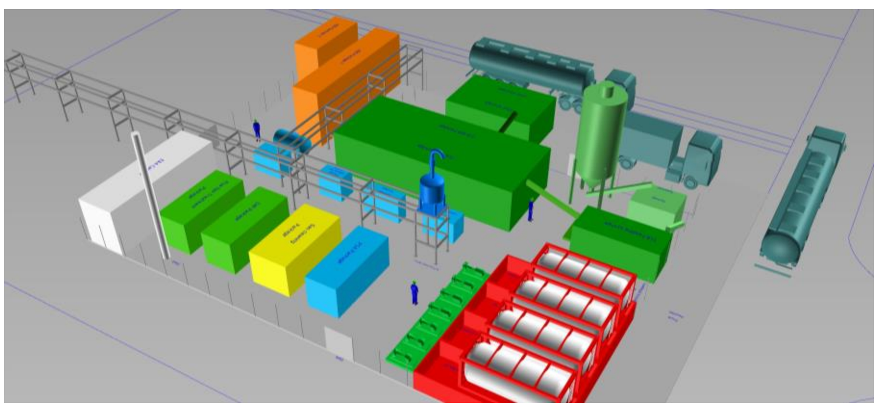
Production of synthetic fuels and green hydrogen from sludge: TO-SYN-FUEL

2synfuel



IWAMA 4th International Workshop

Smart Sludge Management

Tartu, Estonia

Thursday 8th February 2018

Nils Jäger

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grand agreement No 745749.

FAU Friedrich-Alexander Universität Erlangen-Nürnberg
University of Birmingham
Alma Mater Studiorum Università di Bologna
Fraunhofer UMSICHT

Fraunhofer-Gesellschaft
Research and development

- International research with focus on direct use for both private and public sector, and for the benefit of society
- Application-orientated fundamental research

Entrepreneurship

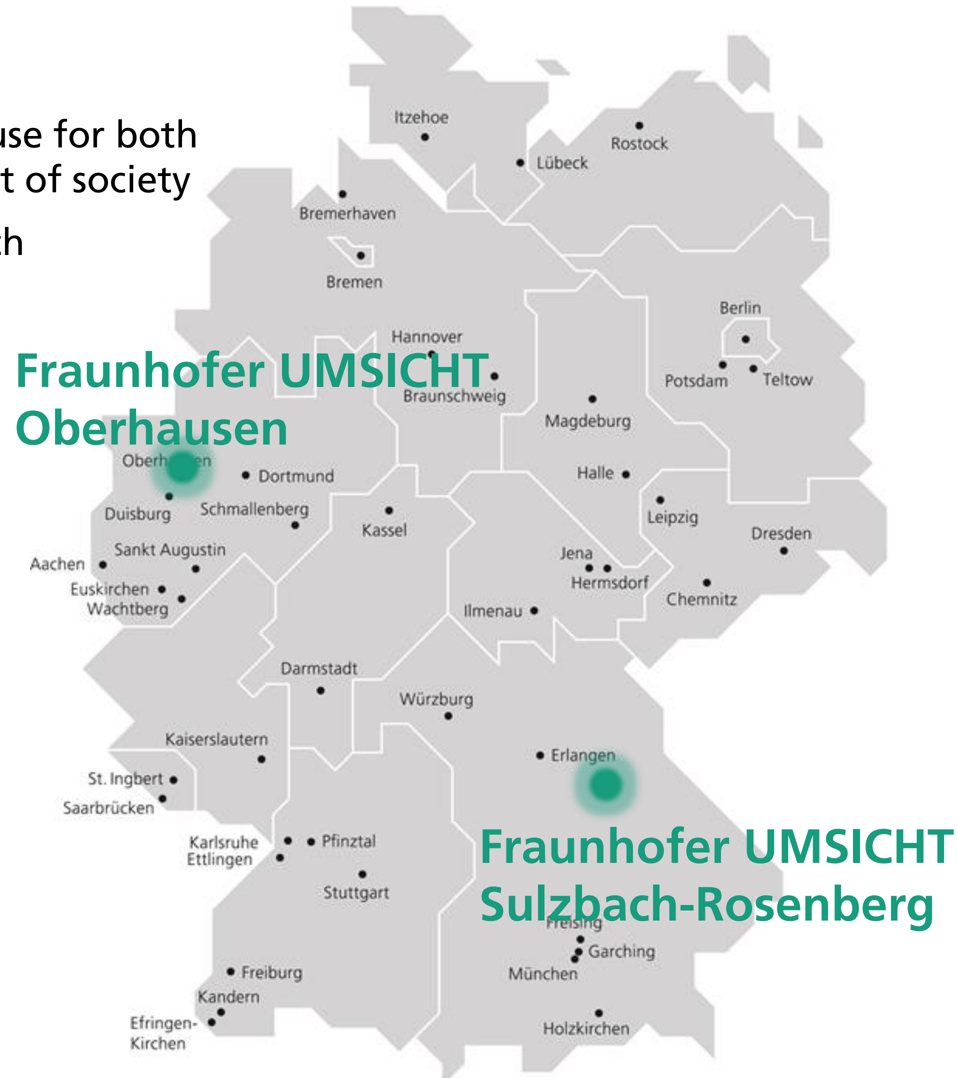
- Institutes organized as profit-centers
- A third of the budget are revenues from industrial projects
- Spin-offs are promoted

