The bioCRACK Process – a refinery integrated BtL-concept

BIOFIT Progress Meeting – day 2

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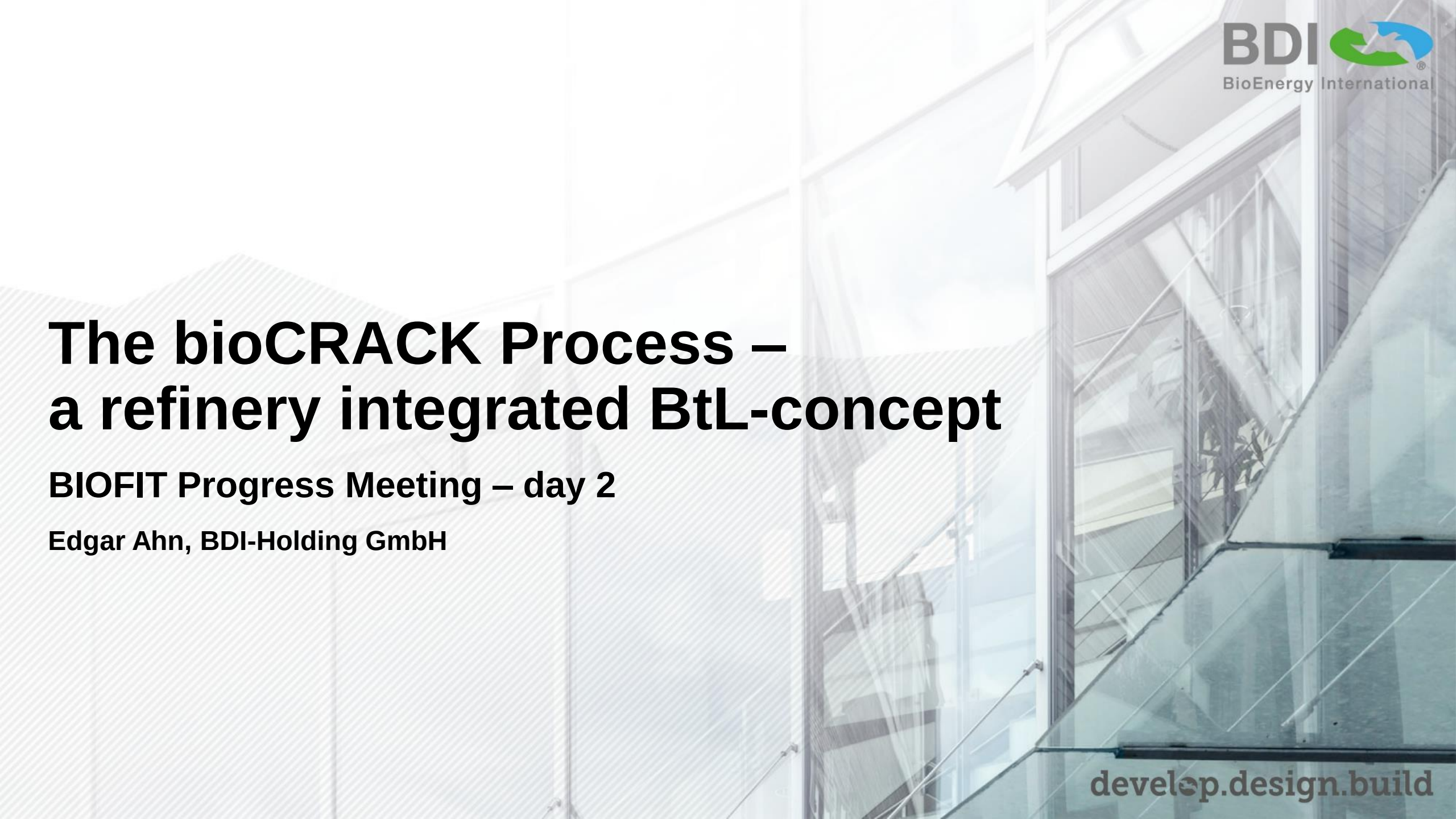

BDI at a glance

- **Austrian based, highly specialized plant engineering and construction company**
- **Tailor-made, turn-key EPC-solutions**
- **Industrial BioDiesel- & BtL-Multi-Feedstock Technology**
- **20 years of experience with >40 reference plants world-wide**
- **Key Figures:**
  - Staff: 120 employees
  - Turnover: 30 – 40 Mio.€

