


ThyssenKrupp Uhde's fluidised bed and entrained flow gasification technologies for biomass and coal

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ThyssenKrupp Uhde

ThyssenKrupp

Krupp Family

Recently, we celebrated round numbers:

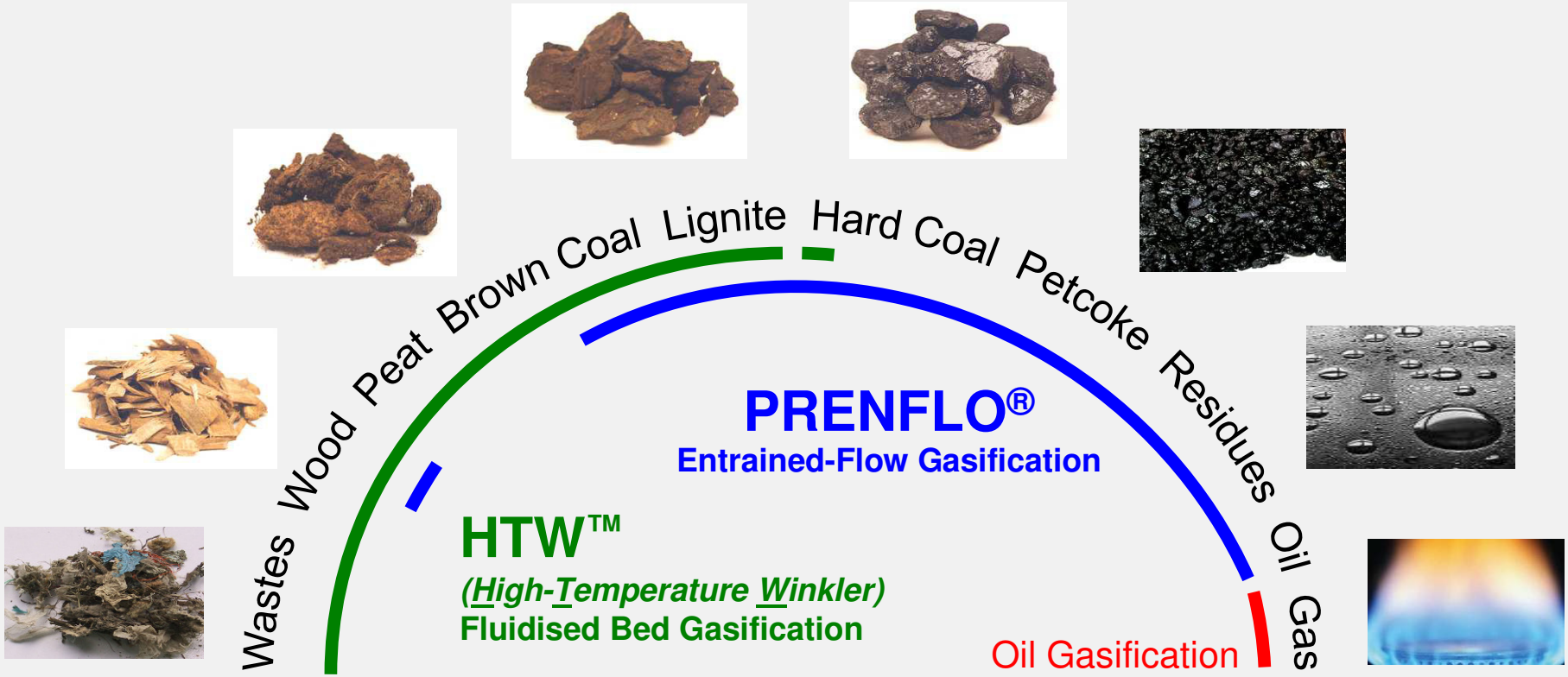
- **200 years** ago: Krupp founded in 1811
- **140 years** ago: Thyssen founded in 1871
- **90 years** ago: Uhde founded in 1921
- **70 years** ago: Entrained-Flow Gasification Koppers-Totzek invented in 1941

Other round numbers...

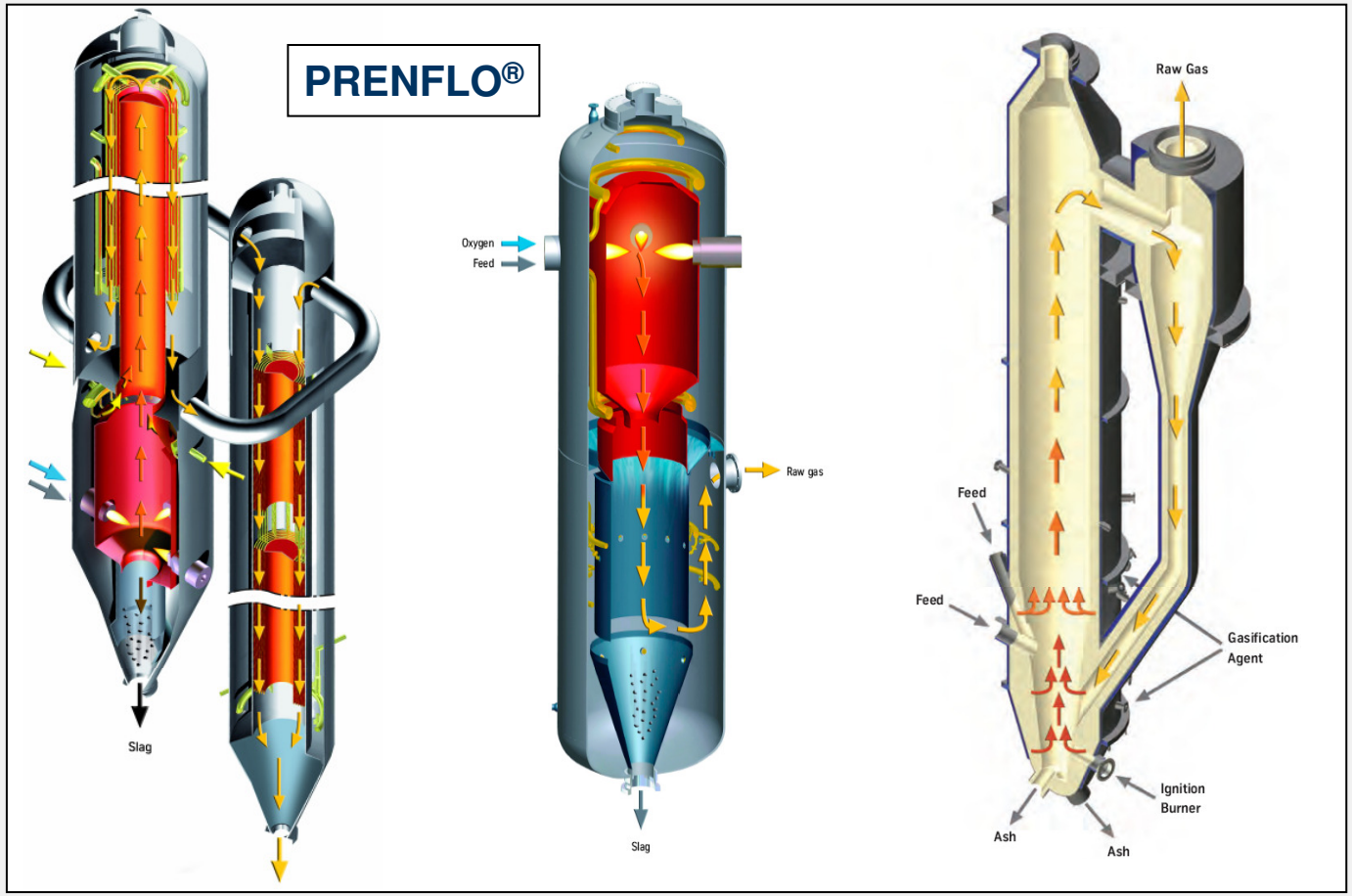
- **Over 100 gasifiers** put into successful operation by Uhde
- **Over 170,000 ThyssenKrupp colleagues** worldwide