Contracting parties/ clients

- Industrial and service companies
- Public sector

Facts and figures

- > 24 500 staff members
- 69 research institutes
- 2.1 bn € annual research budget



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TO-SYN-FUEL

The Demonstration of Waste Biomass to Synthetic Fuels and Green Hydrogen

- Contribute to the Renewable Energy Directive targets for renewable energy by validating waste feedstocks for the production of fuels
- Production of green hydrogen, diesel and gasoline equivalent liquid fuels from sewage sludge

- Showcase for future sustainable investment and economic growth across Europe
- Development of a business case, LCA and dissemination of results

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TO-SYN-FUEL
Project Overview

- Project start May 2017 (project's lifetime 48 month)
- 12 partners from 5 different countries

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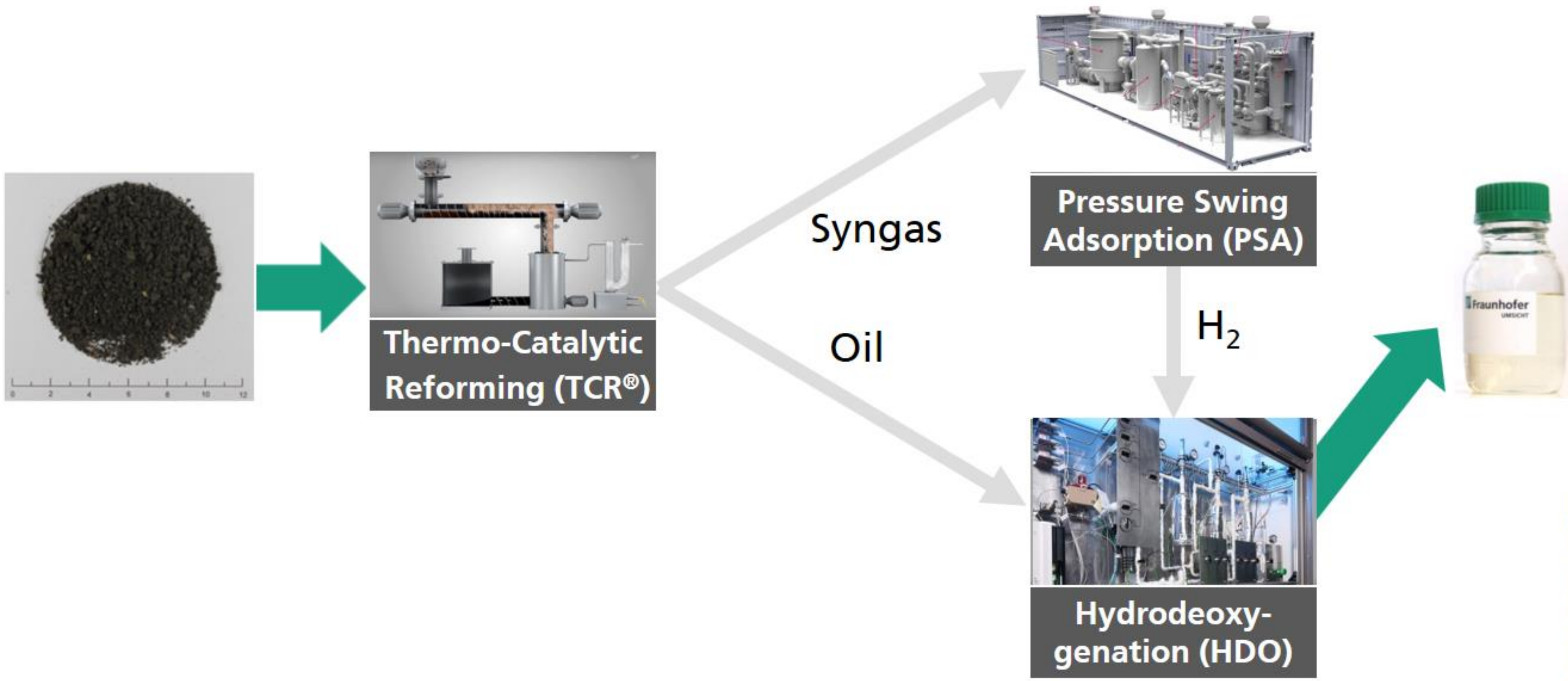
TO-SYN-FUEL
Core components