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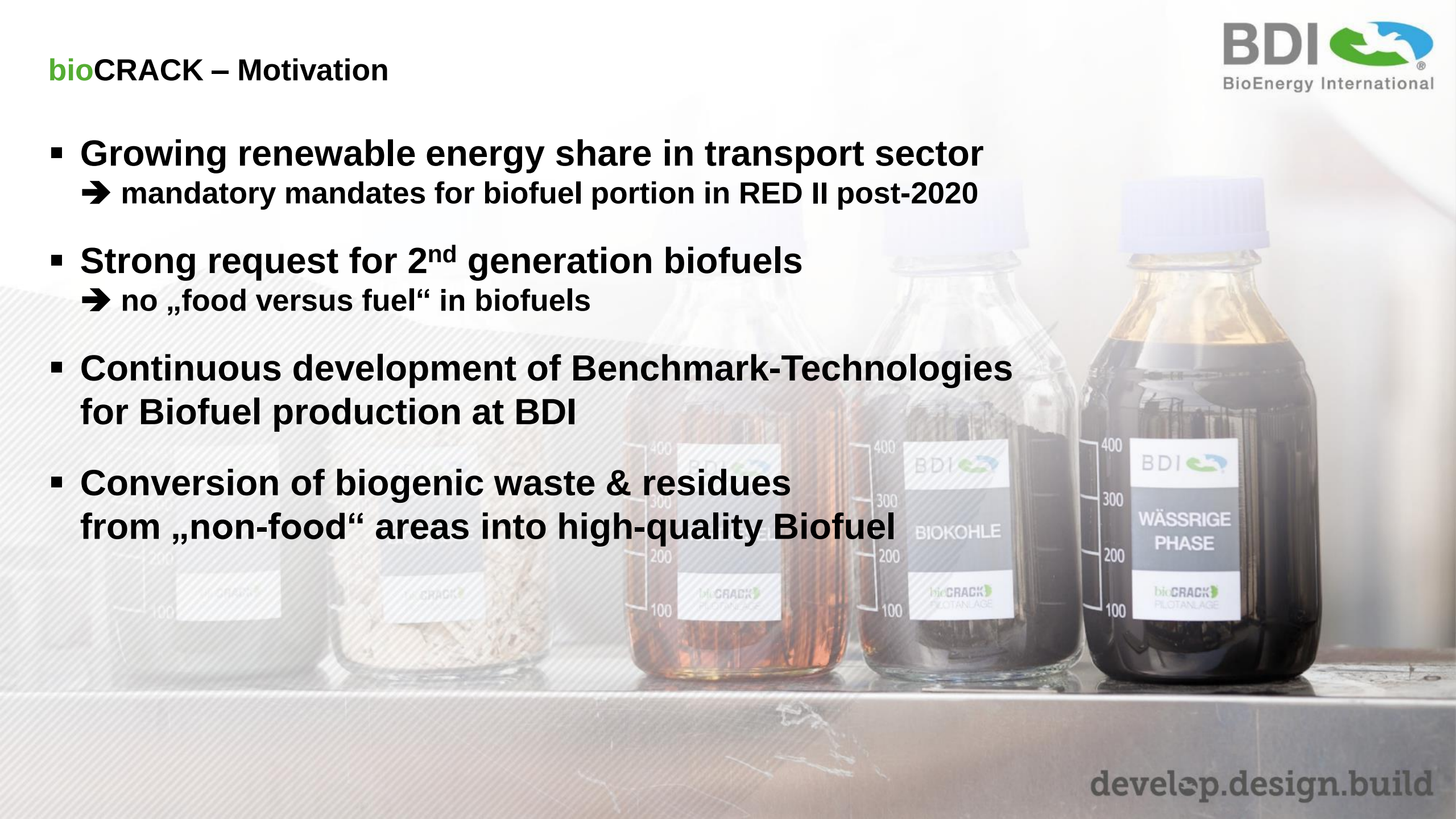
bioCRACK – Motivation

