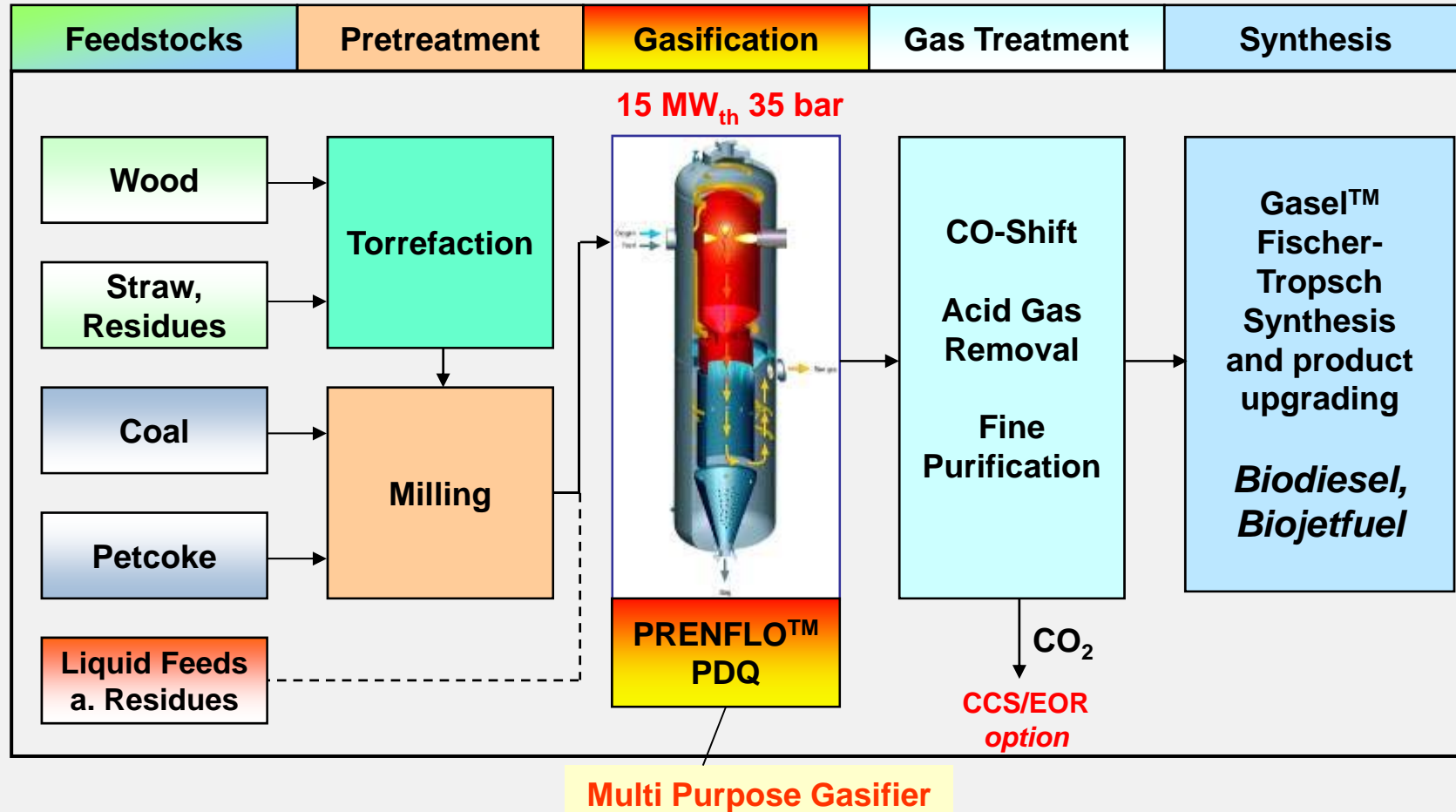
8 years partnership to realize a RD&D programme to develop a complete B-XTL process chain

ThyssenKrupp Industrial Solutions
Workshop Liquid Biofuels
04.11.2014
Ralf Abraham
Norbert Ullrich