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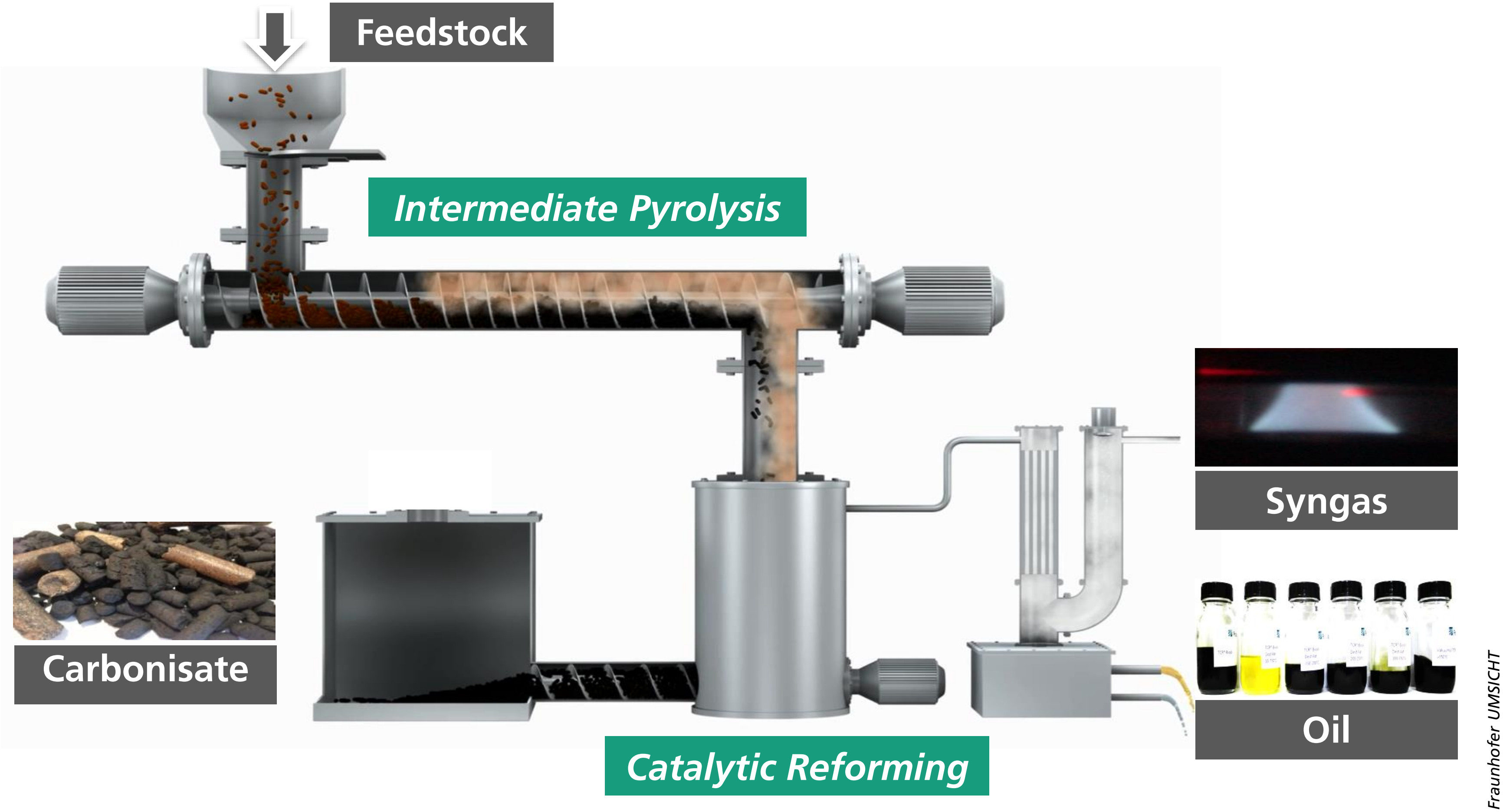
Thermo-Catalytic Reforming TCR®