- **Growing renewable energy share in transport sector**
  ➔ mandatory mandates for biofuel portion in RED II post-2020
- **Strong request for 2nd generation biofuels**
  ➔ no „food versus fuel“ in biofuels
- **Continuous development of Benchmark-Technologies for Biofuel production at BDI**
- **Conversion of biogenic waste & residues from „non-food“ areas into high-quality Biofuel**



bioCRACK – Project goals

- **Simple process technology**
- **Compliance with current fuel quality standards in final fuel product**
- **Useable side-products, no waste streams**
- **Fit in with conventional process of mineral oil refining**
- **Liquid phase pyrolysis**
  (liquefaction of solid biomass)
- **Co-processing of intermediate product in refinery (heavy ends) and solid biomass**

bioCRACK – Feedstock

- **Ideal biomass for bioCRACK is renewable lignocelluloses**
  - Low water content
  - Low nitrogen, chlorine, toxics
  - Fine particle size (<5mm) possible

Examples:

- Wood chips (soft and hard wood)
- Forestry residues
- Chopped straw/agricultural residue …

Biomass contains up to 50% oxygen in complex molecular structure. Oxygen is unwanted element in liquid fuels and has to be removed to reach requested fuel quality!

bioCRACK – basic Process scheme

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Biomass

Carrier oil

pre-treatment

Conditioning

bioCRACK converter
liquid phase pyrolysis (LPP)

separation

Gas

Pyrolysis oil

Raw fuel

Diesel with renewable content

separation

Biochar

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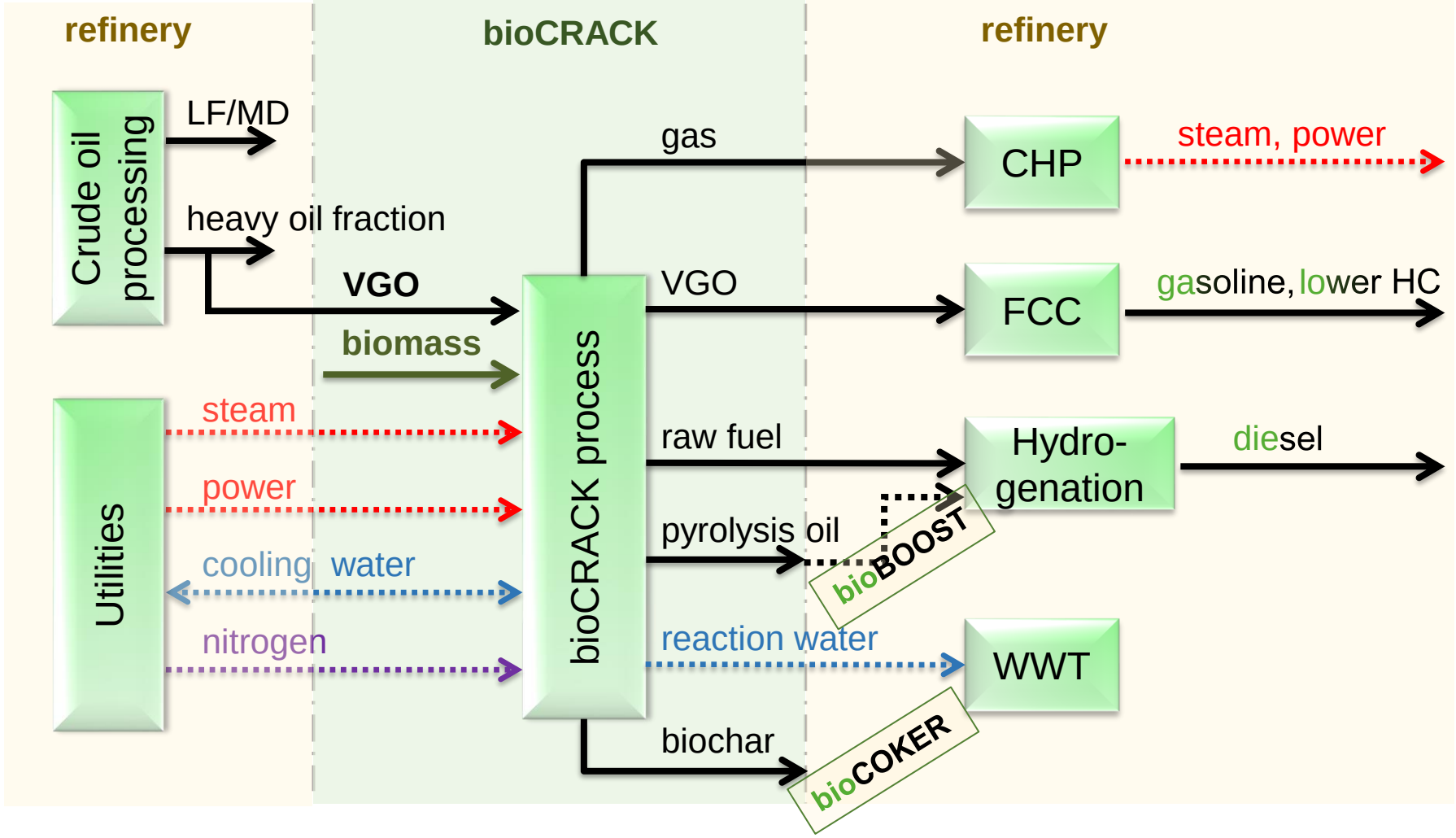
bioCRACK – Refinery Integration



