The BDI bioCRACK Process

- a new approach for a refinery integrated BtL concept

BDI bioCRACK

BDI BioDiesel BDI BioGas BDI RetroFit

Overview

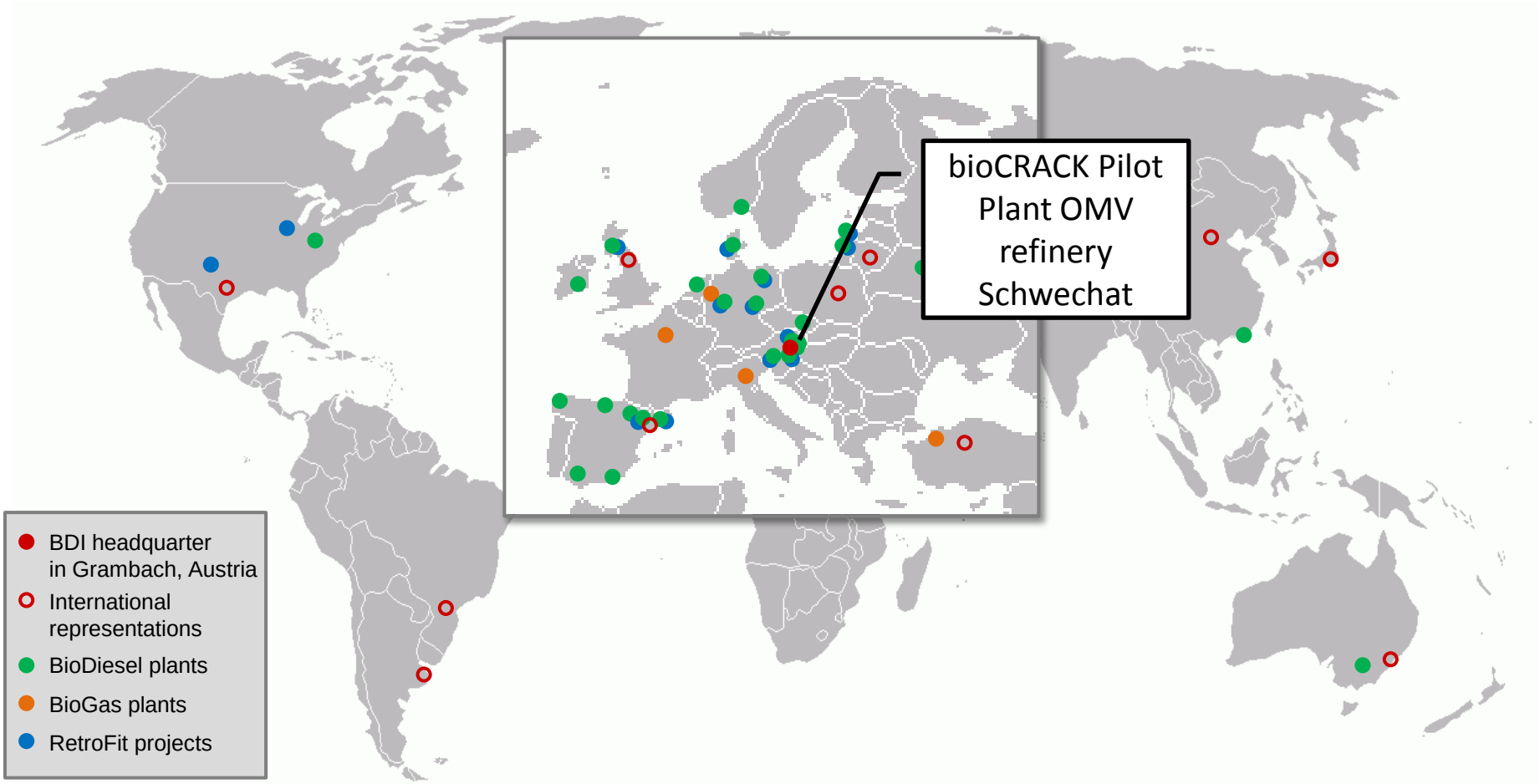
Content:

- BDI at a glance
- Motivation
- Concept
- Pilot Plant
- Experimental results
- Outlook

BDI at a glance

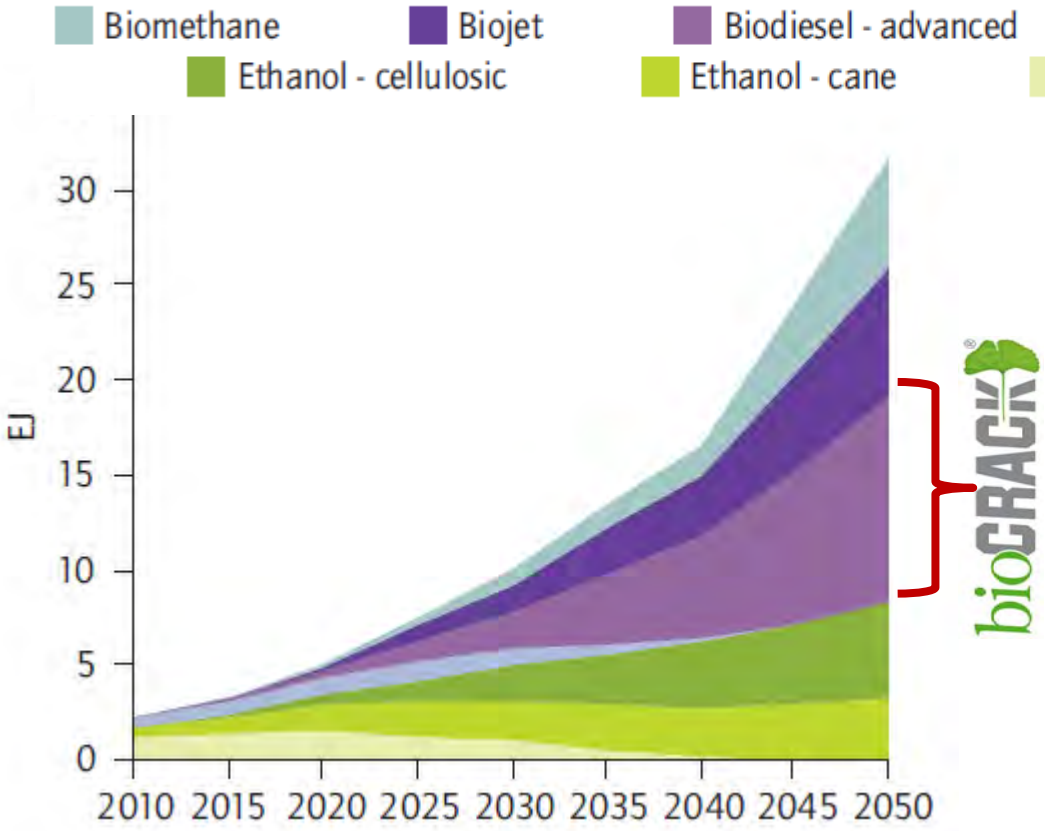
- Highly professional plant engineering and construction company
- Tailor-made turn-key solutions
- Own technologies
  “from waste to value“
- More than 35 reference plants
  on 4 continents, since 1991
- Excellent reputation,
  repeat business by industry leaders
- Key figures 2012:
  Staff: 132 employees
  Turnover: € 30 mio
  Equity ratio: 68%
  Stock market listed in Frankfurt