BioTfuel-B-XTL Project

Process chain 2nd. Generation Biodiesel und Biojetfuel

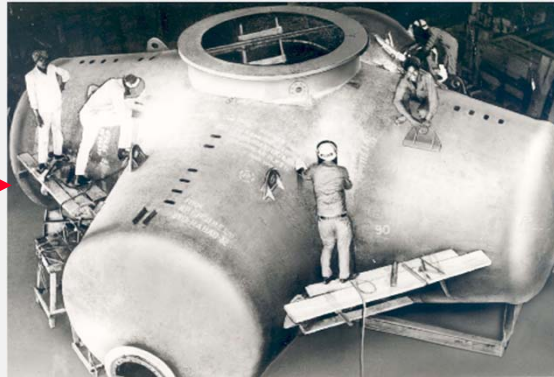


Development Stages from Koppers-Totzek to PRENFLO®

Start Up: 1998

More than 50 years of experience and optimisation

**PRENFLO IGCC
Puertollano 300 MWeI**



4-Head KT-Gasifier

Start Up: 1986

Scale Up Factor:
50

PRENFLO Fürstenhausen
48 t/d (3,500 m³n/h syngas)



Scale Up Factor:
8

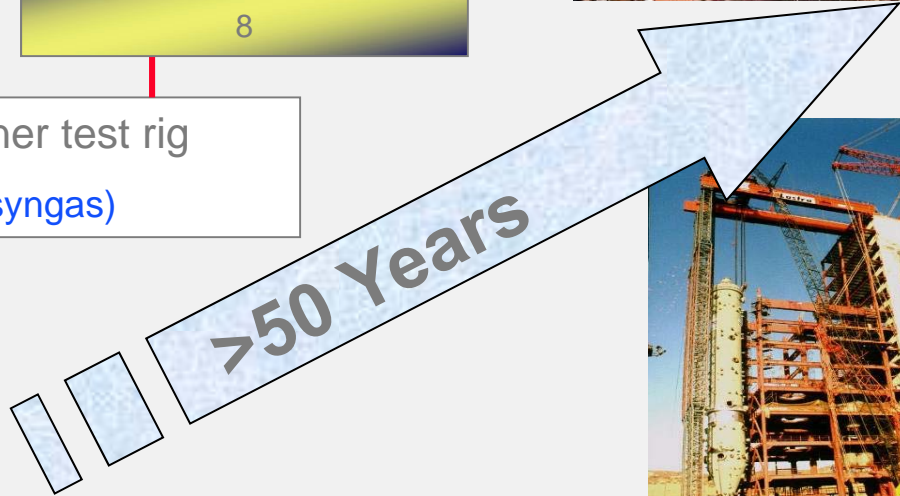
Start Up: 1984

PRENFLO burner test rig
6 t/d (450 m³n/h syngas)