Different Feedstocks require Different Gasification Technology

ThyssenKrupp Uhde‘s Gasification Portfolio



ThyssenKrupp Uhde's *Proprietary* Gasification Technologies



PSG **PDQ**

Entrained-Flow

HTW™

Fluidised Bed

ThyssenKrupp Uhde's firsts in Coal Gasification:

- 1909: first Koppers Gas Generators (a total of 536 built)
- **1941: Invention of first Entrained-Flow Gasification:**
  - **Koppers-Totzek:** dry-fed, membrane wall, multiple burners
- **Development, Design and Construction of**
  - **first Koppers-Totzek** Coal Gasification Plant
  - **first Rummel-Otto** Slag Bath Coal Gasification Plant
  - **first Saarberg-Otto** Coal Gasification Plant
  - **first Texaco (GE) Coal** Gasification Plant
  - **first HTW** Coal Gasification Plant
  - **first Shell-Koppers** Coal Gasification Plant
  - **first PRENFLO** Coal Gasification Plant

BioTfueL Project

Axens
IFP Group Technologies

cea
energie atomique • energies alternatives

ifp Energies nouvelles

Sofiprotéol,
l'engagement
durable

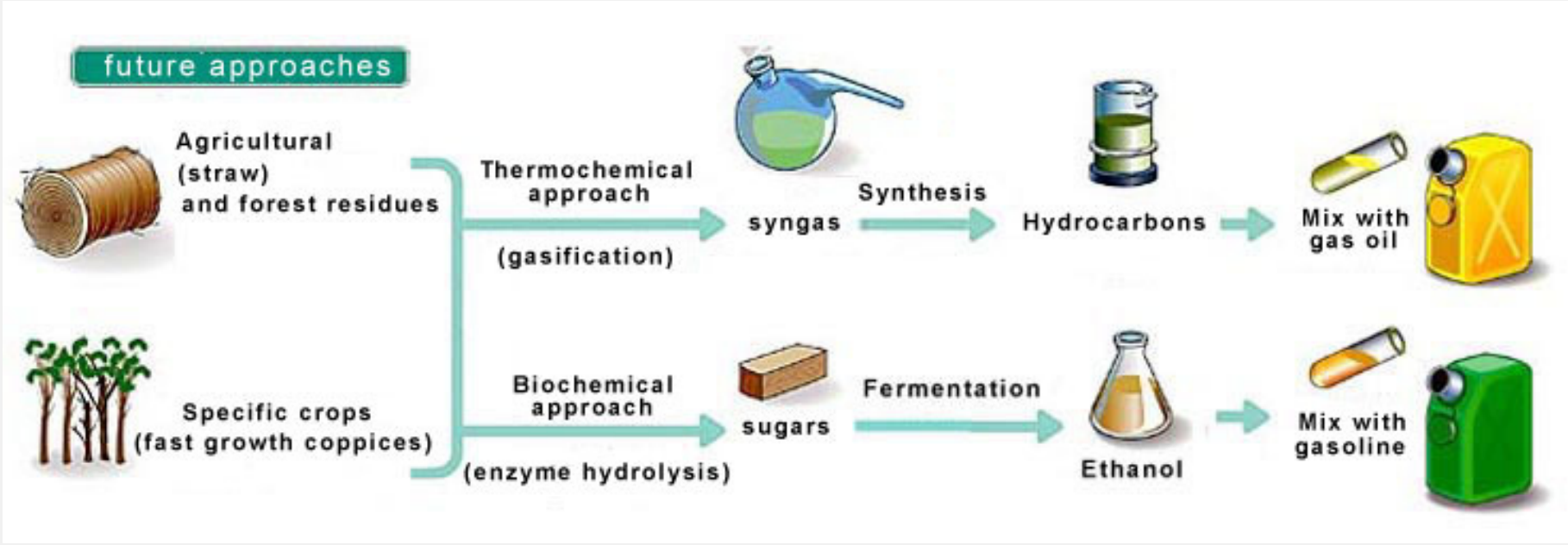
TOTAL

ThyssenKrupp

ThyssenKrupp Uhde

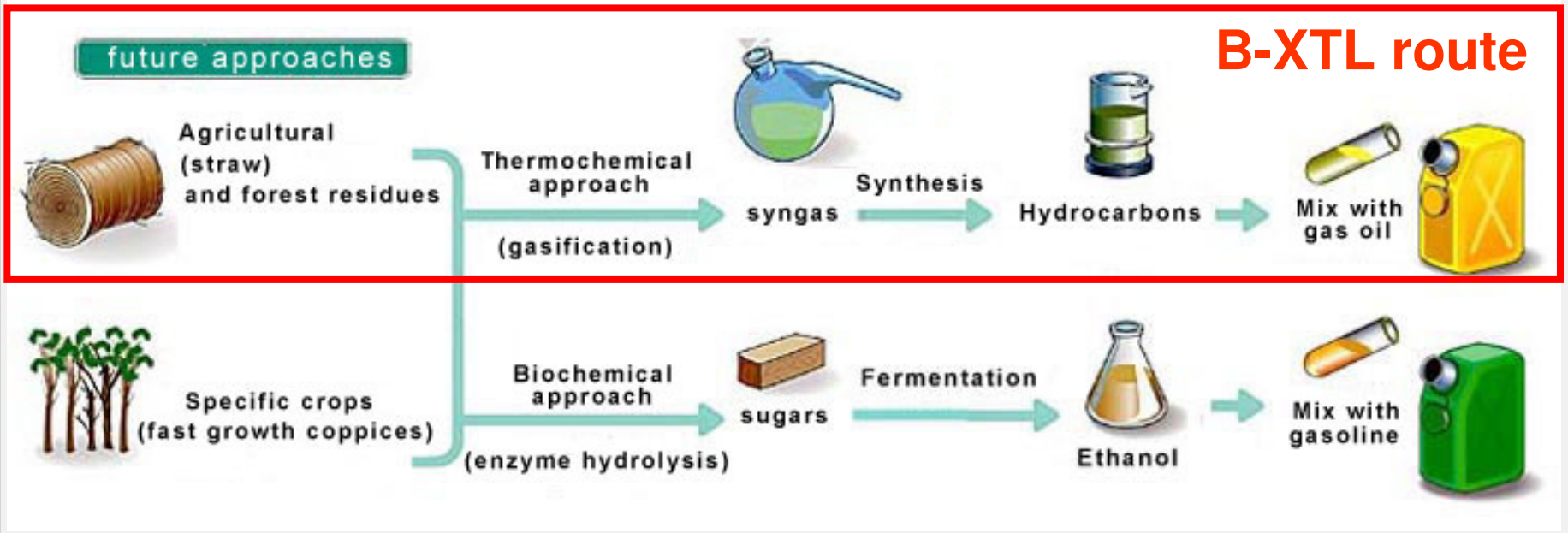
2nd generation Biofuels: the B-XTL route