Global Player



bioCRACK Motivation

IEA projected global biofuels demand



Huge projected global demand on biofuels especially on advanced (Bio)Diesel

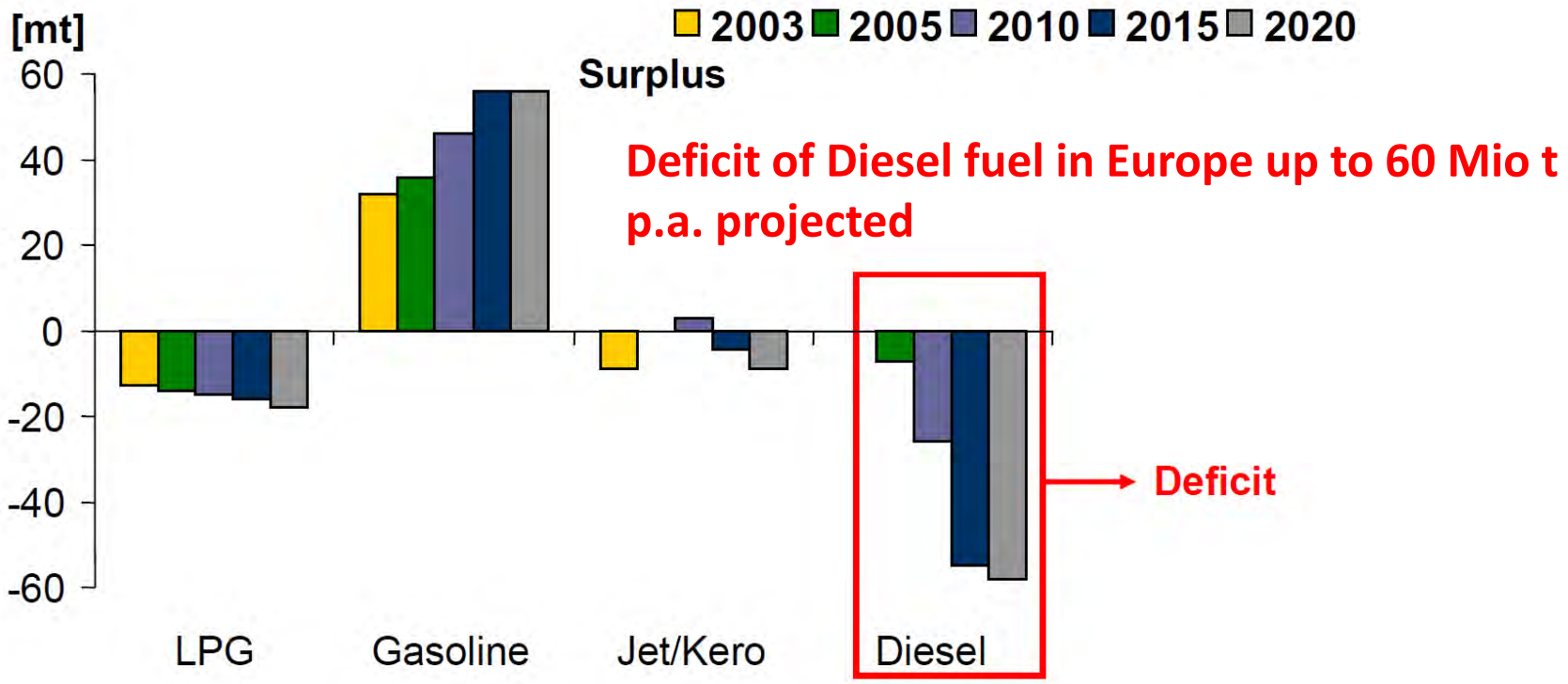
EU RED:
Double (quad) counting for (residual) lignocellulosic fuels + weak counting for oil seed biofuels

US RFS2:
Mandate (2012) for Type C / D3:
Cellulosic Biofuel 1,9 Mio m^3 ↑ ↑

Source: IEA Technology Roadmap - Biofuels for Transport 2011 1 exajoule ~ 23-24 Mio t Oil