Start Up: 1978

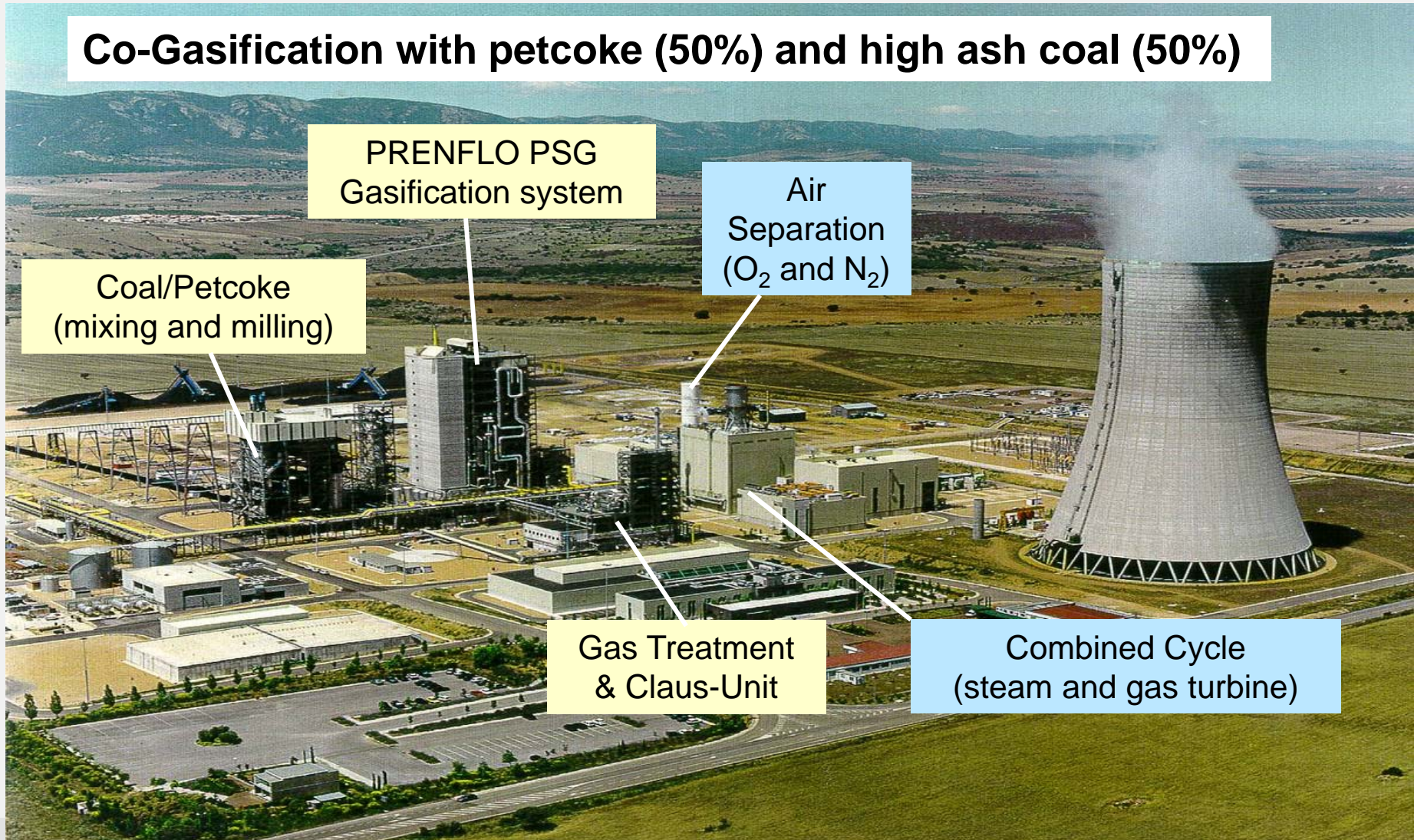
Shell-Koppers pilot plant
with 30 bar in Hamburg
150 t/d coal

Koppers-Totzek
Start of development 1941



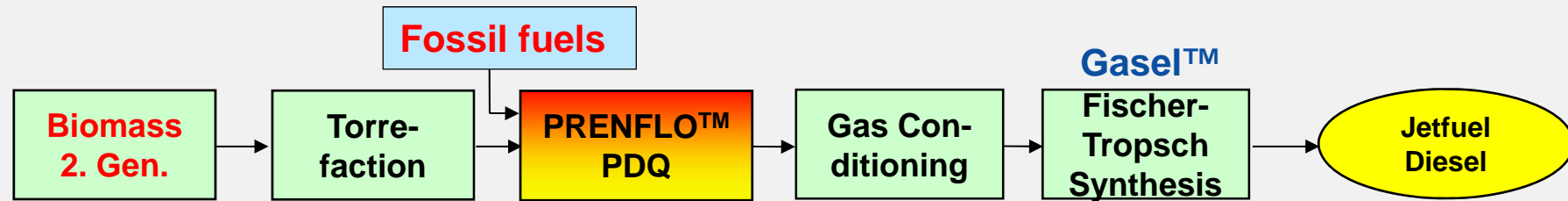
World's largest single-train IGCC (300 MWe) Elcogas IGCC Power Plant, Puertollano, Spain

Co-Gasification with petcoke (50%) and high ash coal (50%)