Fuels and base chemicals from syngas

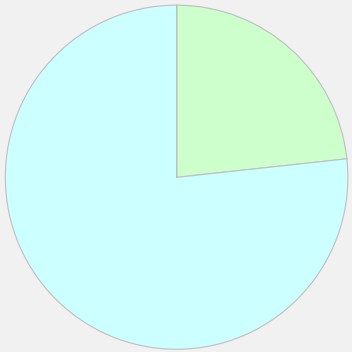


2nd generation Biofuels: the B-XTL route

Fuels and base chemicals from syngas

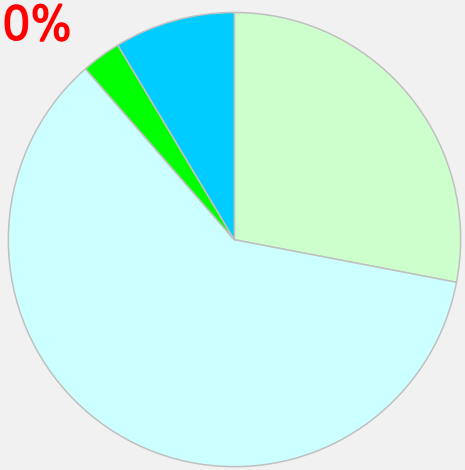


Fuels and policy context: Biofuels market prospective



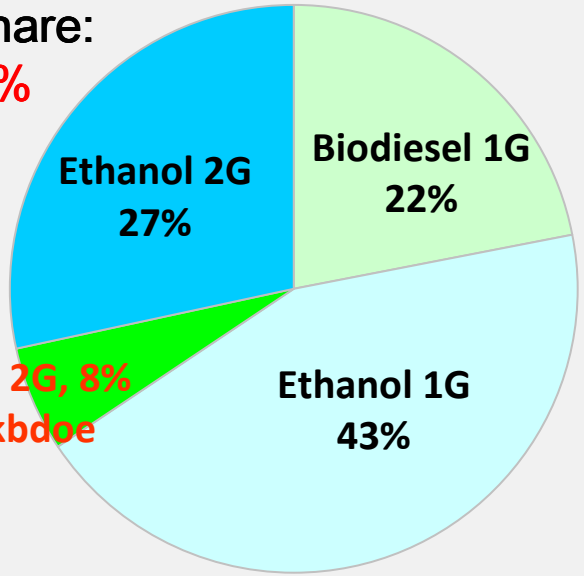
~ 1 Mbdoe
(2010)

2G-Share:
10%



~ 2 Mbdoe
(2020)

2G-Share:
35%



~ 3.5 Mbdoe
(2030)

1G-Biodiesel
1G-Ethanol
2G-Biodiesel
2G-Ethanol

~ 300 kbdoe
2G-Biodiesel / Aviation Fuel

Mbdoe = Million barrel oil equivalent per day
Source: Axens estimates

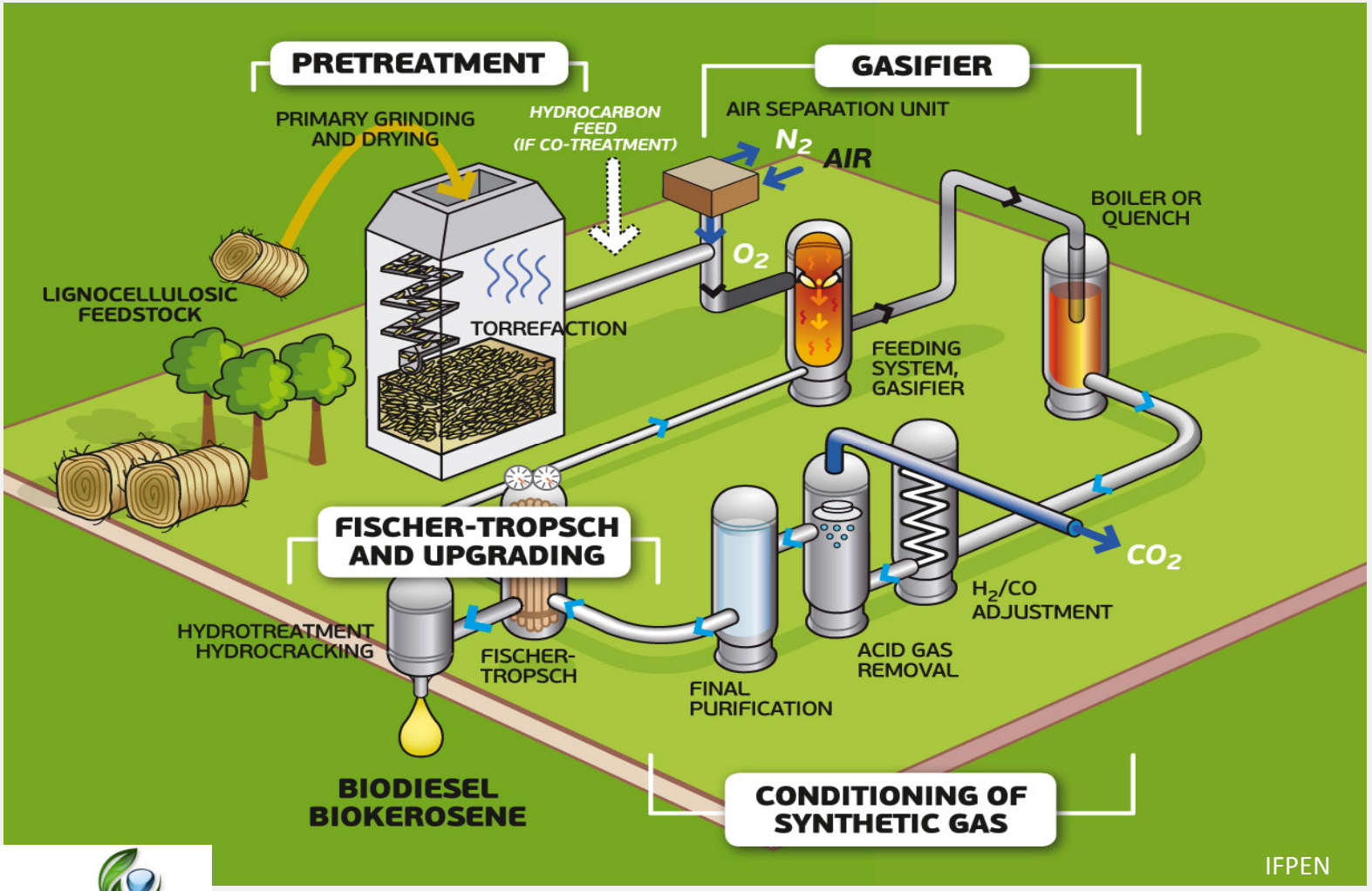
BioTfueL - a consortium of partners with complementary core businesses...