bioCRACK Motivation

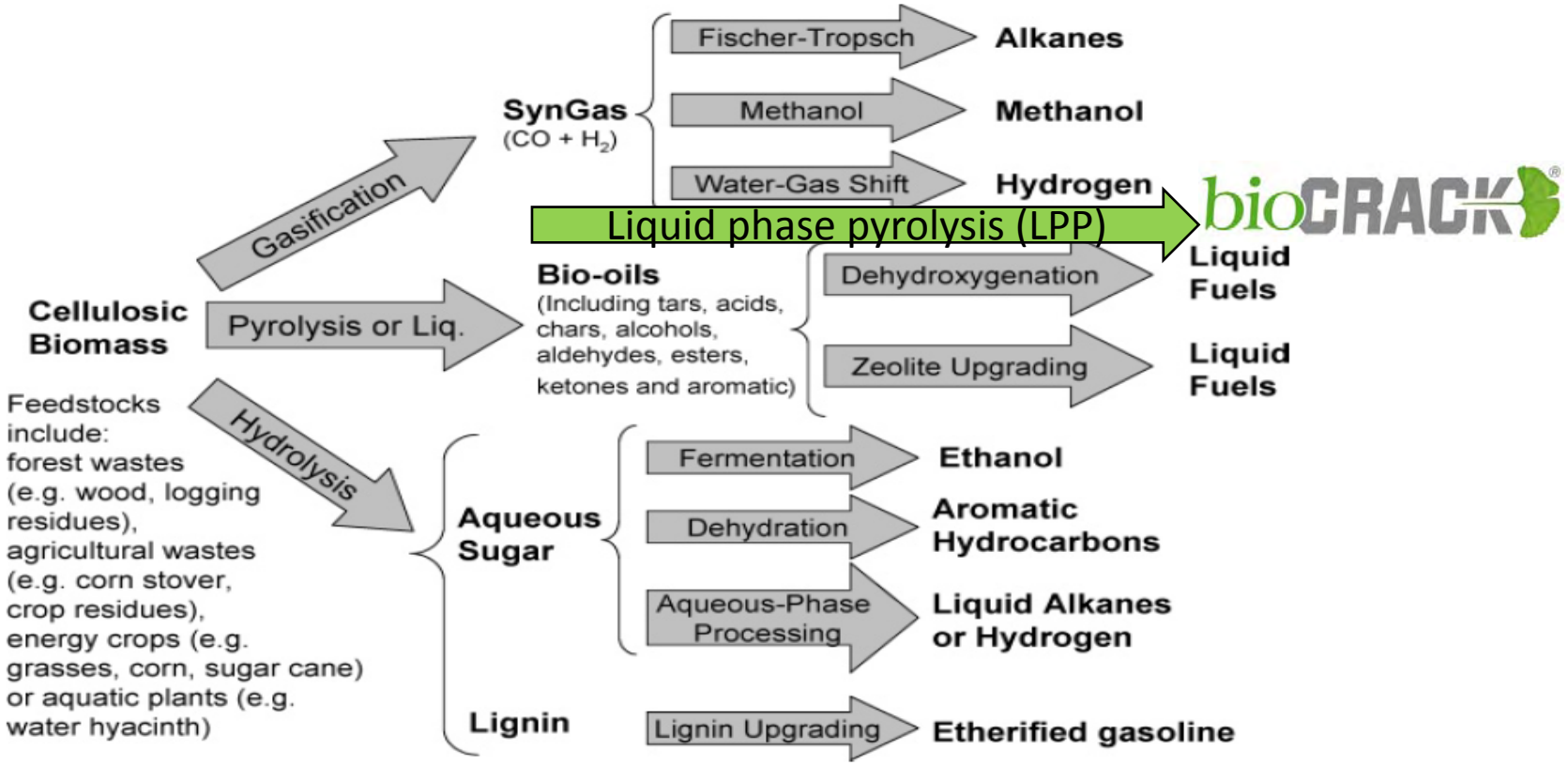
Europe oil product balances



Source (by OMV): Refining Capacity Study, EUROPIA Strategy Council

bioCRACK Concept

Typical pathways from lignocellulosis to biofuel



Quelle: Chem.Rev.2006,106,4044ff

bioCRACK Concept

In liquid phase pyrolysis (LPP) a hot liquid is used as heat carrier:

Pro:

- Moderate process conditions (ambient pressure, temperature <450°C)
- Compared to other technologies simple concept
- Heat recovery possible
- Usage of standard industrial equipment
- Time to market short
- Direct conversion from solid biomass to liquid hydrocarbon

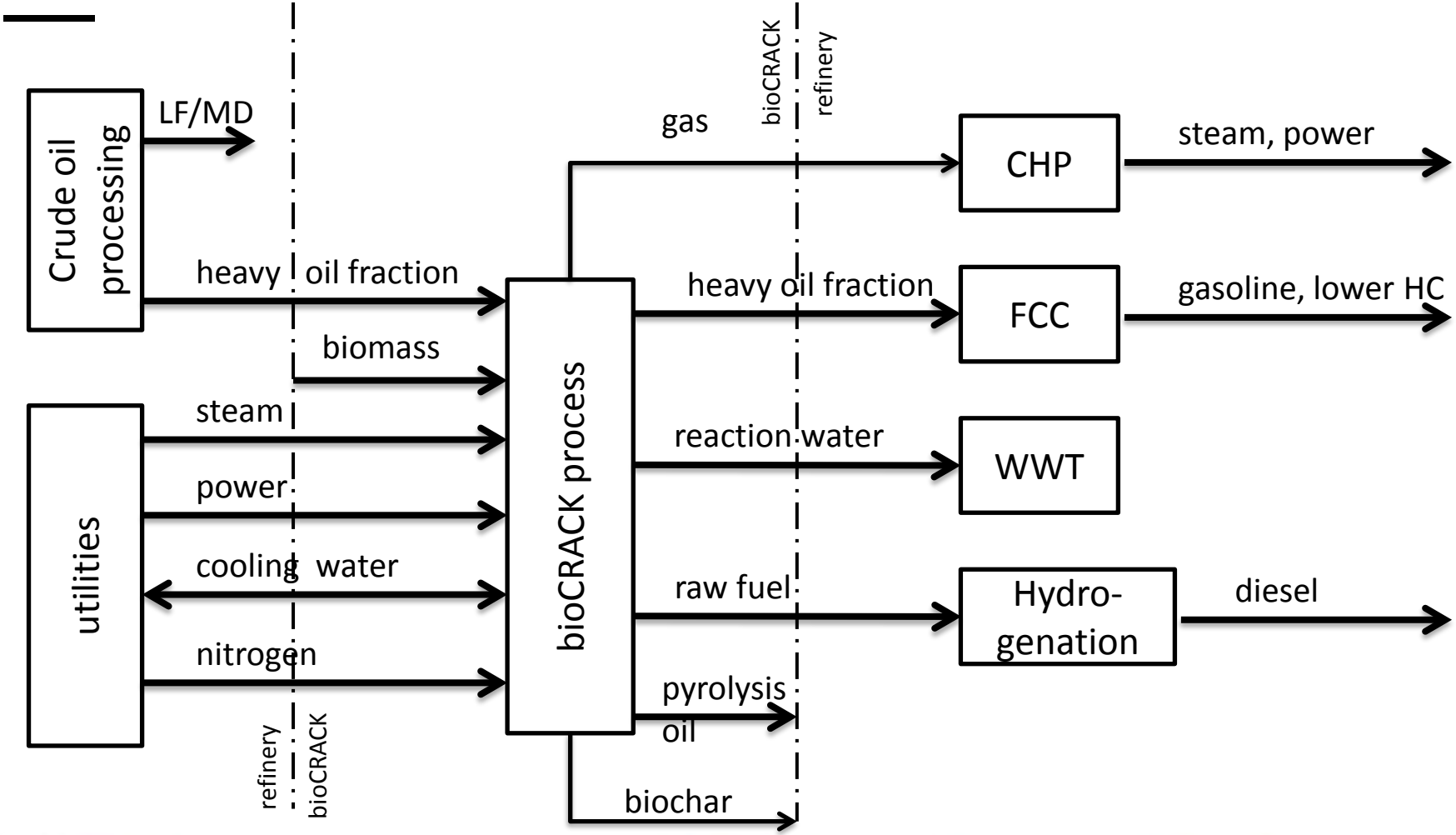
Contra:

