

# Fast Pyrolysis Bio-Oil Technology and Production



*Your Sustainable Alternative*

**Technip**  
*take it further.*

**btg-btl**  
*biomass-to-liquid*

The logo graphic for btg-btl consists of a stylized green leaf with a dark brown drop at its base, representing biomass and liquid production.

# Fast Pyrolysis Bio-Oil Technology and Production



*Gerhard Muggen (BTG-BTL)*

**WBA Webinar**

**31<sup>st</sup> of January, 2017**

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# 1. Pyrolysis Technology



What  
Why  
How  
?



# 1.1: What is pyrolysis?



## ➤ Thermal cracking of organic material in the absence of oxygen

- Main Product = Liquid Bio-oil

- Process conditions:

T = 400 - 600 °C

P = atmospheric

- By products:

Heat (Steam)

Power (Electricity)

## ➤ Works with most lignocellulosic (non-edible) feedstocks

- Wood chips, sugar cane bagasse, straw, sunflower husk, etc.

### Typical Pyrolysis Oil Characteristics

Composition	$C_2H_5O_2$
Density	1100 - 1200 kg/m <sup>3</sup>
Heating value	17 - 20 GJ/m <sup>3</sup>
• Water content	20 - 30 wt. %
• Ash	< 0.1 wt. %
• Acidity (pH)	2.5 - 3

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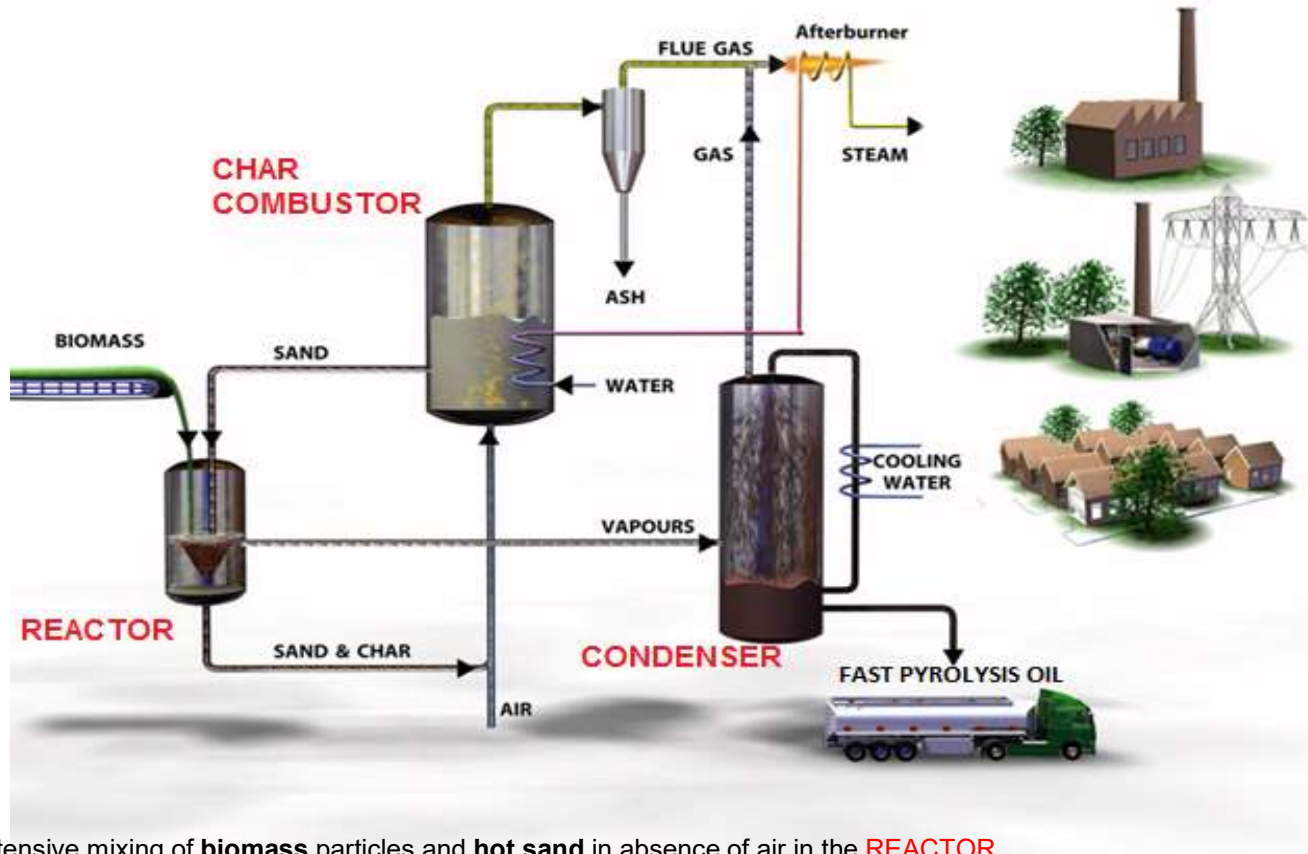
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## 1.2: Why pyrolysis?