bioCRACK – Pilot plant (2013 - 2015)

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Integrated pilot plant at the OMV refinery Schwechat/Austria (1.000 to BM/y)

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Upgrading of raw diesel to EN590 quality is possible

Parameter	Untreated raw diesel	After hydro treatment	EN 590
Density (15°C)	868 kg/m³	**833 kg/m³**	820 - 845 kg/m³
Viscosity (40°C)	2,53 mm²/s	**n.a.**	2 - 4,5 mm²/s
Cetan	44	**53**	> 51
C/H/O	85/13/2 wt.%	**86/14/0 wt.%**	n.a.
Volatile <350°C	83 wt.%	**86 wt.%**	> 85 % (v/v)
Sulfur	177 mg/kg	**3 mg/kg**	< 10 mg/kg

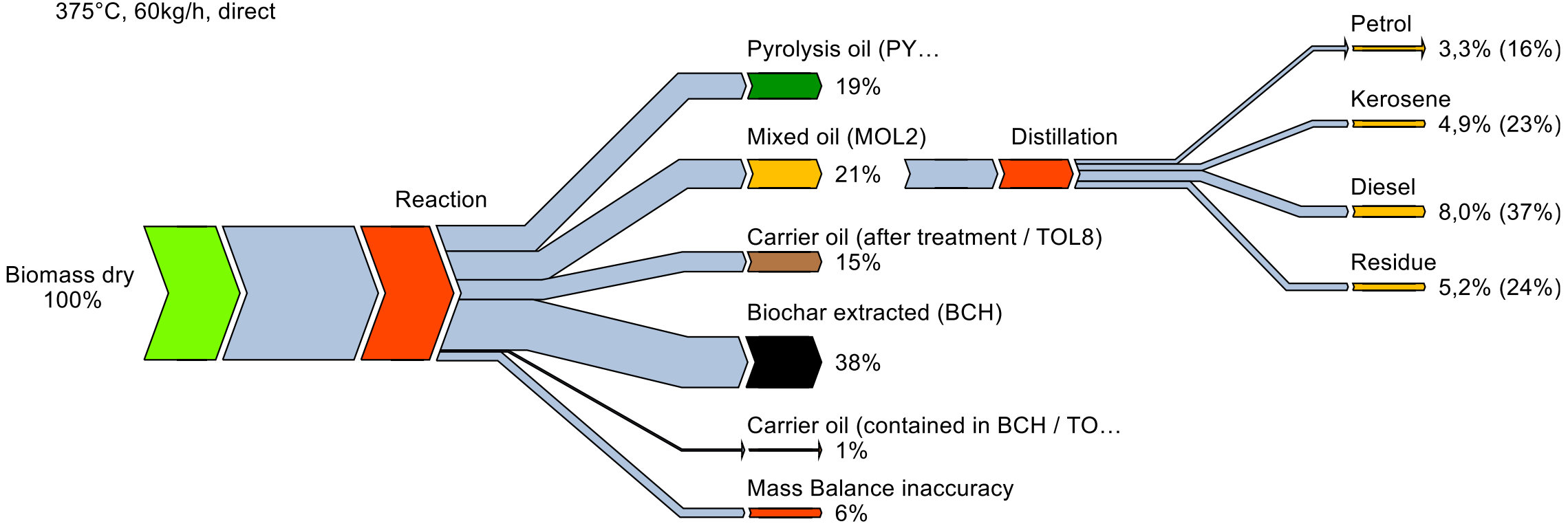
Example integration bioCRACK in OMV refinery concept:

- general increase of fuel production from VGO by **+ 5%**
- Shift in fuel distribution from **petrol (-11%) to diesel (+25%) and kerosene (+15%)**