- Limitation in maximum temperature
- Limited conversion from solid to fuel
- Challenging separation task solid/liquid
- Utilisation of by-products necessary
- Cracking of the heat carrier oil

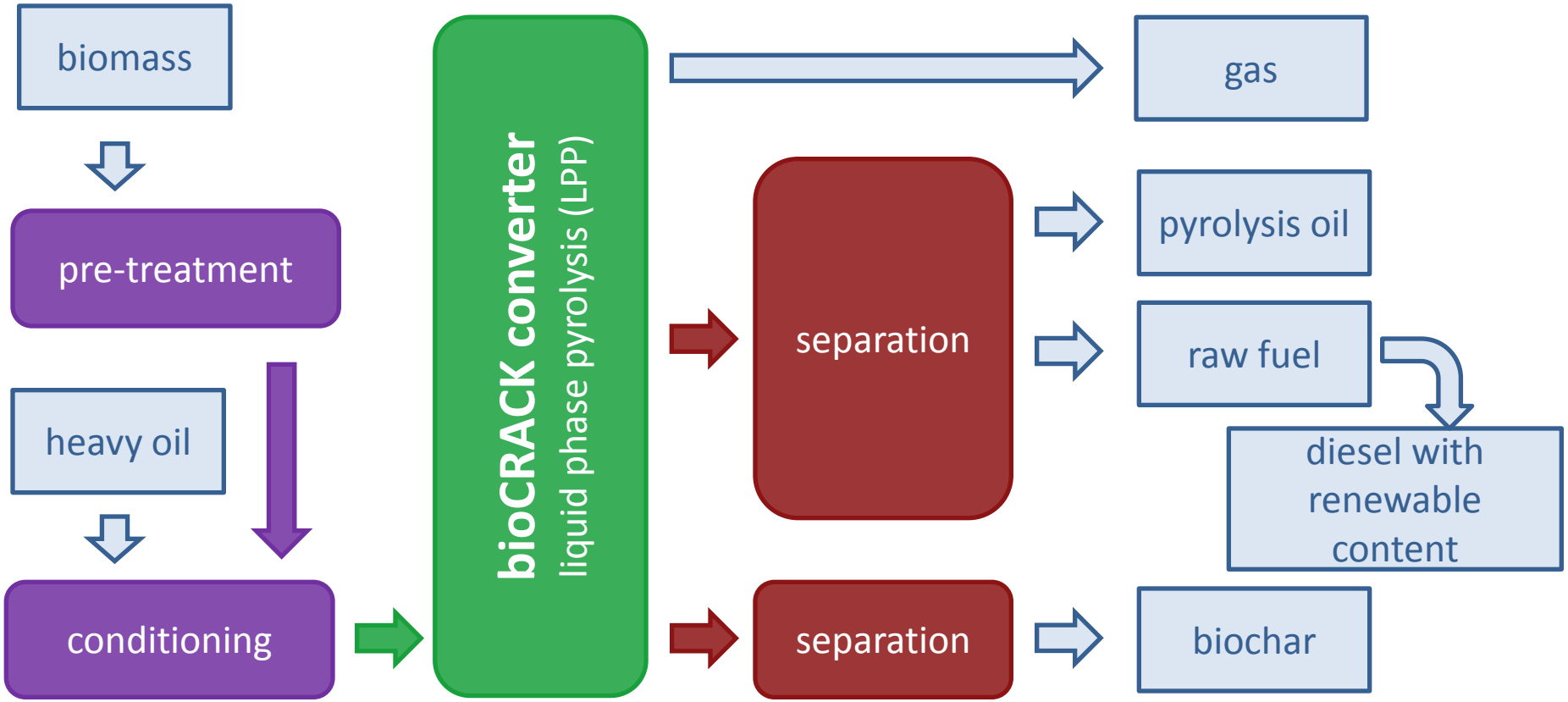
→ Chance for a integrated process in a standard refinery

To succeed with LPP one need to use a heat carrier oil where cracking is desired!