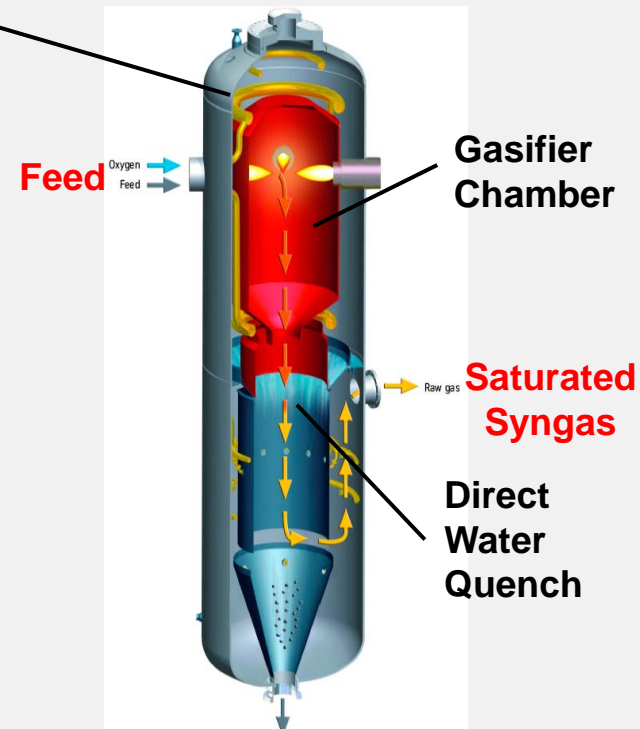
BioTfuel-Project

PRENFLO PDQ Integration in the BioTfuel process chain



PRENFLO PDQ Features

- Single-line capacity up to $>1,000 \text{ MW}_{\text{th}}$
- Dry powder feed (coal/biomass)
- Horizontal co-annular burners
- Long-life steam cooled reactor screen
- Direct water quench
- Compact gasification system



Multi Purpose Gasifier

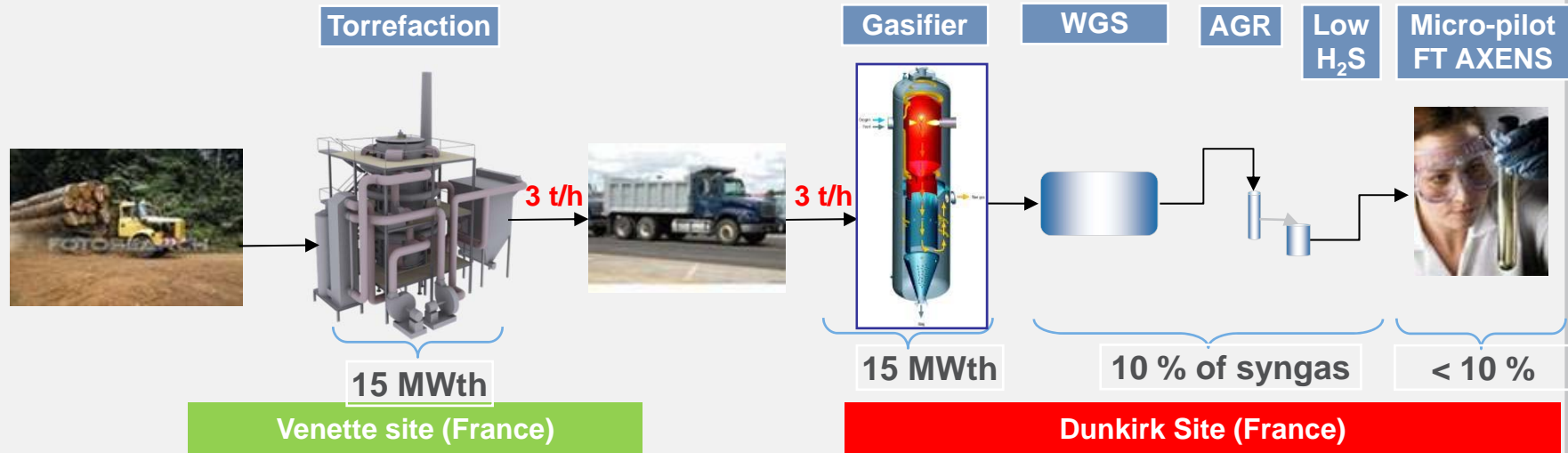
BioTfuel-Project

BioTfuel main figures & objectives

➤ BioTfuel demo plants:

- **Two multiple scale demo plants** will be located in France
 - to get scale-up data
 - to validate various scheme/configurations

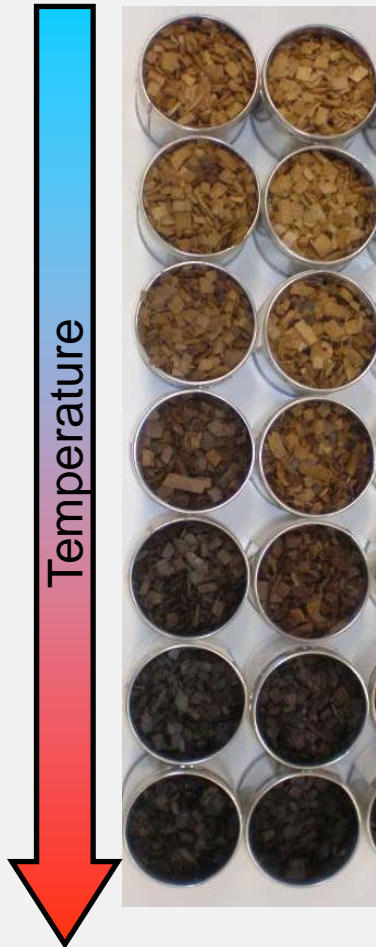
Demonstration



Multi scale demo plants (Plant Investment >100 M€)