A Platform Technology to use residues and to produce storable energy carriers



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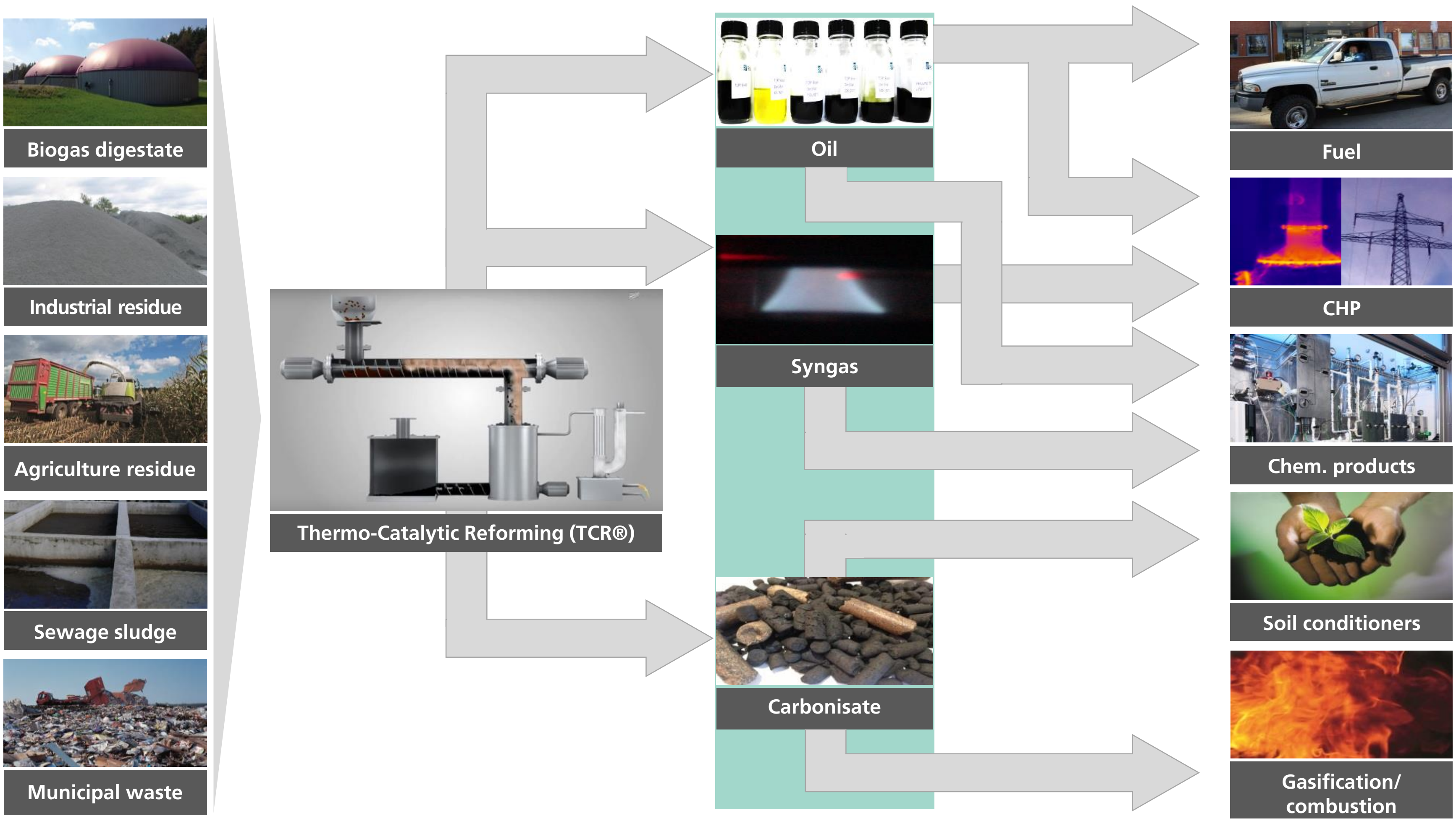
Thermo-Catalytic Reforming TCR®