- Decouple biomass resource from location and scale of application
- Works with a variety of biomass feedstocks
- Yields a homogeneous, 2<sup>nd</sup> generation liquid, that serves as a sustainable alternative to fossil fuels
- Produces bio-oil which is easier to store and transport due to significant volume reduction of solid biomass of about 12 on average
- High overall efficiency of ~ 85%: Conversion of biomass to main & by- products
- Versatile application: Heat, power and transportation fuels
- Utilize existing fossil fuel infrastructure:
  - Pyrolysis oil provides a viable link between the agriculture and (petro-) chemical industry.
  - Renewable feedstock for petrochemical industry in the production **second generation biofuels**



## 1.3: Fast Pyrolysis Bio-Oil Process



- Intensive mixing of **biomass** particles and **hot sand** in absence of air in the **REACTOR**
- **char** and **sand** are recycled to a **COMBUSTOR** where the char is burned to reheat the sand
- vapours leaving the reactor are rapidly cooled in the **CONDENSER** yielding the **pyrolysis oil** and some gases.
- The **gases** and the surplus heat from the combustor can be used to generate **steam** for **power generation**, **biomass drying** or **external use**
- The minerals contained in biomass stay behind in the **ashes**. They can be **reused** locally, thus avoiding mineral depletion

## 2. Technip – BTL Collaboration



- Rolling out fast pyrolysis bio-oil (FPBO) technology & commercial production



## 2.1: Technip – A World Leader in the Energy Industry



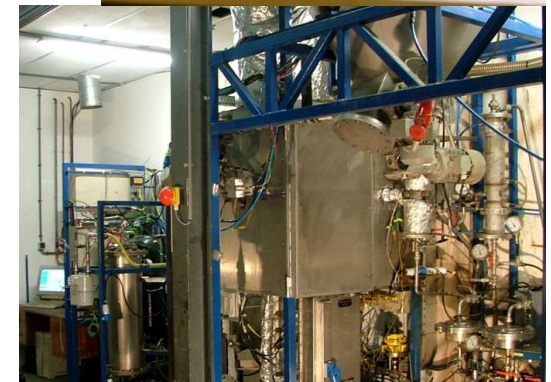
- Global footprint with ~32, 500 people in 45 Countries
- Global expertise in Engineering, Procurement and Construction (EPC)
- Technology leader in Hydrogen, Ethylene, Refining & Petrochemical
- Advancing innovative, green solutions to meet the world's energy challenges



**Technip's mission is to deliver safe, sustainable, quality and successful projects**

## 2.2: BTG Bioliquids

- Active in research and development of biomass technology
- Patented fast pyrolysis oil technology
- Reference commercial production plant with operational know-how



**BTG Bioliquids contributes towards a sustainable society by providing a renewable alternative to fossil fuels**

## 2.3: Technip – BTL Collaboration

- Green technology
- Complete turnkey (EPC) delivery of the Fast Pyrolysis Bio-Oil (FPBO) units
- Operational support for commercial production of pyrolysis oil
- The link between biomass (agricultural) and petrochemical Industries