R&D	Technologies licensors	Fuels producers

From R&D to market
From field to wheel

Development and Demonstration of a complete B-XTL process chain

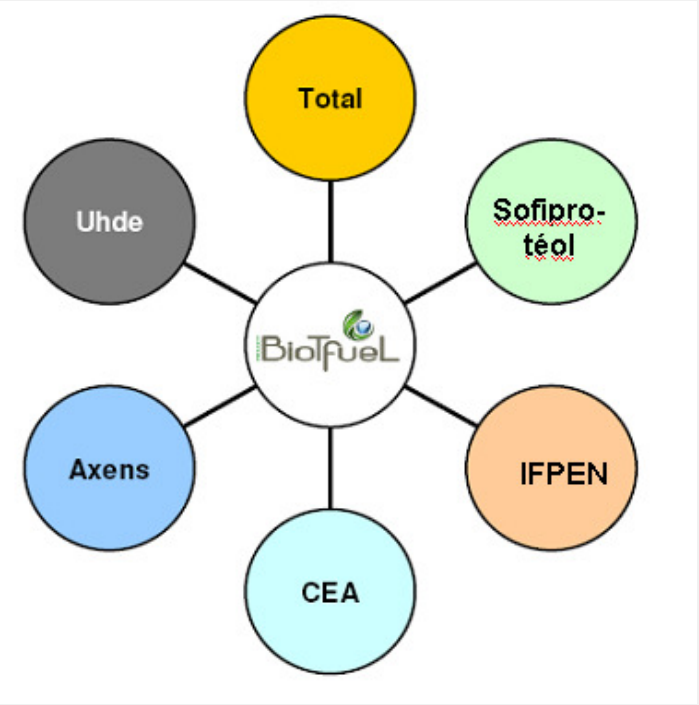
BioTfueL: 2nd Generation bio-diesel and bio-jetfuel process chain



PROJECT BioTfueL

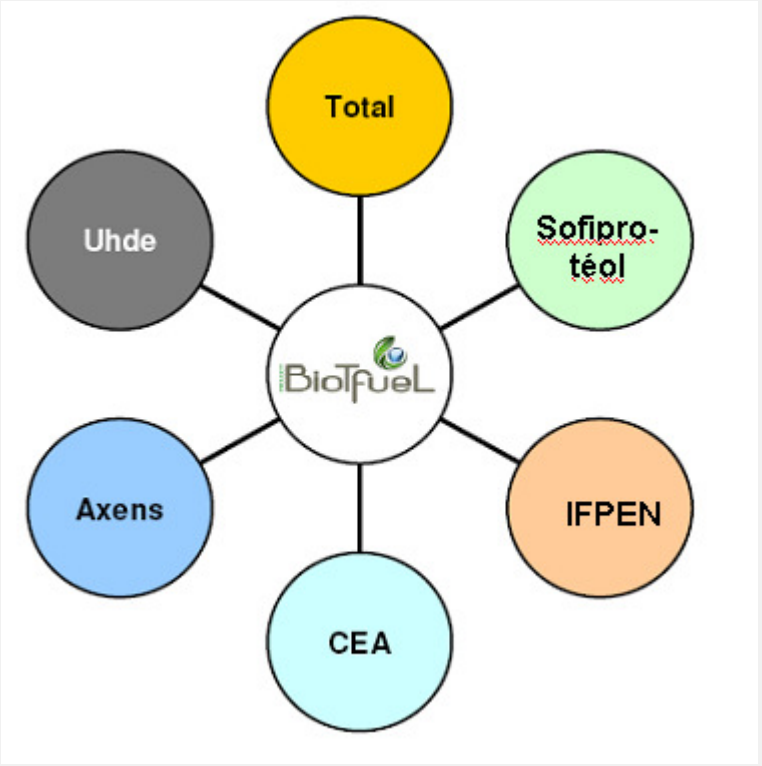
BioTfueL main figures & objectives

- **BioTfueL objectives:**
  - Develop, demonstrate and commercialize a full B-XTL chain
    - flexible to the widest range of feedstock (solid & liquid, bio & fossil)
    - reliable
    - economically and environmentally competitive
  - Realize the complete integration of the various processes and utilities of the B-XTL process chain
    - Process Book elaboration for industrial plant
  - Validation of the sustainability criteria
    - Life Cycle and multi-criteria Analyses



BioTfueL main figures & objectives

- **BioTfueL project:**
  - **7** years programme [2010- 2016]
    - R&D = 7 years
    - EPC = 2 years
    - Test programs = 4 years
  - **6** partners
  - **2** sites for demo plants
    - Sofiprotéol Venette site
    - Total Dunkirk site
  - Budget = **112.7 M€**
    - Project Subsidies: 33.3 M€
      - ADEME: 30.1 M€
      - CRP: 3.2 M€



BioTfueL Locations

Dunkerque

Compiègne

2nd generation Biofuels: the B-XTL route

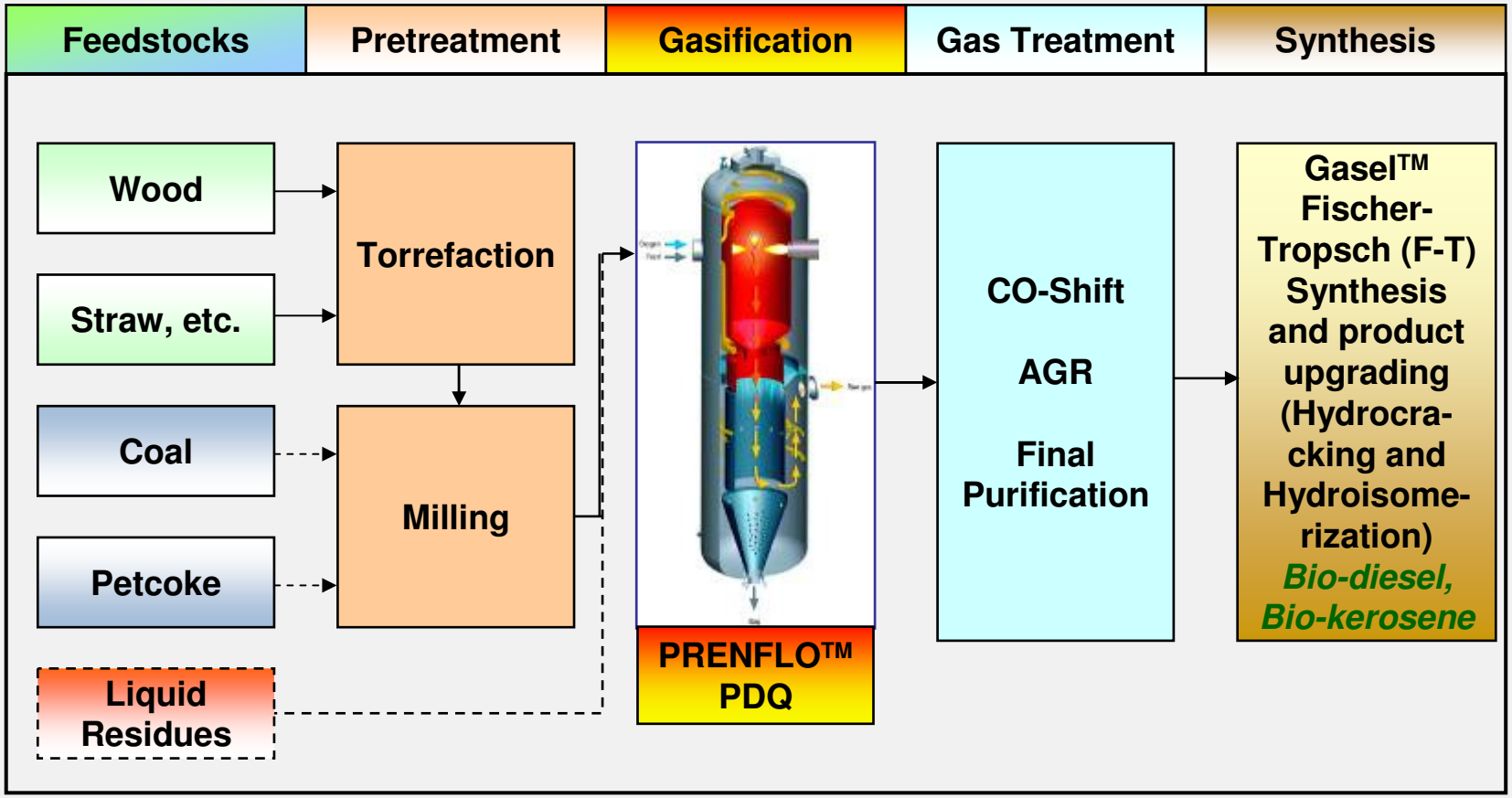
- **B-XTL route (B = Biomass, X = Fossil FueL):**
  - Biomass availability fluctuates (quality, quantity)
  - Biomass collect in huge quantities (Mt/yr) is a challenge
  - High plants Stream Factors ⇒ final product cost reduction
  - King size plants ⇒ final product cost reduction