Concept



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Thermo-Catalytic Reforming TCR®

Products and their characteristics

Syngas with a high hydrogen content

- Almost tar, aromatic and dust free gas
- Engine-ready gas
- Adjustable hydrogen content

Carbonisate for a variety of applications

- High soil stability
- Transportable and storable
- Very low H and O content

Fuel with a high quality

- No tar issues
- Miscible with fossil/bio fuels
- Low fraction of non-volatiles

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Thermo-Catalytic Reforming TCR®

Syngas from sewage sludge

Engine-ready gas

HHV: ≈23 MJ/m³

H_2	35 ± 3 v/v%
CO	8 ± 2 v/v%
CO_2	30 ± 3 v/v%
CH_4	14 ± 2 v/v%
C_xH_y	3 ± 1 v/v%

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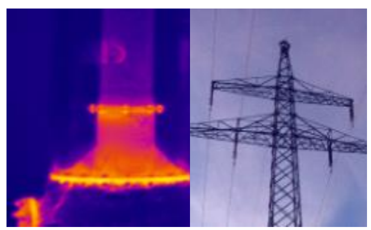
Thermo-Catalytic Reforming TCR®
Product utilization – Syngas

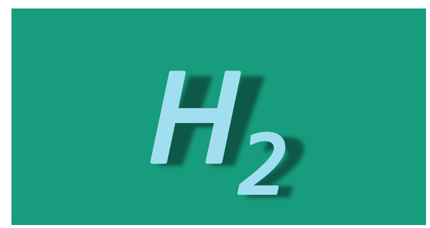
Energetic Use

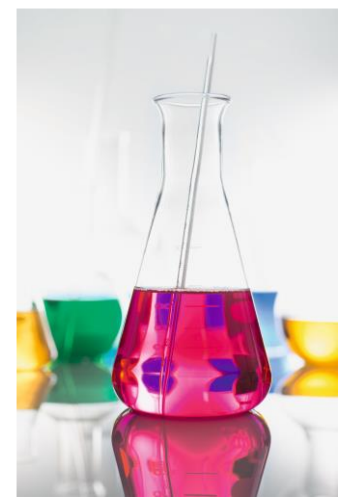
- CHP Engine
- Dual Fuel Engine (with Bio-oil)
- Gas Burner (Heating)

Material Use

- Synthesis Gas
- Green Hydrogen



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Thermo-Catalytic Reforming TCR®

Carbonisate from sewage sludge

Very low H and O content

HHV:
≈10.5 MJ/kg

C	33.5 wt.%
H	0.1 wt.%
N	3.5 wt.%
S	0.7 wt. %
O (diff.)	<2 wt. %
H_20	<1 wt. %
Ash	62 wt. %

Thermo-Catalytic Reforming TCR®
Product utilization – char

Energetic Use

- Co-Combustion in Power plant
- Cement Industry
- Gasification

Material Use

- Soil Improvement
- Phosphorous recovery






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Thermo-Catalytic Reforming TCR®
Phosphorous recovery from TCR-char