Detailed C_{14} Balance ➔ Biocarbon transfer

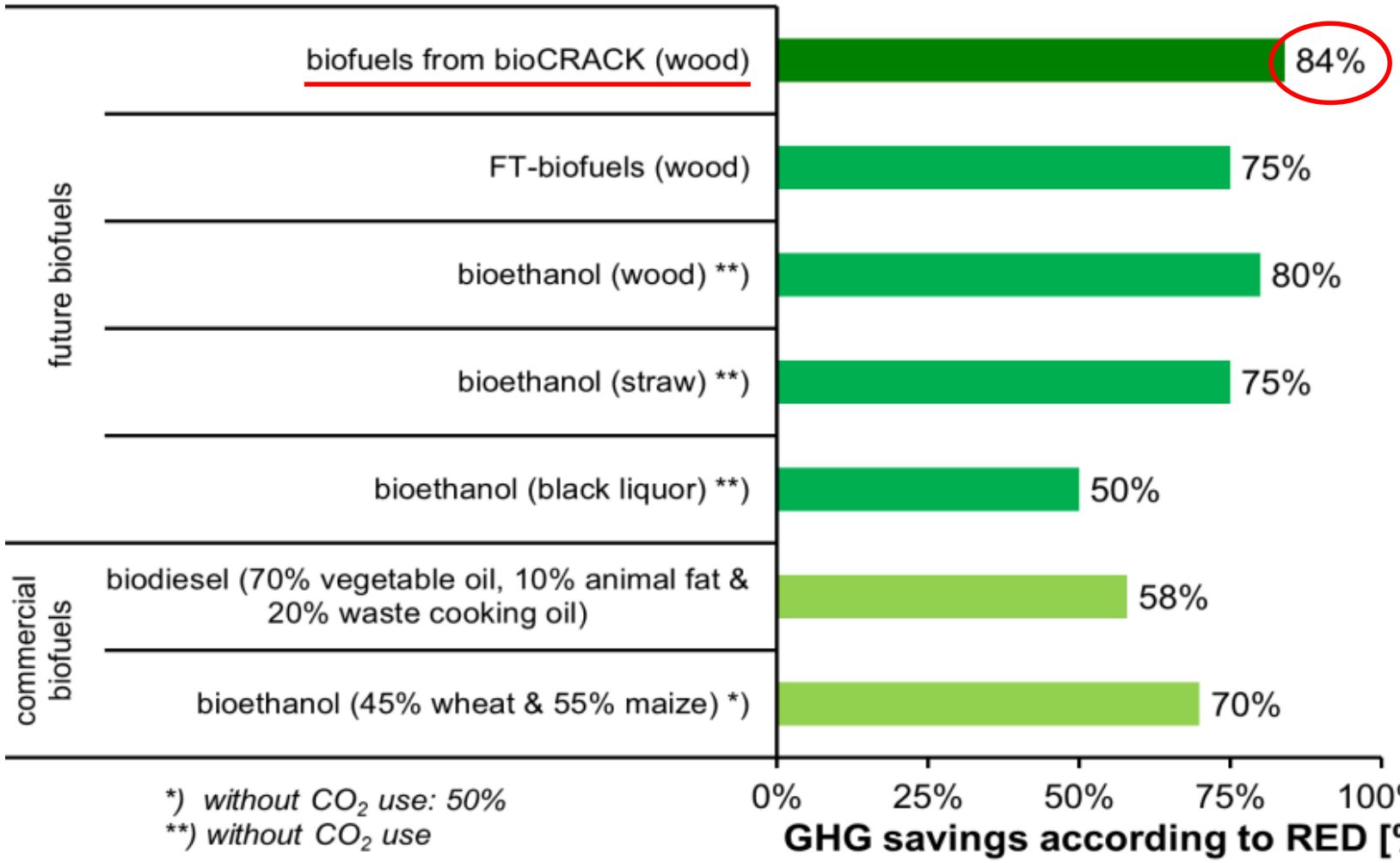
H06.2

375°C, 60kg/h, direct



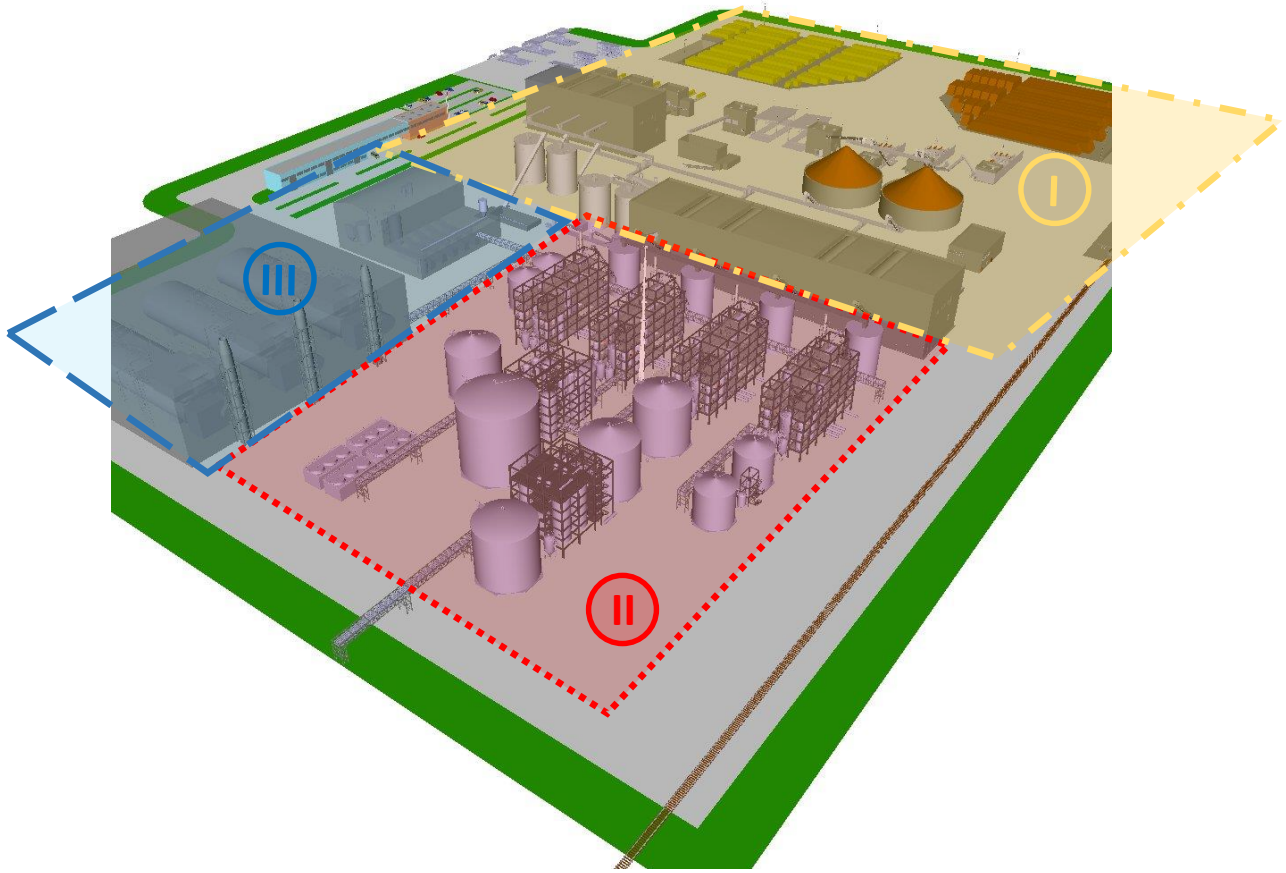
Results from bioCRACK pilot plant Schwechat
Feedstock: spruce

GHG-Saving potential (accord. to RED)
Comparison to other biofuels in Austria



Source: JOANNEUM RESEARCH (2008 – 2014)

bioCRACK – Industrial scale-layout



- **Capacity:**
  400.000 to/y BM ➔ 60.000 to/y biofuels;
  Total Area: 235.000m²