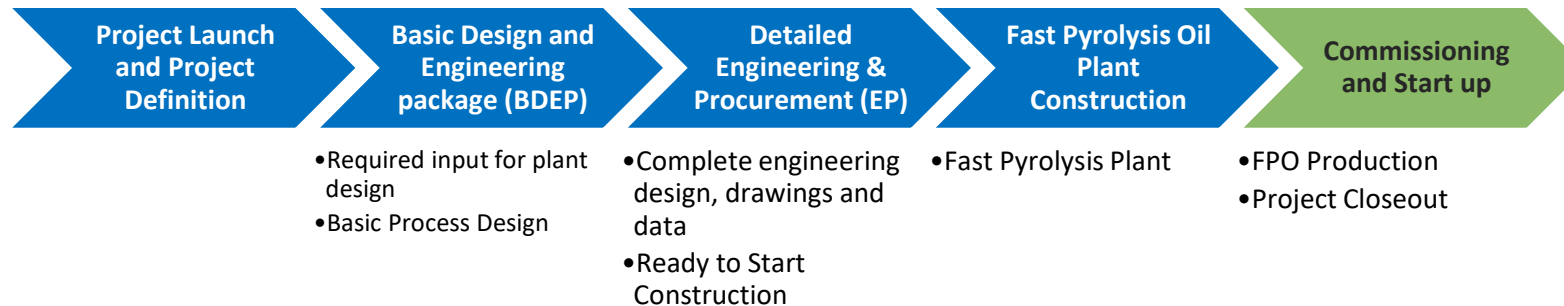
We offer **proven technology** and **EPC expertise** for **modular** pyrolysis oil units.

## 2.4: Technip EPC Project Execution

Projects are executed in accordance to TECHNIP's procedures and phases

Technip is the EPC Contractor

- Responsible for turnkey delivery of pyrolysis plant with focus on safety & quality
- Collaborates with BTL for pyrolysis technology
- Align your requirements to project outcomes



- A feasibility study may be conducted for better project definition
- An **“approved”** basic design phase is required to commence detailed Engineering, Procurement and Construction (EPC) phases
- Post construction services include start-up engineers with BTL (Empyro) plant experience and operational know how



## 2.5: Benefits of Technip – BTL FPO Plants

- Plant functions **autonomously** (stand-alone installation)
- **High operating plant efficiency** (~ 85%) as no external fuel or power is consumed during normal operation
- Plant can produce enough LP **steam** to dry biomass from 55%.wt moisture content down to 5%.wt moisture
- At lower biomass moisture content, plant can:
  - Export **excess steam** to an external local user and/or,
  - **Electricity generation** via steam turbine, enough for the plant and export excess to an external grid.
- Absence of inert carrier gas recycle, results in minimum downstream equipment size and thus a small plant with **low CAPEX**.
- **Modular** approach for turnkey delivery of pyrolysis oil plant
  - Shorter delivery time and safer construction
- Plant can be operated and controlled by **one operator**

### 3. Commercial Production

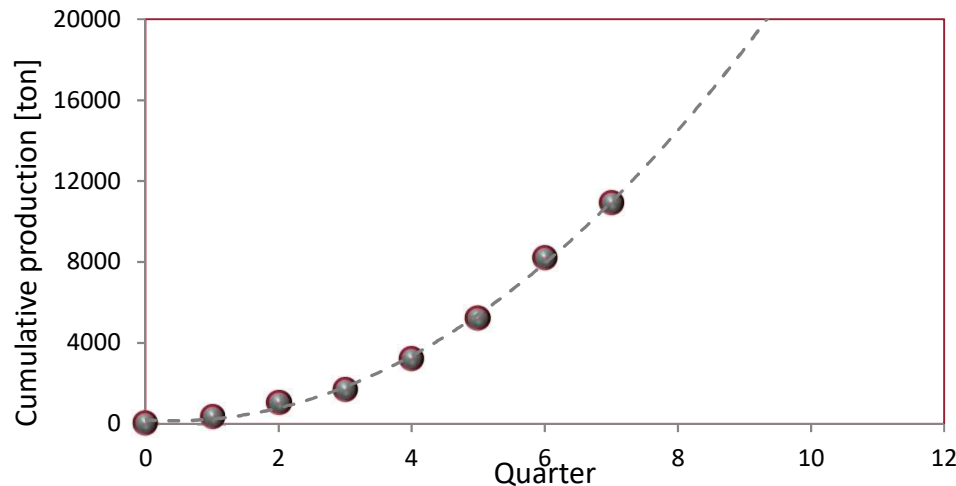
#### Empyro Plant in Hengelo, the Netherlands