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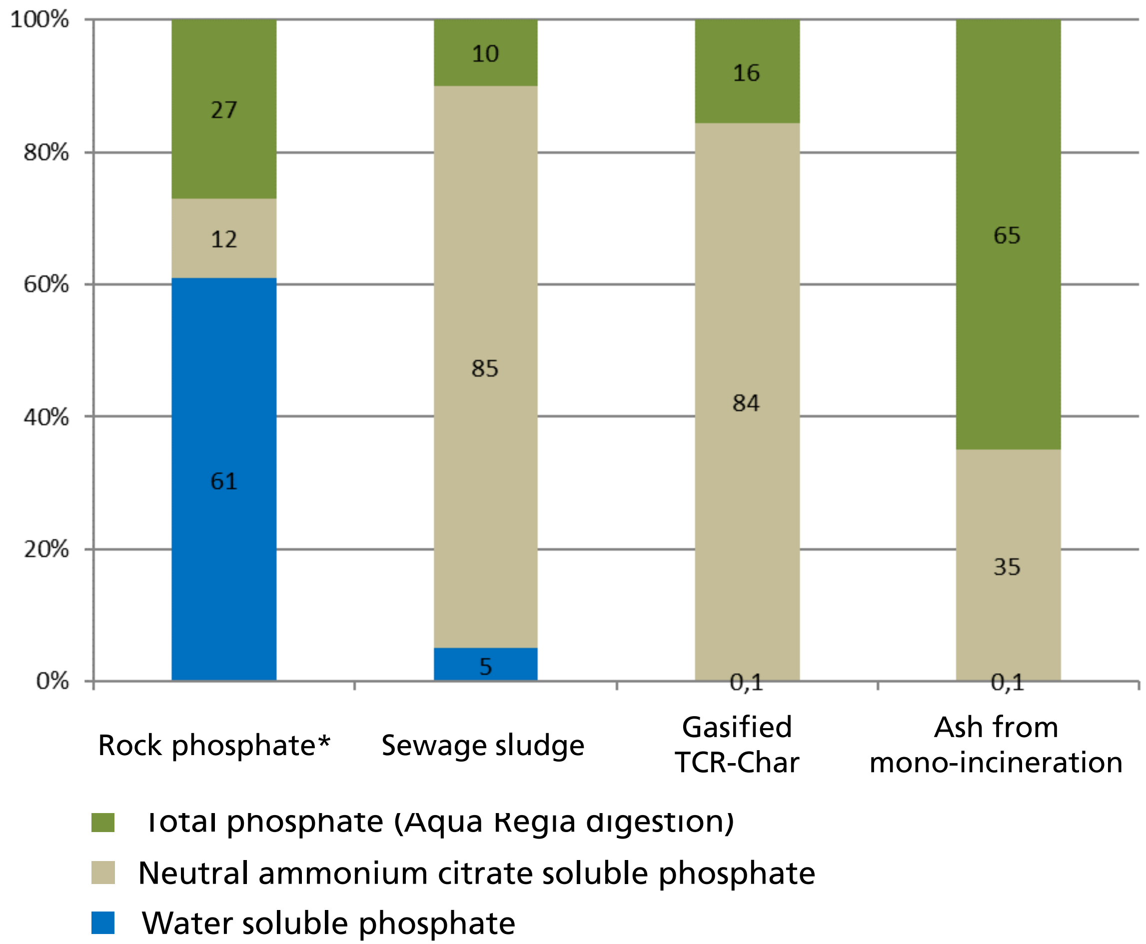
Thermo-Catalytic Reforming TCR®

Phosphorous recovery from TCR-char



*partial solubilisation

Sources: Kratz&Schnug 2008; FhU 2016, Krüger&Adam 2015

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Thermo-Catalytic Reforming TCR®
Bio-oil from sewage sludge

High quality, engine-ready

LHV: ≈38 MJ/kg

C	83.7 wt. %
H	9.0 wt. %
N	2.1 wt. %
S	0.9 wt. %
O (diff.)	3.7 wt. %
H_2O	0.6 wt. %
TAN	0.6 mg KOH/g
Ash	< 0.005 wt.%

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TCR® bio-oil as renewable fuels
General properties of TCR® bio-oil

- TCR® bio-oil is miscible with ethanol, biodiesel, vegetable oil, gasoline, diesel, crude oil…
- TCR® bio-oil + syngas directly applicable on dual fuel engines
- TCR® bio-oil is free of organic acids
- TCR® bio-oil is atmospheric distillable without coking
  - Distillation example of TCR® bio-oil

Cut Data		Atmospheric Cuts						
Start (°C) End (°C)	IBP FBP	C5 65	65 150	150 200	200 250	250 300	300 350	350 FBP
Yield (% wt)		2,1	33,4	12,5	13,5	3,4	11,2	23,9

IBP: Initial Boiling Point FBP: Final Boiling Point

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Thermo-Catalytic Reforming TCR®