Biomass Torrefaction - what does it mean? (Source: TKIS Resource Technologies)

< 220 °C → drying



> 300 °C exothermic reaction

Materials

- second generation biomass – wide range of properties
- soft and hard wood, straw, miscanthus, switch grass

Torrefaction Conditions and Requirements

Temperature Range: 220°C – 300°C, homogenous temperature distribution

Reaction: endothermic

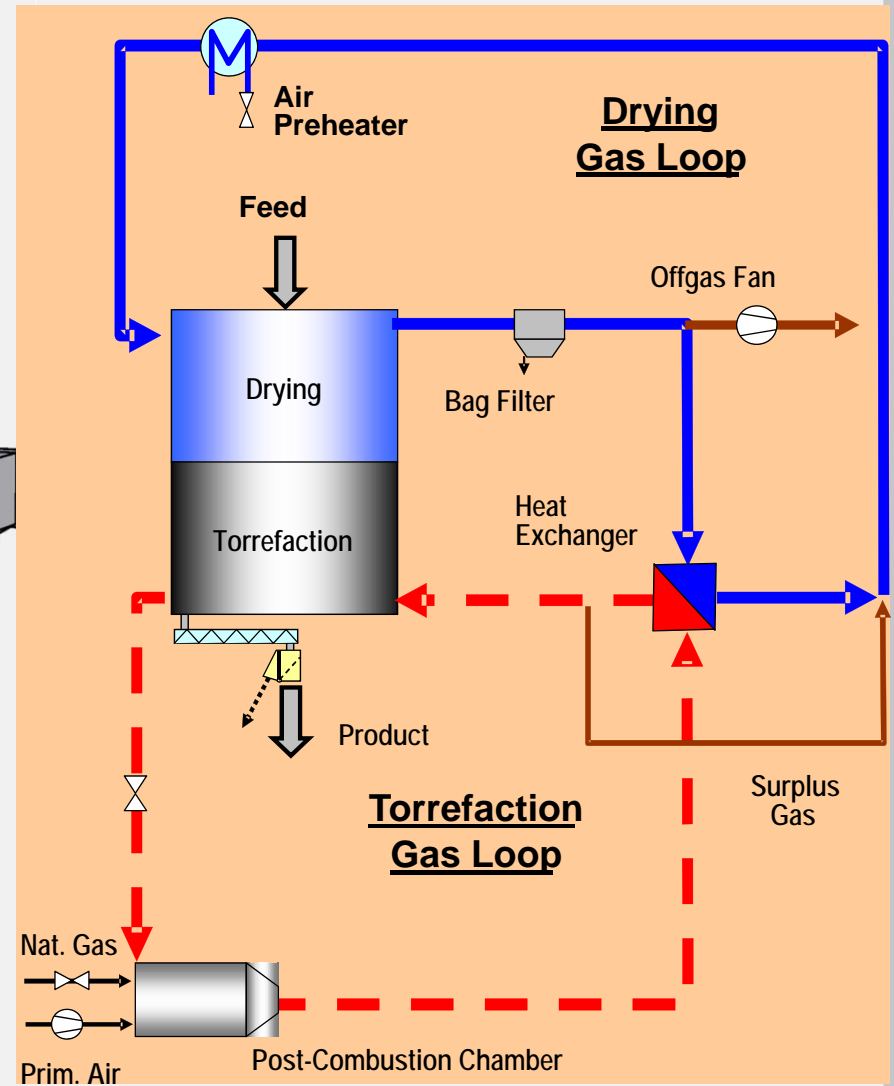
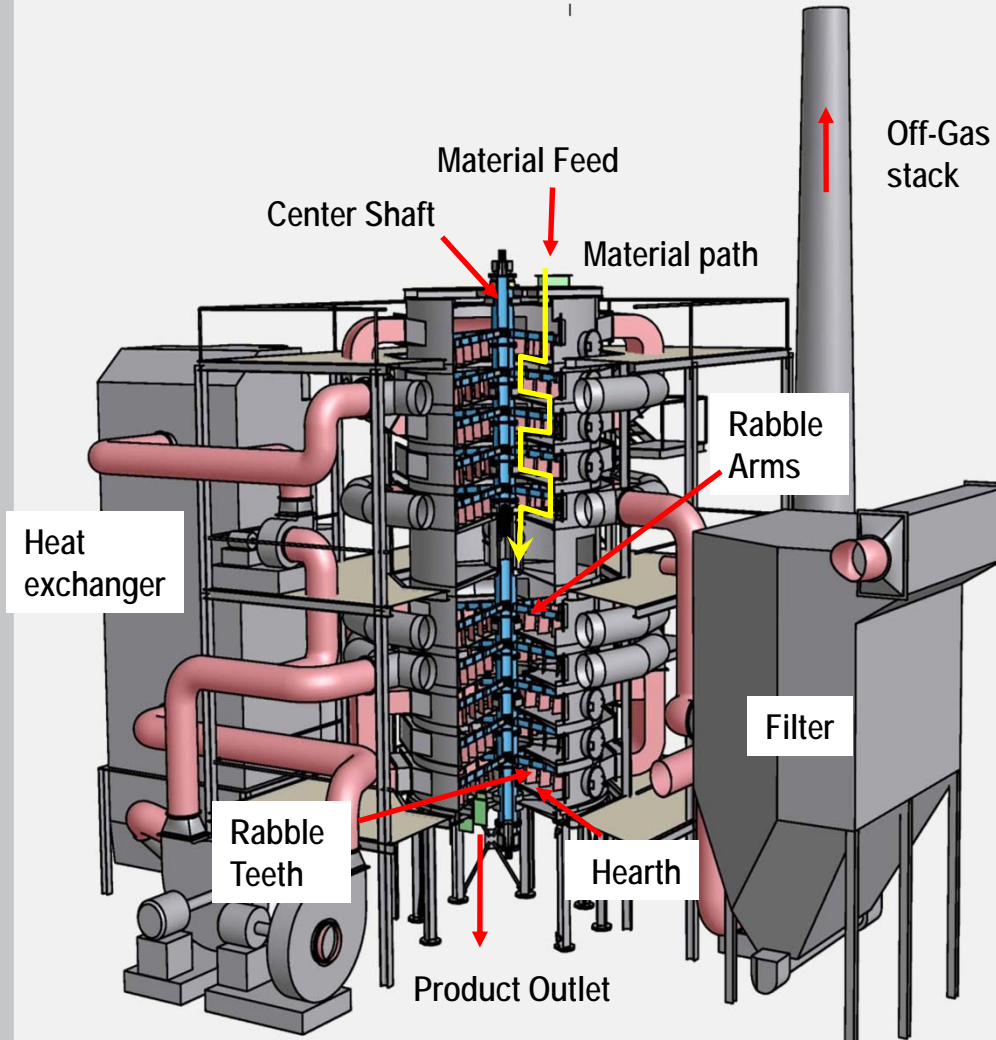
Material properties: pre-dried: ~ 3% moist., chips or pellets < 50mm

Process: continuous, variable retention time, inert, optimal mixing + heat exchange

Torrefaction Material Features

- Homogeneous product quality
- High energy density → adjustable 22 - 25 MJ/kg
- Grindability similar to coal → HGI > 50°
- Fluidisable → suitable for pneumatic transport
- No biogenic activity/Hydrophobic charac. → suitable for open storage
- Suitable for briquetting → lower costs for storing and transportation

Biomass Torrefaction - but how? → Source: TKIS Resource Technologies



Summary

- ThyssenKrupp Industrial Solutions has more than 70 years experience in gasification
- Thyssen Krupp Industrial Solutions can offer **different** gasification technologies **for Liquid Biofuels Solutions**
- ThyssenKrupp Industrial Solutions is a **technology provider** and **EPC contractor**
- One Megatrend is feedstock flexibility specially **with green fuels**
- **Co-generation** of different feedstocks will be one key for the future
- The **BioTfuel demonstration project objectives** are to develop, demonstrate and commercialize **a full B-XTL chain** for the production of biodiesel and biokerosene



Thank you for your attention



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PRENFLO Gasification Plant, Puertollano, Spain



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