<b>Plant Data</b>	
<b>Plant Capacity</b>	120 tonnes of dry wood residue /day
<b>Plant Feedstock</b>	Wood Residue
<b>Plant Output per year</b>	
• Oil	20 million litres
• Electricity	2,200 MWh
• Steam	80, 000 tonnes
• CO2- eq. reduction	24,000 tonnes

## Update Empyro after 2 years of operation

- Scale up successful, our modified RCR (Rotating Cone Reactor) performs very well
- Some start-up challenges ('teething troubles') as was expected but Empyro uptime gradually increasing
- Process is stable and easy to control (only one operator during the night shift)
- Oil quality has been excellent from the first batch and remained highly constant since
- January 2017: 10 million liters of oil produced at Empyro!
- Running at 3.3 tons of oil per hour (design capacity) at the moment



# 4. Fast Pyrolysis Bio-Oil Applications

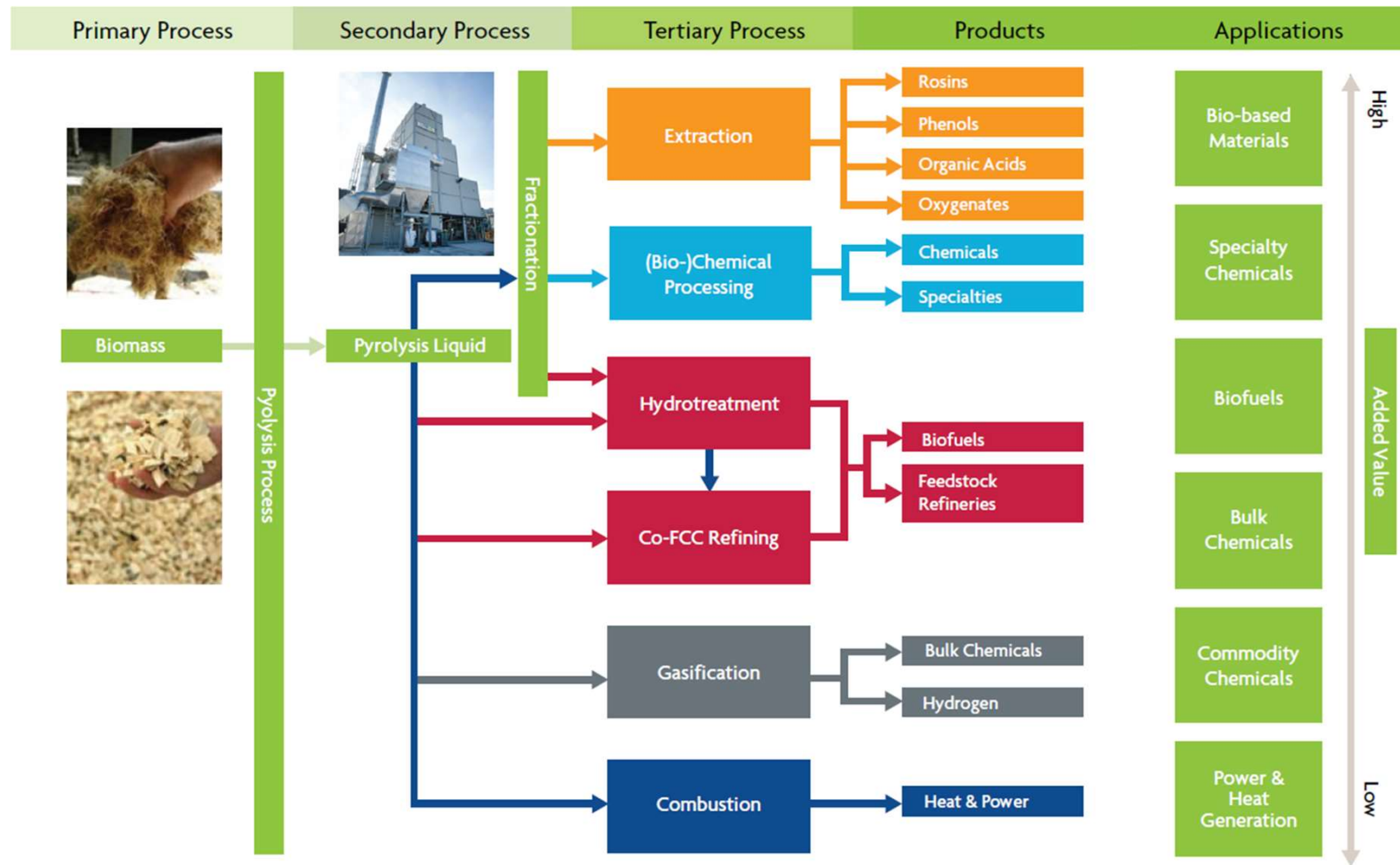
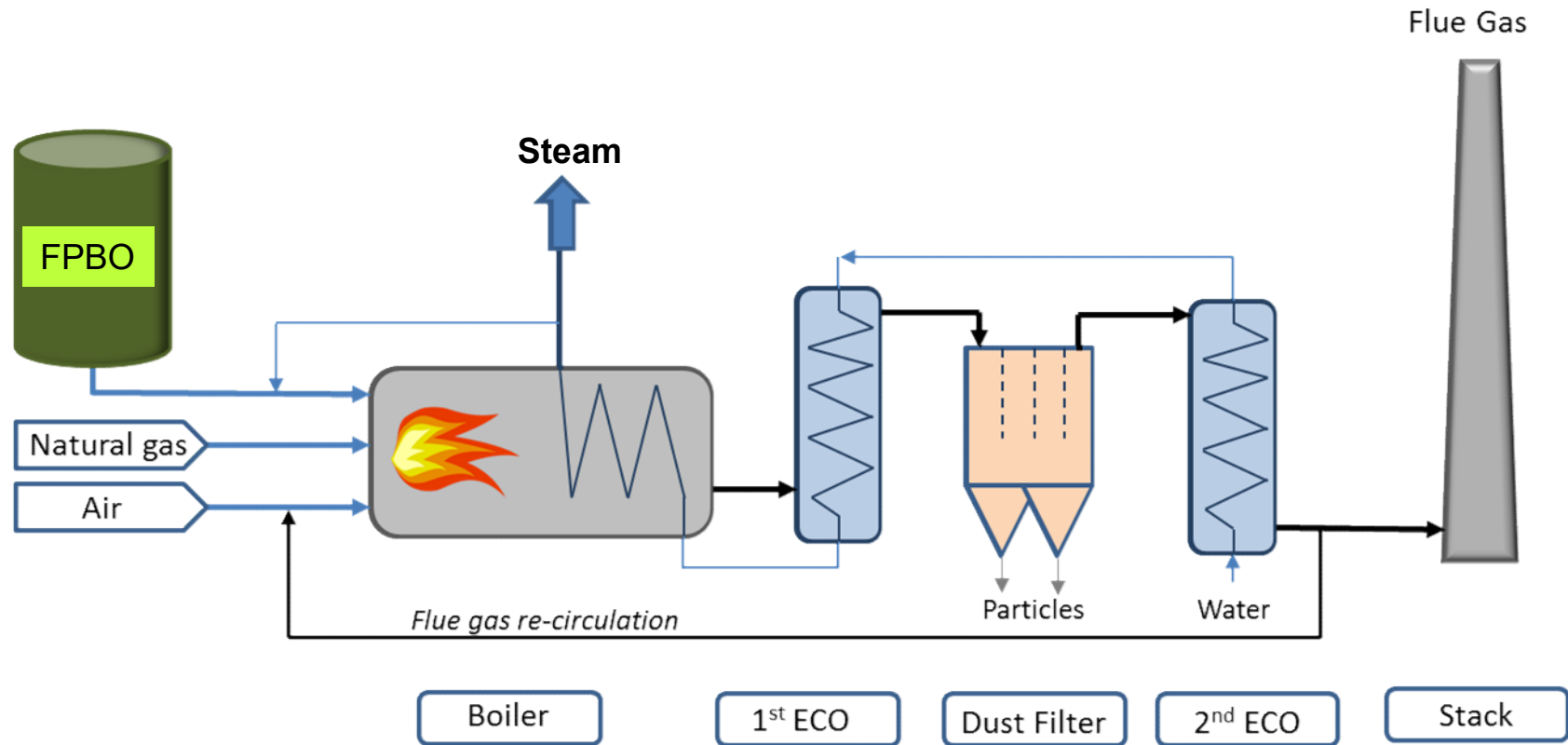