- **Area I:**
  Multi-Feedstock biomass preparation

- **Area II:**
  bioCrack Refining 1- 4, product treatment
  VGO-Conditioning

- **Area III:**
  Energy central station, bioChar treatment

- **Estimated Capex 400.000 t p.a. biomass: 200 - 300 Mio €**

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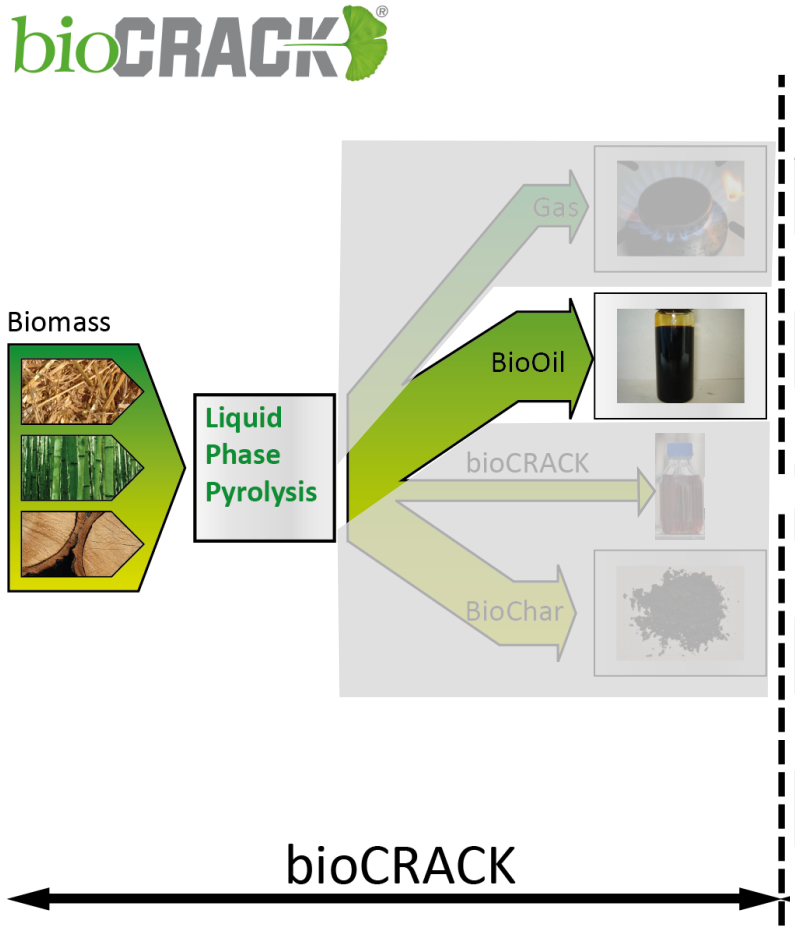
bioCRACK – Pyrolysis oil



LIQUID PHASE PYROLYSIS OIL		
Water content	[wt.%]	57.0%
LHV	[MJ/kg]	7.4
Density	[kg/m³]	1092
Viscosity	[mPa·s]	3.5
Carbon content	[wt.%]	22.3
Hydrogen content	[wt.%]	9.4
Rest	[wt.%]	67.8
Nitrogen content	[wt.%]	<1
Biogenic Carbon	[wt.%]	100%

- **Brown liquid with a few hundred compounds**
  - Low pH
  - High water content
  - High corrosivity
  - High viscosity
  - Low stability (polymerisation reactions)
  - Smoky smell

- **Differences to fast pyrolysis oil:**
  - Lower molecular size distribution (< 2.000 g/Mol)
  - Higher water content
  - Lower viscosity

bioBOOST – Possible usage & upgrading techniques

- Material utilization (Extraction of phenols, acetic acid, „liquid smoke“,..)
- Electro-chemical upgrading (stabilization)
- Steam reforming
- Gasification & Fischer Tropsch Synthesis (e.g. KIT)
- Usage as fuel additive (emulsions)
- Usage in fuel cells (sugar in pyrolysis oil)
- Hydrodeoxygenation (HDO)

bioBOOST – Project

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Goals:

- **Value-adding utilization of side-product „pyrolysis oil“ from bioCRACK-process**
- **Increase biogenic carbon transfer, preferably into fuel ➔ production of additional biogenic portion of fuels from biomass feed**
- **Using standard Hydrotreating / HydroCracking process parameters**

bioBOOST - Results

- **Hydro-deoxygenation of pyrolysis oil from bioCRACK Process successful, using low-pressure/-temperature Hydrocracking parameters**
- **Endproduct complies with fuel specification, depending on boiling range**
- **In combination with bioCRACK-Process yield increase in production of biogenic fuel portion**
- **Increase in GHG-saving potential up to 86%**
- **Concept for Multi-feedstock BiomassPyrolysisRefinery proven**

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Hydrocarbon liquid production *via* the bioCRACK process and catalytic hydroprocessing of the product oil