⇒ **Co-processing is a good opportunity**

Green carbon is introduced upstream the chain,
GHG reduction **> 90%** for the green part of the product

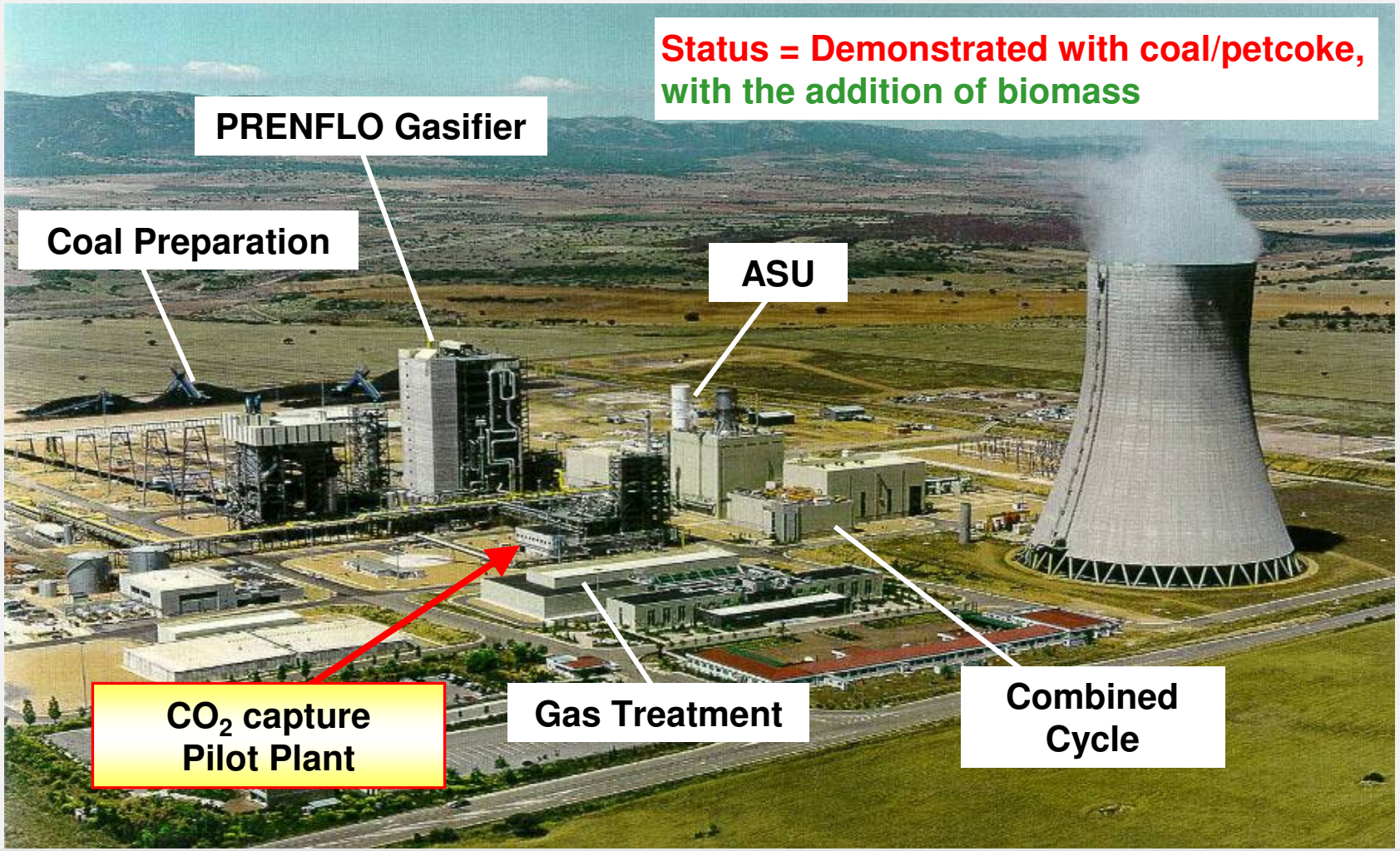
2nd generation Biofuels: BioTfueL B-XTL process chain

Integrated Process Chain for the Production of Second Generation Synthetic Biofuels



World‘s largest single-train coal/coke IGCC, 300 MWel: PRENFLO Gasification Elcogas, Puertollano, Spain

Feedstock: petcoke / coal, with addition of biomass

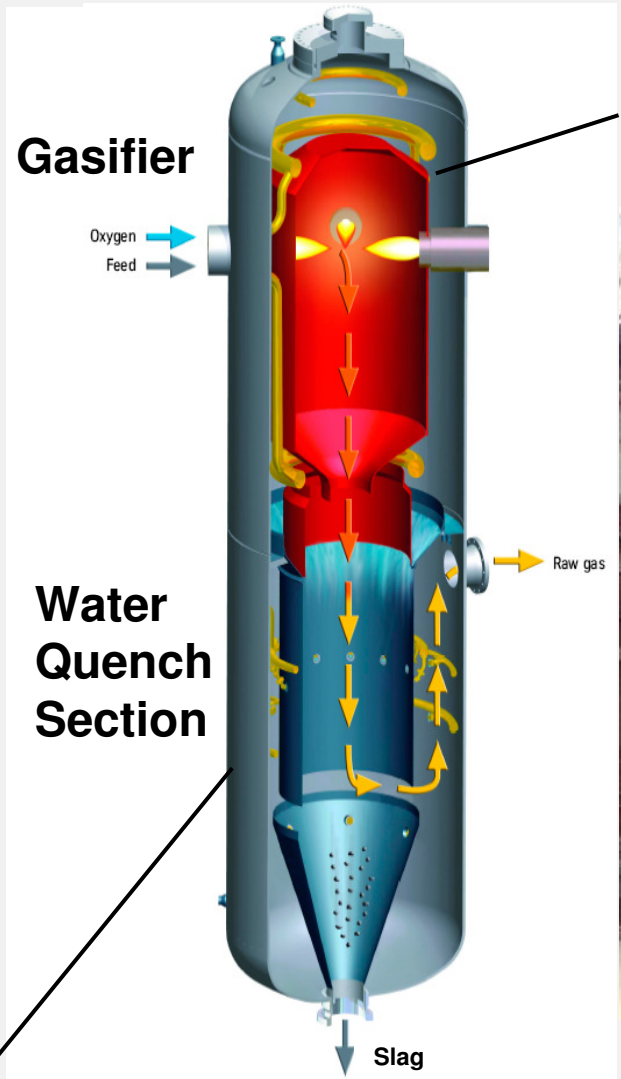


BioTfueL Technologies

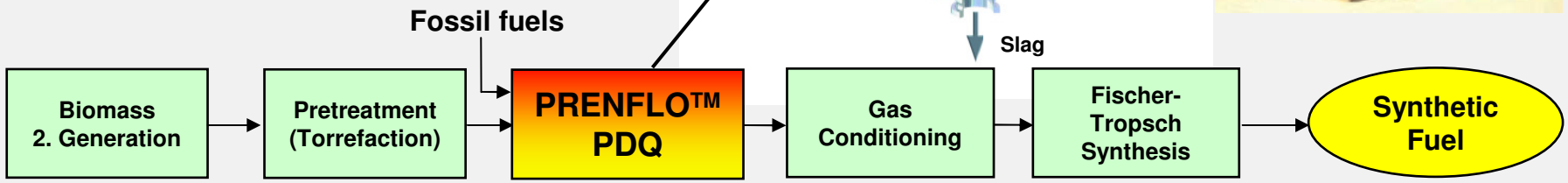
PRENFLO
with Direct Quench
1.200 MW_{th}, 42 bar