bioCRACK Refinery Integration



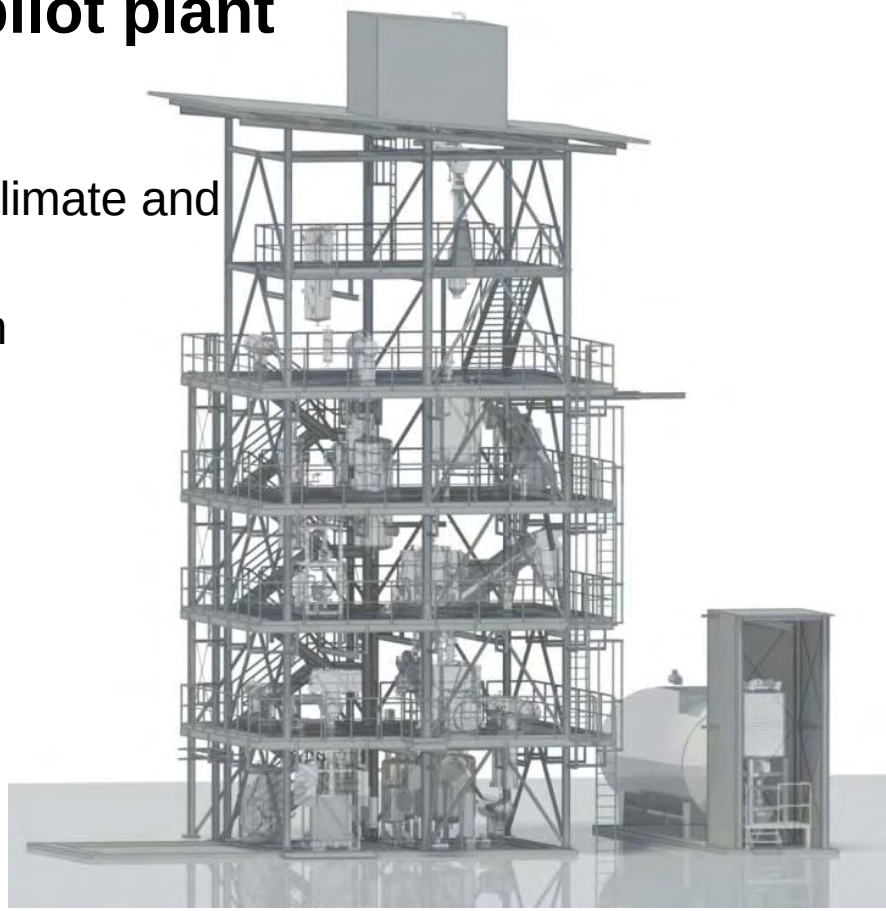
bioCRACK Process Scheme



bioCRACK Pilot Plant

Facts and figures bioCRACK pilot plant

- Project duration: April 2010 - 2013
- Project cost: €7 Mio (Grand by Austrian Climate and Energy Fund: € 2,0 Mio.)
- Dimensions: basis: 7,5x7m, height: 21,5m
- Steelwork: 60 tons
- Pipes: >2.000 m
- I/O: > 700
- Engineering demand: ~ 17.000 hours
- Feed capacity: 100 kg biomass and 250 kg heavy oil
- Pressure: atmospheric
- Temperature: up to 400°C



bioCRACK Pilot Plant

Integrated pilot plant OMV refinery Schwechat/Austria

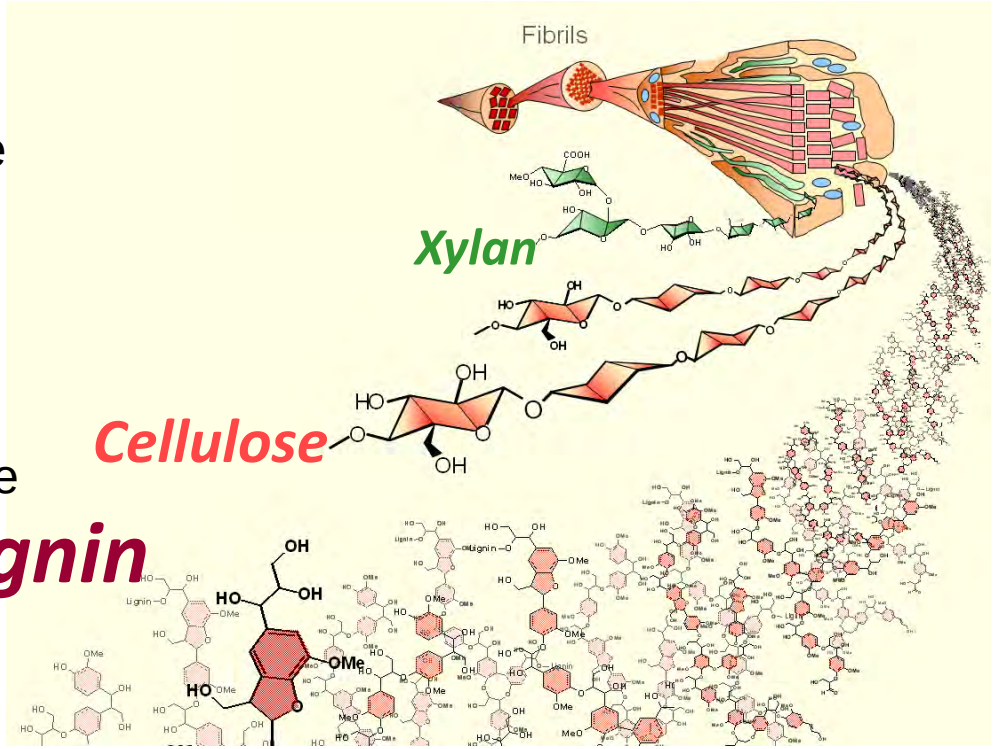
bioCRACK Feedstock and Products

Ideal biomass for bioCRACK is renewable lignocelluloses:

+ Low water content
+ Low nitrogen, chlorine, toxics
+ Fine particle size (<5mm) possible

Examples:

o Wood chips (soft and hard wood)
o Forestry residues
o Chopped straw/agricultural residue
o Torrefied material
o …..