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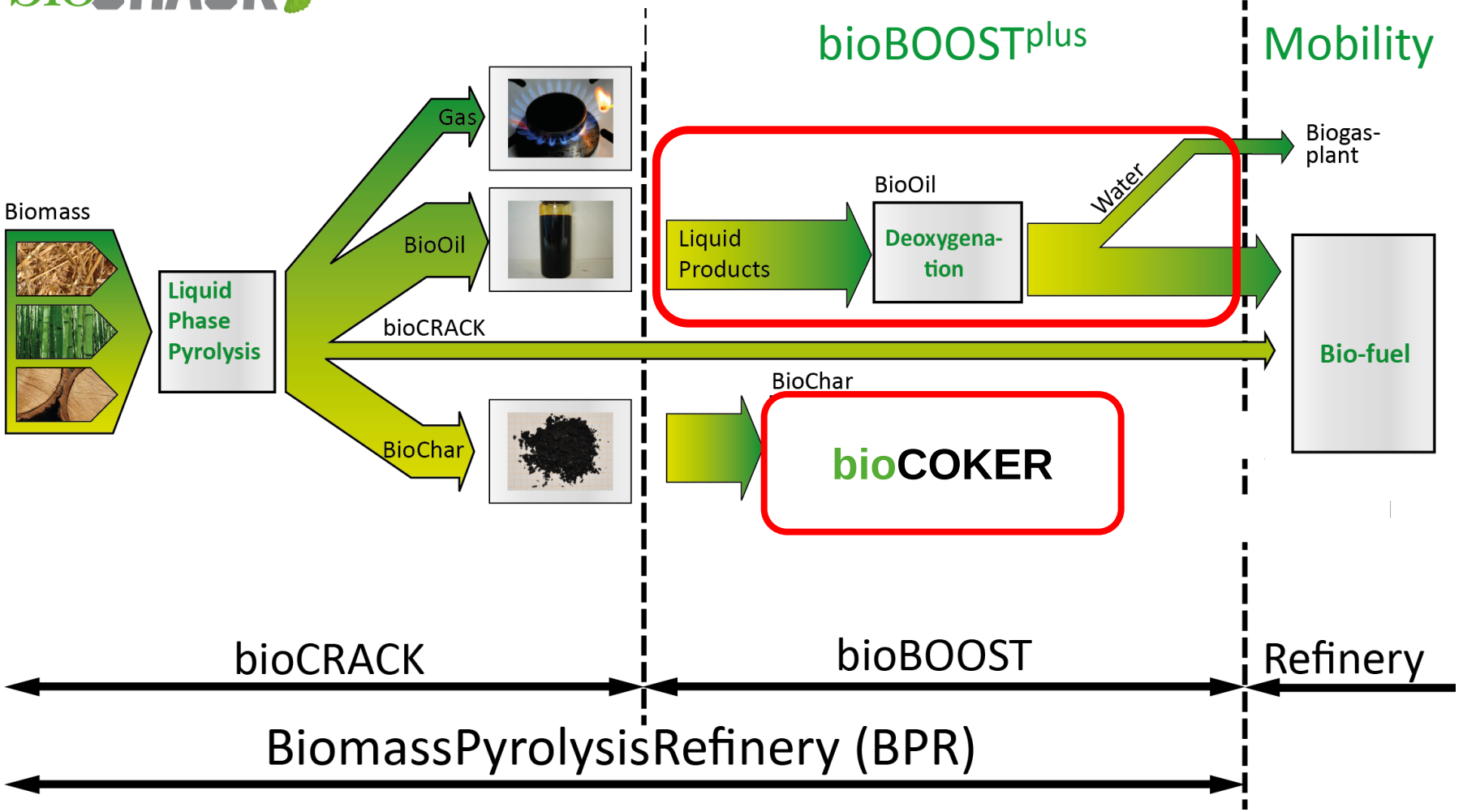

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Summary

- **bioCRACK-Process:**
  new, patented BtL-process, as add-on technology to existing mineral oil refinery
- **Tested in pilot scale for 2 years (~1.000 t/y biomass)**
- **Produced raw diesel can be up-graded to EN590-diesel, using standard hydrogenation unit**
- **Biogenic portion up to 20% (C_{14} - analysis)**
- **Side-product stream „pyrolysis oil“ can also be up-graded with Hydrodeoxygenation units (project „bioBOOST“) to biogenic fuel.**
- **Search for partners/licensee**

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Thank you for your kind attention.