PRENFLO PDQ Features

- dry powder feed (coal/biomass)
- 4 horizontal co-annular burners
- membrane wall
- direct water quench
- operation pressure flexible to requirements (25 - 42 bar)
- raw gas temperature outlet of quench (200 - 250 °C)
- compact gasification system with low plant investment

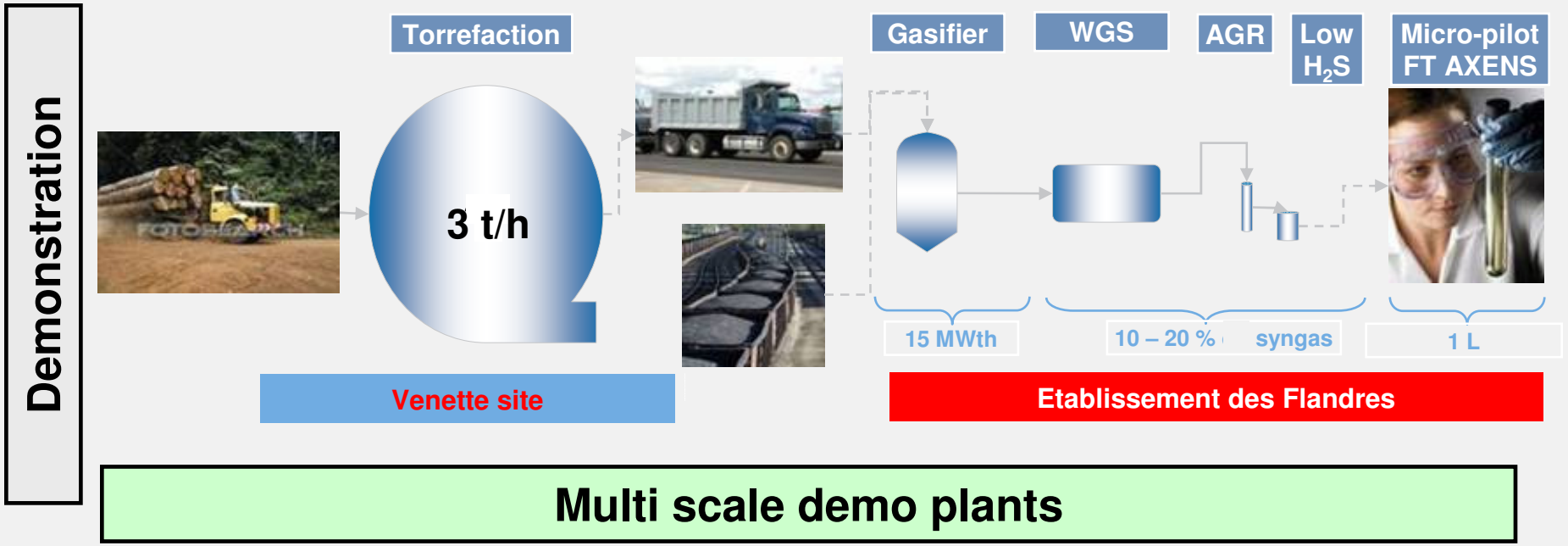


PDQ



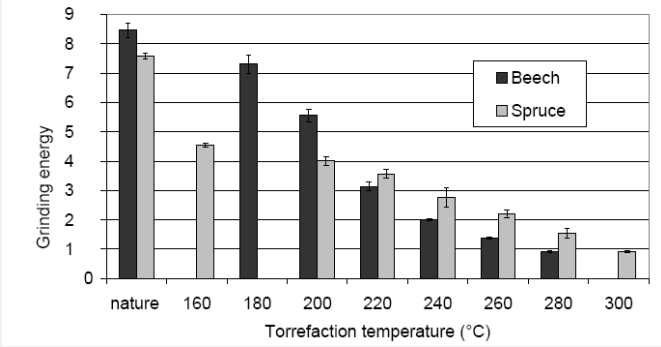
BioTfueL main figures & objectives

- **BioTfueL demo plants:**
  - Multiple scale demo plants
    - to get scale-up data
    - to validate various scheme/configurations



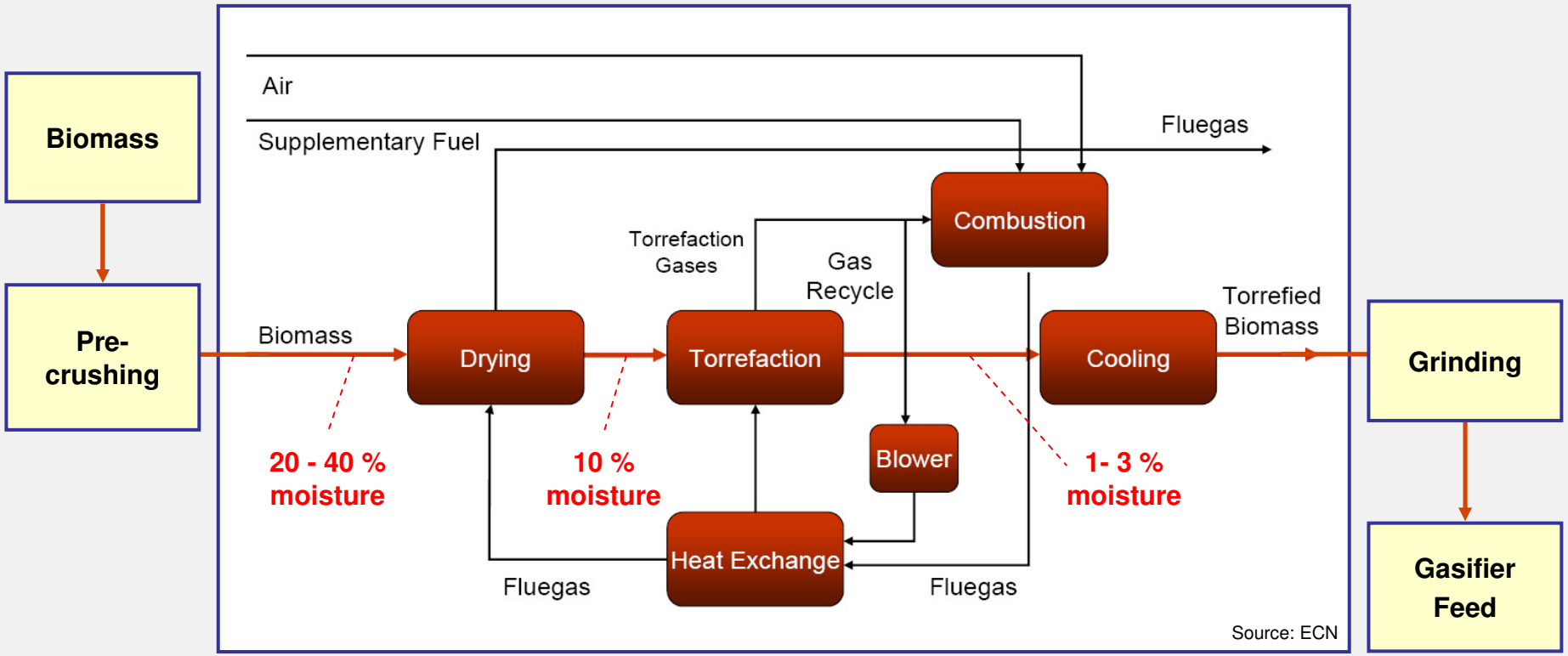
BioTfueL Technologies

- **Biomass feedstock preparation:**
  - **Torrefaction**
    - ⇒ Improvement of feedstock properties for
      - fluidization
      - pneumatic transport
      - grindability with lower energy consumption
      - storage & transport (up to 800 kg/m³) + enhanced energy content
    - ⇒ Moderate process conditions
      - [250 – 300 °C]
      - ≈ atmospheric pressure