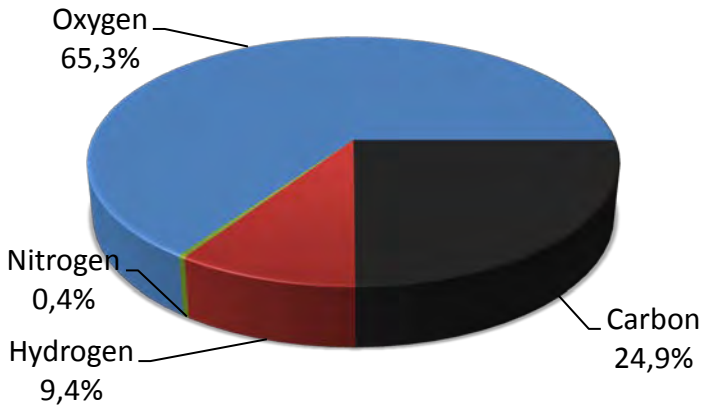
Source:L ehnen & Faix; vTI

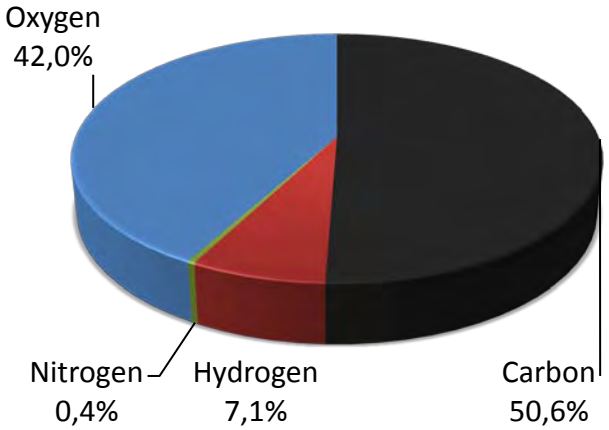
Note for mass balances:
Biomass contains up to 50% oxygen.
Oxygen is an unwanted element in liquid fuels and has to be removed!

bioCRACK Pyrolysis Oil

Dehydration of bioCRACK pyrolysis oil is possible:

	Pyrolysis Oil	Pyrolysis Oil - dehydrated
Water content:	40-60%	<10%
Density kg/m³:	1050-1100	1200
LHV MJ/kg	4-6	18-19





Utilisation:
- Renewable liquid fuel for combustion
- Source for chemicals
- Further upgrading to transportation fuel

Results from BDI pilot plant Schwechat H02
Feedstock: spruce

bioCRACK Diesel Fuel

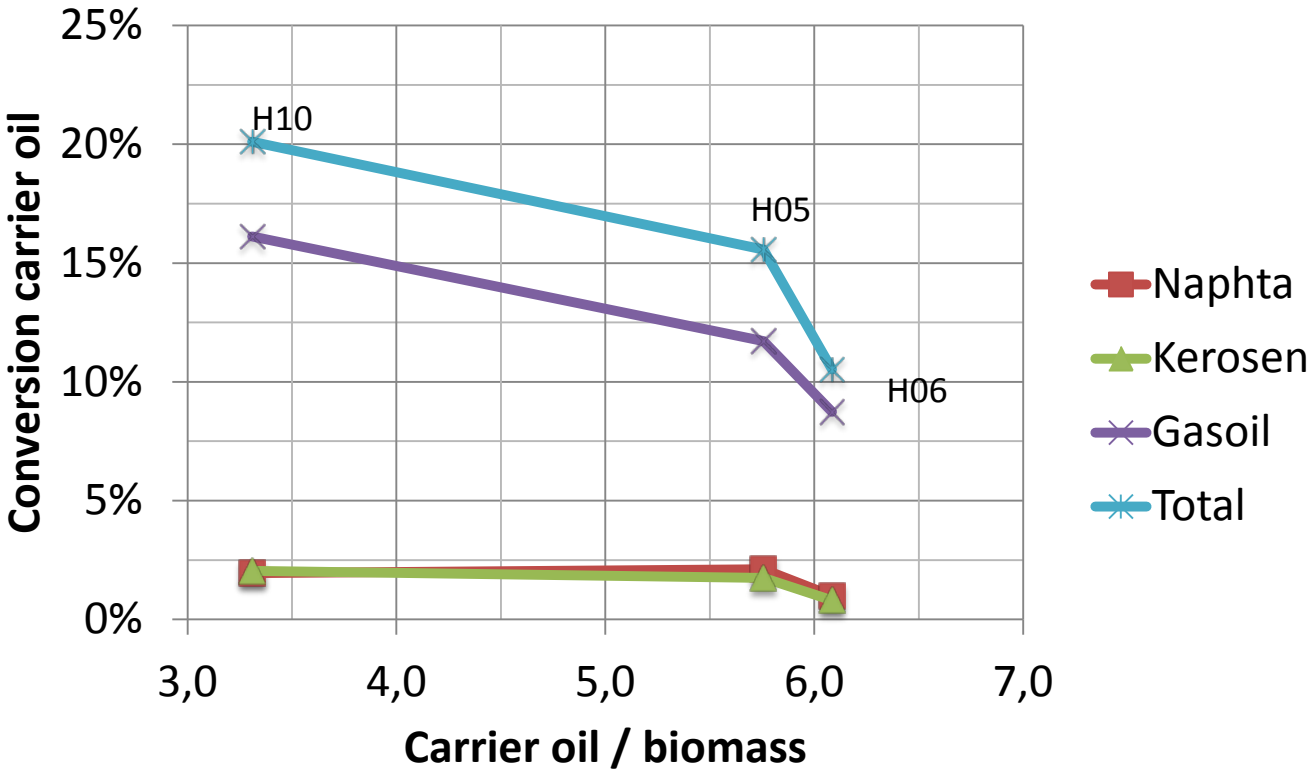
An upgrading of the raw diesel to EN590 quality is possible:

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

Results from pilot plant BDI/Grambach and hydrogenation at OMV/Schwechat
Feedstock: spruce chips

bioCRACK Cracking Carrier-Oil

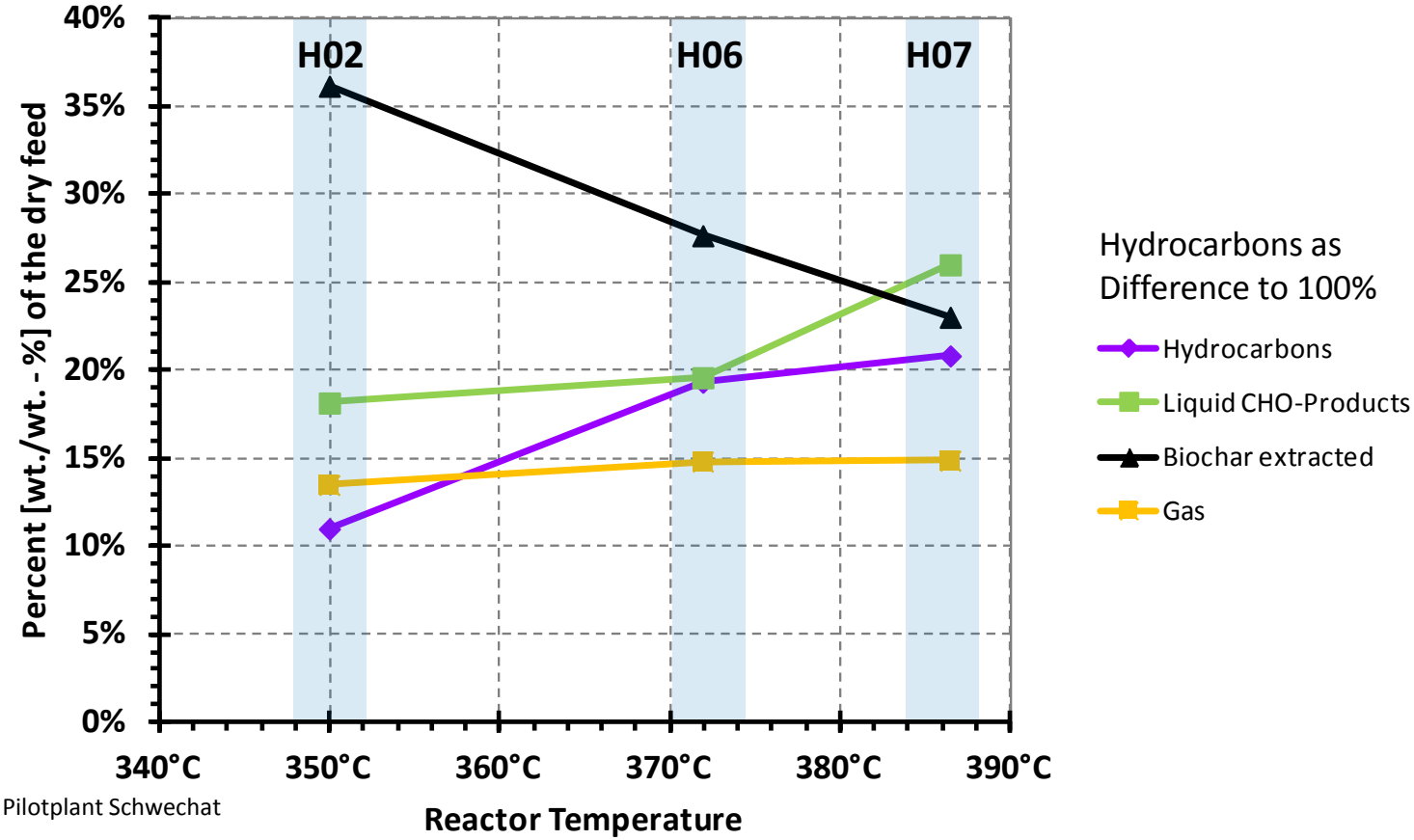
Cracking of fossil carrier-oil vs. biomass/oil ratio



Results from bioCRACK pilotplant Schwechat
Feedstock: spruce

bioCRACK Biomass Conversion

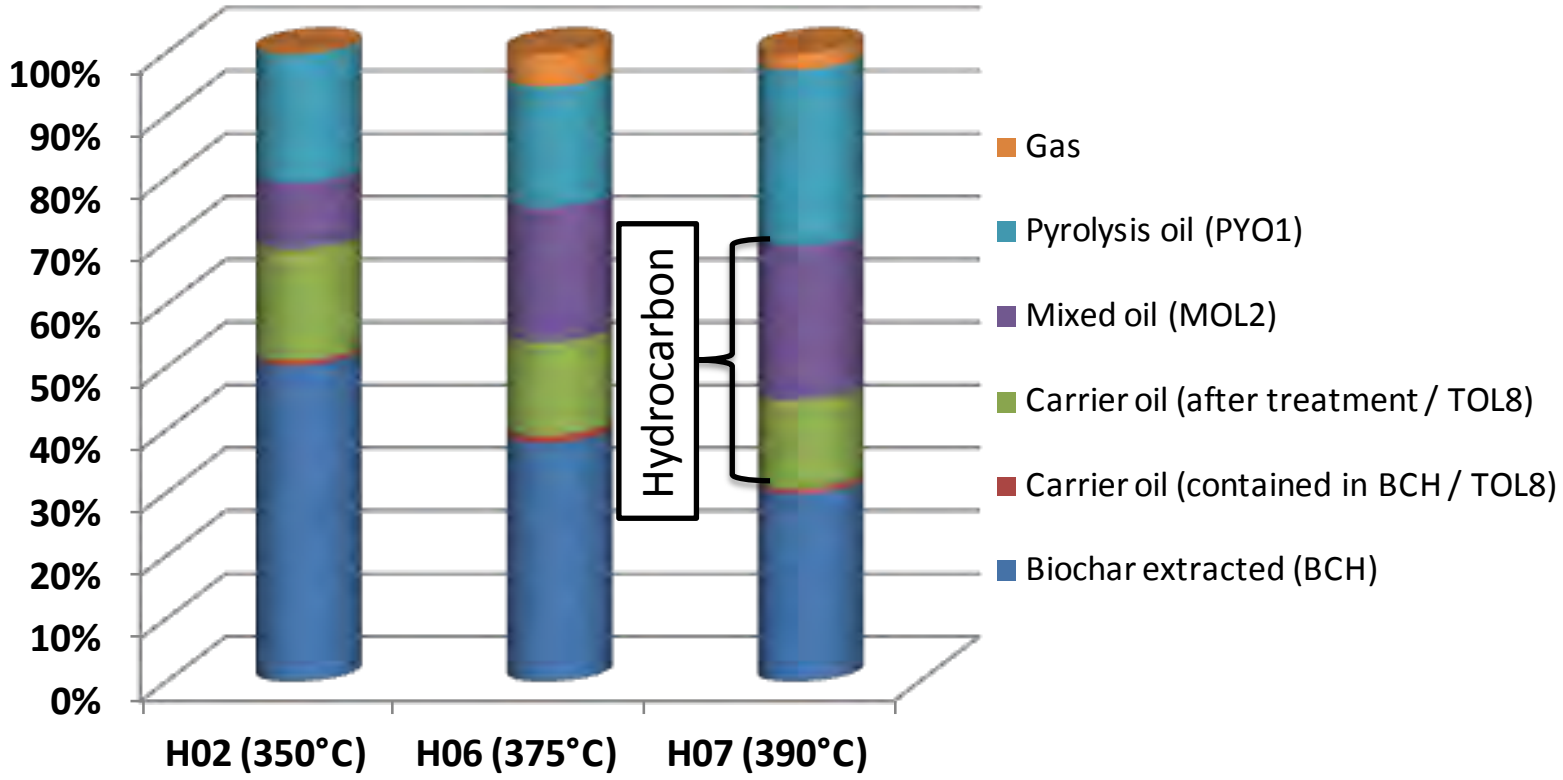
Mass-conversion of biomass vs. temperature