Figure based on BTG Biomass Technology Group B.V. intellectual property



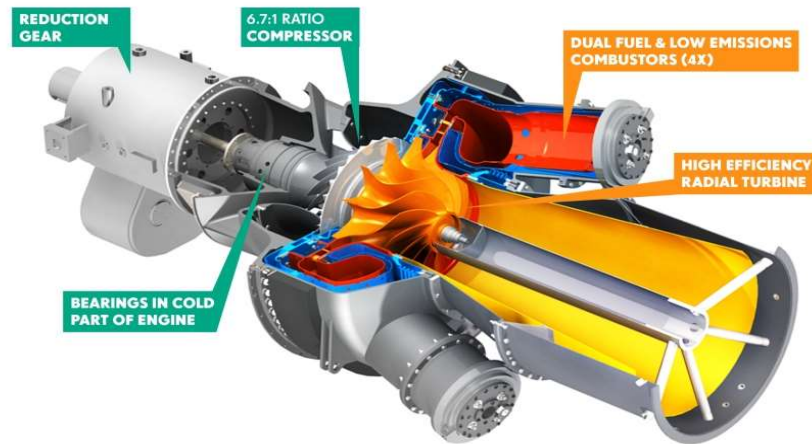
# 4.1: Industrial Steam Generation



## 4.2: Heat & Power Generation

**Gas Turbines** can be used to produce electricity and heat in a combined heat and power plant

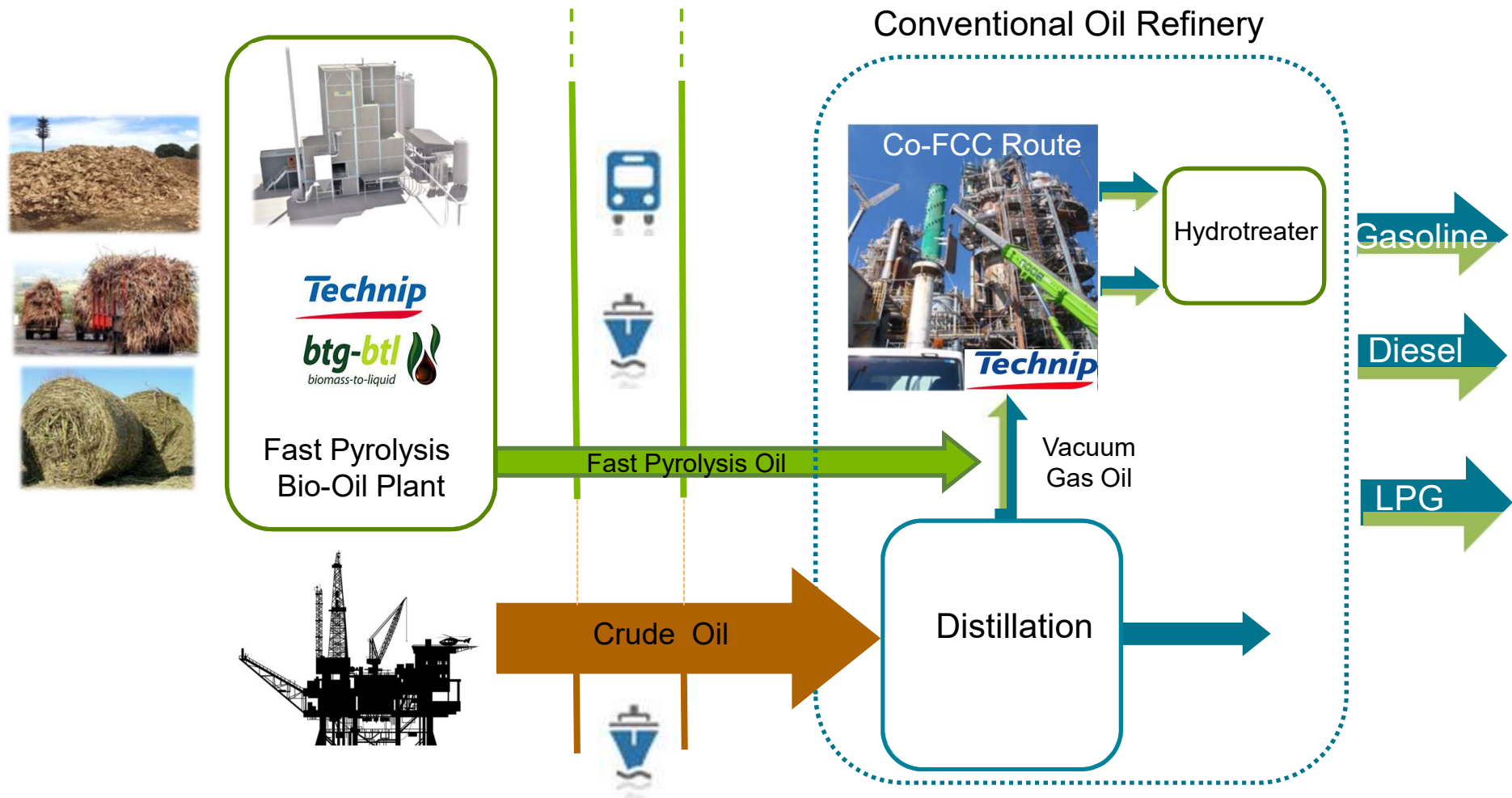
- Generation sets can be adapted to run on pyrolysis oil e.g. Opra Turbines
- Heat and power applications in oil & gas, industrial, commercial and marine sectors.



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## 4.3: Co-FCC Route Based on Technip FCC Technology



Co-refining FPBO in FCC enables production of 2<sup>nd</sup> generation bio-fuels while utilizing existing refining infrastructure.

## 4.4: Technip FCC Capabilities

- Over 35 years experience in the development, design and construction of its own FCC technology
- The most experience in revamping technology upgrades on FCC licensed by others
- Formed FCC Alliance in 1993 with IFP/Axens and Total
- Several FCC Alliance achievements including
  - 61 grassroots FCCs
  - More than 250 FCC revamps
  - 90 FCC related patents



Offer **cost-effective** solutions to meet refiner's bio-energy challenges and obligations via application of **FCC Co-feeding route**

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## 4.5: Transition Towards a Bio-based Economy

**Technip** and **BTL** are developing the **Co-FCC Route** to facilitate:

- Bio-based feedstock (FPBO) for the petrochemical industry
- Refining industry production of second generation biofuels and bio-based products while utilizing existing infrastructure
- A viable and cost effective development of a bio-based economy in order to meet renewable energy and sustainability targets:
  - ❑ As per EU Legislative Framework 2020; 6% greenhouse gas reduction target as been set in carbon intensity of road transport fuels and a 10% use of renewable energy in transport by 2020.



# Thank you



**Technip Benelux B.V.**

P.O. Box 86  
2700 AB Zoetermeer  
The Netherlands  
+31 79 3293600

[jdejager@technip.com](mailto:jdejager@technip.com)  
[www.technip.com](http://www.technip.com)

**BTG BioLiquids B.V.**

P.O. Box 835  
7500 AV Enschede  
The Netherlands  
+31 53 486 2287

[gerhard.muggen@btgbtl.com](mailto:gerhard.muggen@btgbtl.com)  
[www.btg-btl.com](http://www.btg-btl.com)



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