BioTfueL Technologies

➢ Biomass feedstock preparation: Technology Route - Torrefaction



Summary BioTfueL Project

- The BioTfueL objectives are to develop, demonstrate and commercialize a full B-XTL chain
- The BioTfueL project combines the strength of 6 companies
- The BioTfueL project allows to give full performance guarantees for the complete chain from biomass to jet fuel and Diesel
- Gasification and Fischer-Tropsch are proven technologies and allow flexibility in feedstock
- First industrial B-XTL plants will have a capacity of 5.000 bbl/day (200 kt/yr) in one single train

Commercial-Scale HTW Coal to Methanol Plant

Berrenrath, Germany

Operating results

Capacity: 140 MW_{th}; 10 bar

- smooth, reliable gasifier operation
- successful component test program (**CTP**) for IGCC application
- 67,000 h of operation
- methanol production 800,000 t
- average **plant availability** over 10 years:

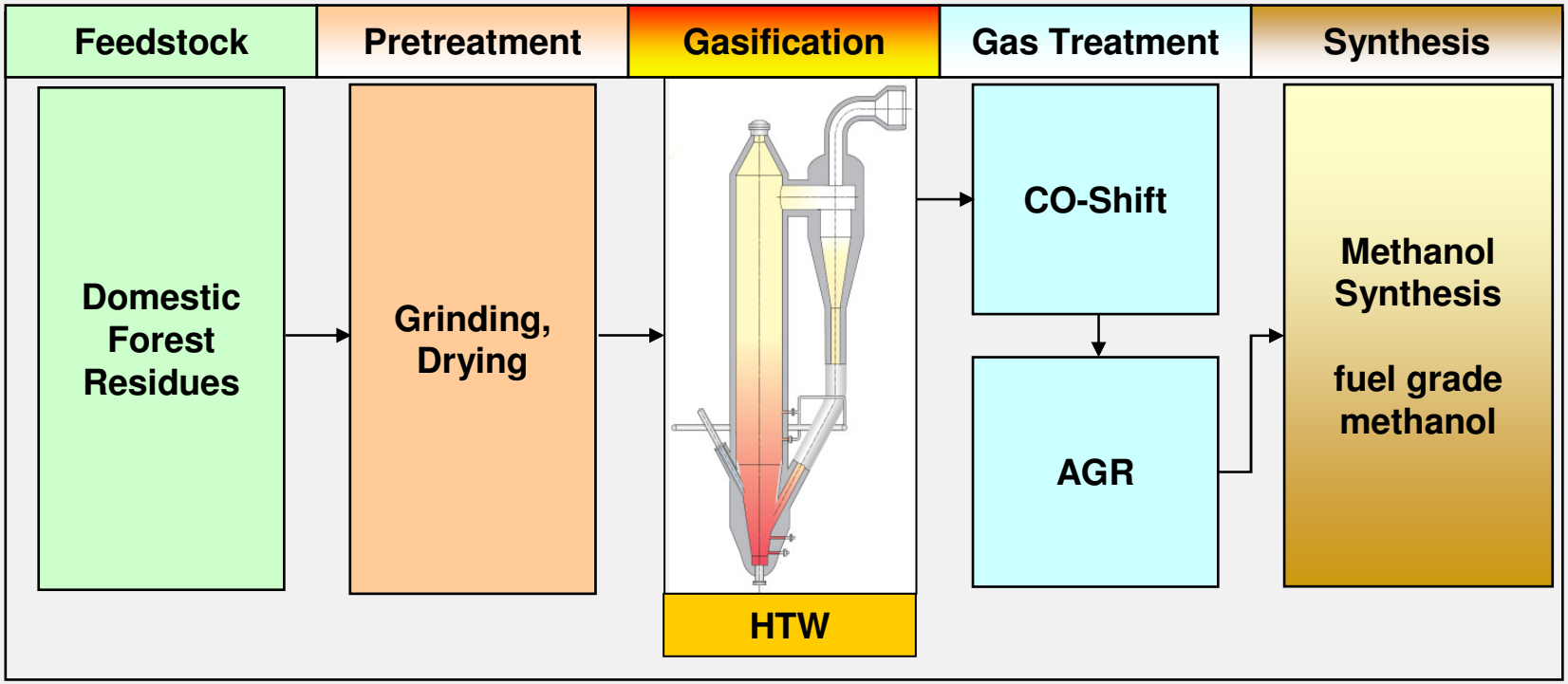
  ~ 85 %

  best year:

  > 91 % (>8,000 h)

VärmlandsMetanol AB

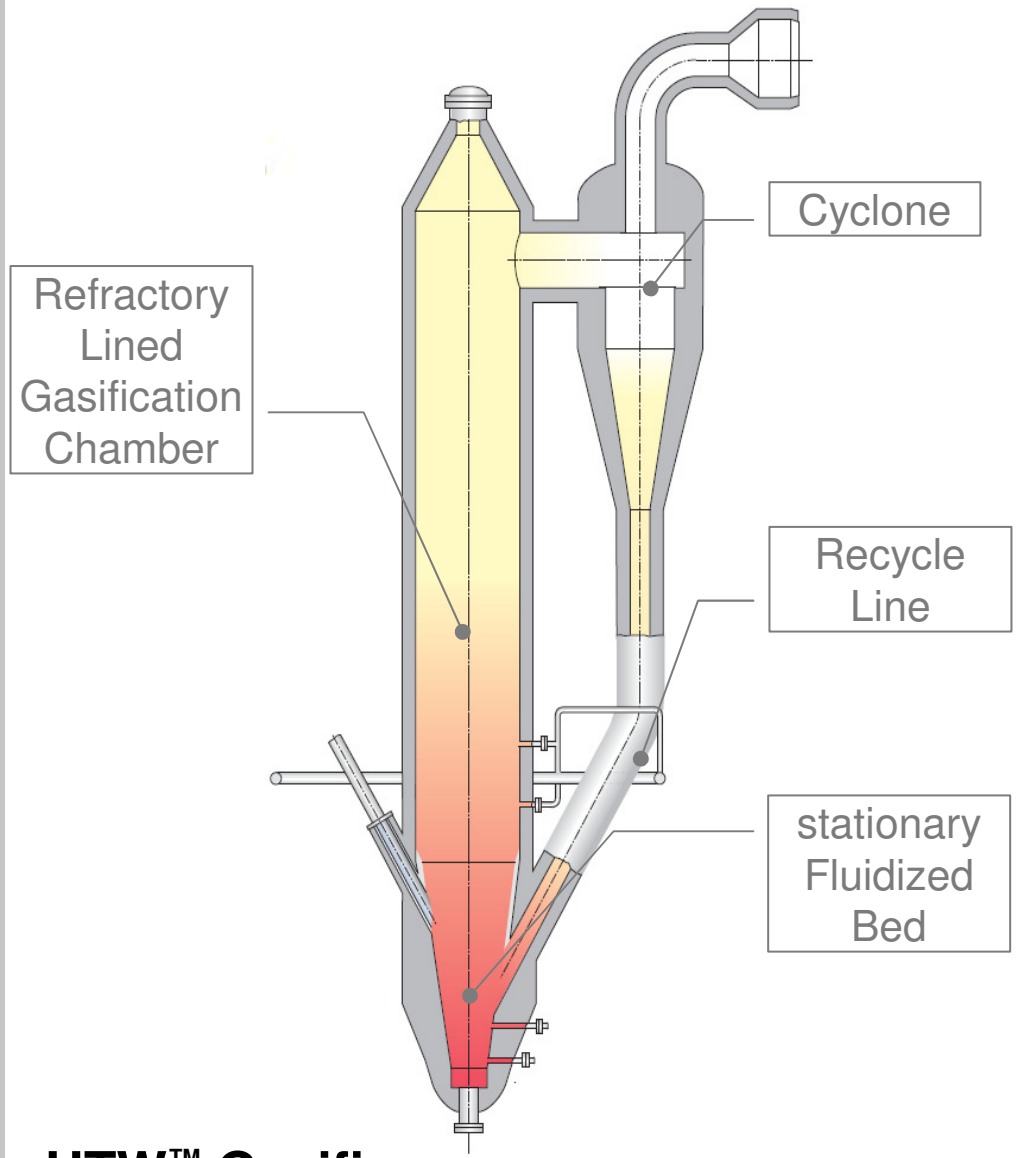
Integrated Process Chain for the Production of Bio-Methanol