Results from bioCRACK Pilotplant Schwechat
Feedstock: spruce

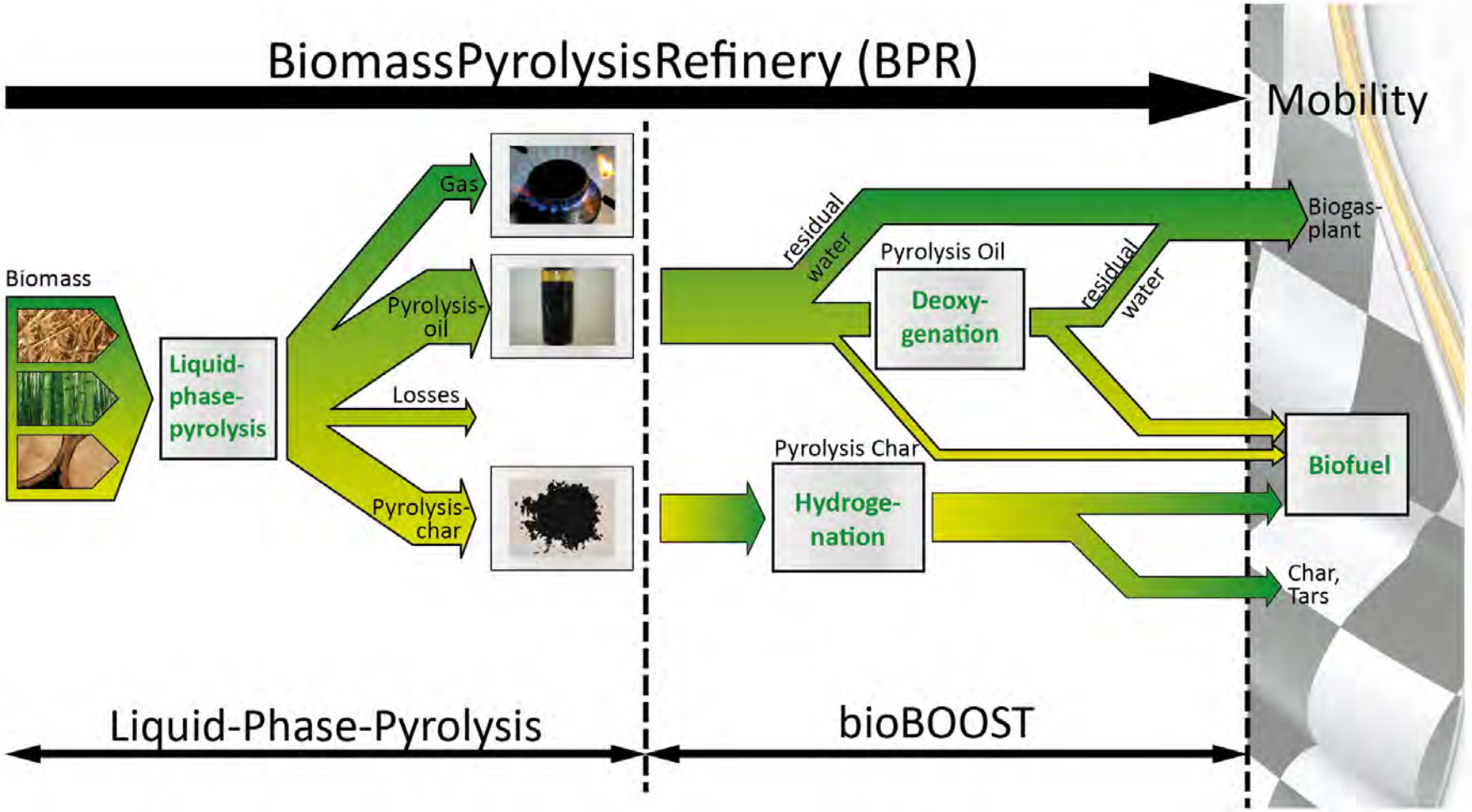
bioCRACK C14 Balance

Bio-carbon transfer vs. temperature



Results from bioCRACK pilotplant Schwechat
Feedstock: spruce

Ongoing Research & Development



bioCRACK Partners

BDI – BioEnergy International AG

OMV Refining and Marketing GmbH

Institute of Chemical Engineering and Environmental Technology
Prof. Dr. M. Siebenhofer

Austrian Climate and Energy Fund
“Neue Energien 2020”