Biomass to Methanol, VärmlandsMetanol, Sweden

applying HTW Fluidised Bed Gasification

HTW™



HTW™ Gasifier

HTW™ Gasification Rt1

- Pressurised, fluidised bed
- Temperature: 800 - 1000 °C
- Pressure: 10 - 30 bar
- Operates below ash melting point (ideal for coals with high ash melting point, biomass, lignite, waste)

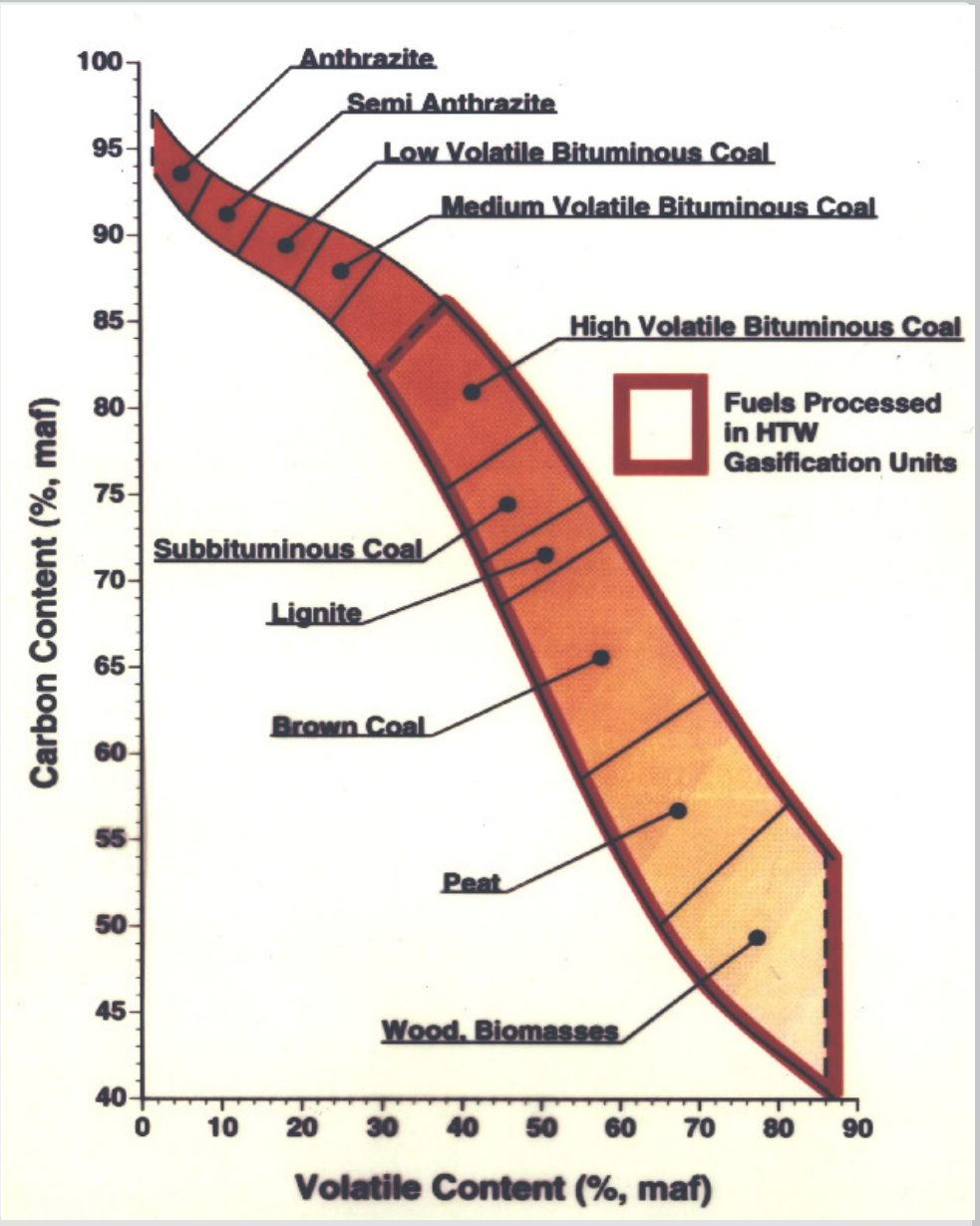
Current VärmlandsMetanol Project, Sweden:

- Biomass to Methanol plant
- Feedstock:
  Domestic forest residue
- Grain size:
  < 4mm for biomass

Slide 25

Rt1 Karsten Rick Radtke; 01.10.11

Solid Feedstocks operated in HTW™ Gasification



VärmlandsMetanol, Sweden
HTW Biomass to Methanol Project

Uhde selected as technology supplier and EPC contractor

Plant Capacity:

100,000 t/a of fuel grade methanol + district-heating 15 MW_{th}

Feedstock:

Domestic forest residue, ~25 t/h

Process:

Fluidized bed gasification (HTW)

(eq. 111 MW_{th})

VärmlandsMetanol AB

Key Project Differentiators

BioTfueL Project:

- Project target: to develop a **complete B-XTL chain**, converting biomass into renewables-based fuels
- The **PRENFLO PDQ entrained-flow** gasifier is designed as **multi feedstock gasifier** with the ability to simultaneously gasify biomass, coal, petcoke, liquid vacuum residues and Fischer-Tropsch recycle gases

VärmlandsMetanol Project:

- Project target: to produce **fuel grade bio-methanol** used as liquid motor fuel substituting fossil fuels
- The **HTW fluidized bed** gasification has a capacity of 111 MW_{th} and uses domestic **forest residue** to produce 100,000 t/a of fuel grade methanol

Many thanks for Your attention!

PRENFLO Gasification Plant
Puertollano, Spain
October 2012

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