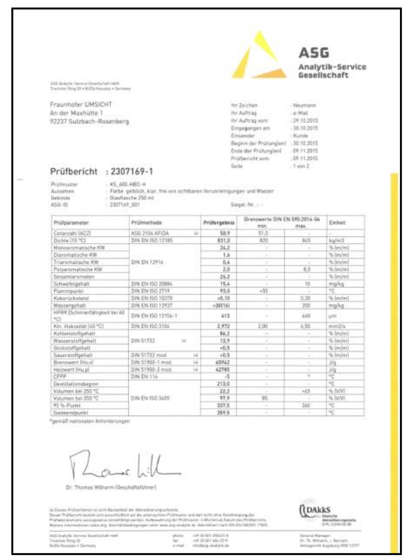
Product utilization – Bio-Oil

Crude TCR®-Oil

- Fuel Blends
- Dual Fuel Engine (with Syngas)
- CHP Engine

Up-graded TCR®-Oil

- Green Diesel
- Green Naptha and Jet Fuel
- Green Chemicals



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Prüfbericht : 2307169-1

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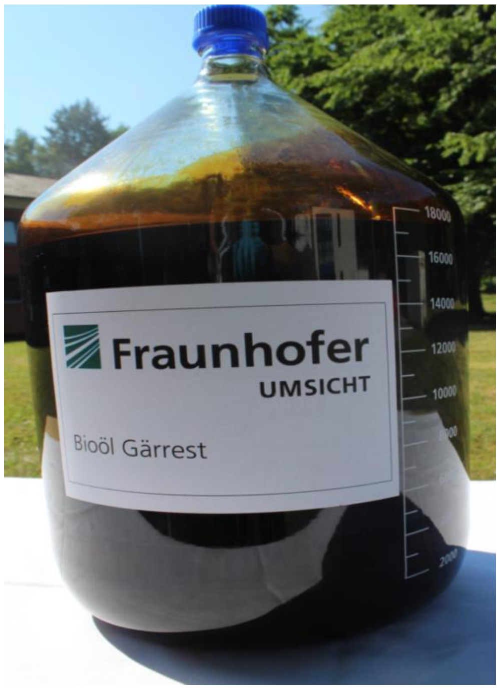
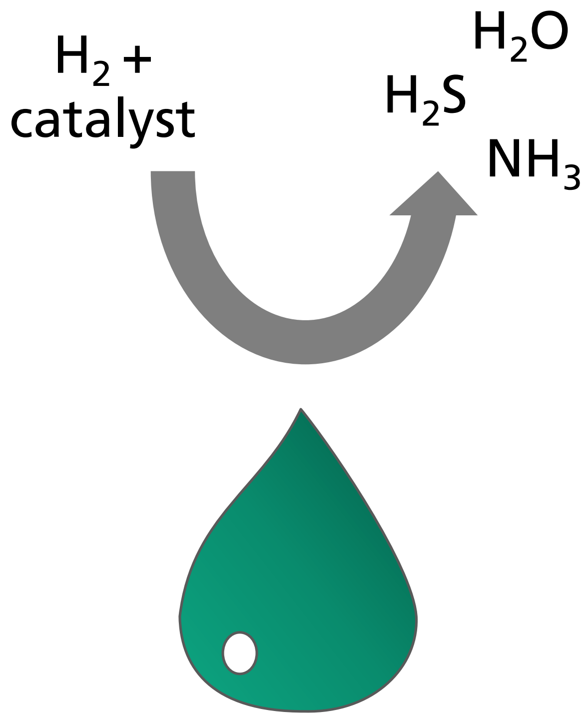
Upgrading of TCR® bio-oil for renewable fuels
Hydrotreating of TCR® bio-oil



TCR® bio-oil



Hydrotreated TCR® bio-oil (HBO)

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Upgrading of TCR® bio-oil for renewable fuels

Hydrotreating of TCR® bio-oil from digestate

TCR® BIO-OIL

C	77.6 wt%
H	8.0 wt%
N	4.6 wt%
S	0.6 wt%
O (diff.)	7.0 wt%
H_2O	2.2 wt%
Ash	< 0.005 wt%

LHV	34.0 MJ/kg
TAN	2.1 mg KOH/g
Viscosity	4.4 mm²/s
Density	1014.4 kg/m³

HYDROTREATING

HYDROTREATED TCR® BIO-OIL (HBO)

C	86.2 wt%
H	13.0 wt%
N	< 0.5 wt%
S	0.01 wt%
O (diff.)	< 0.7 wt%
H_2O	0.003 wt%
Ash	< 0.005 wt%

LHV	42.25 MJ/kg
TAN	< 0.1 mg KOH/g
Viscosity	0.97 mm²/s
Density	815 kg/m³
Flash point	< - 20 °C
Yield	83 wt%

Neumann, J.; Jäger, N.; Apfelbacher, A.; Daschner, R.; Binder, S.; Hornung: Biomass and Bioenergy, 2016

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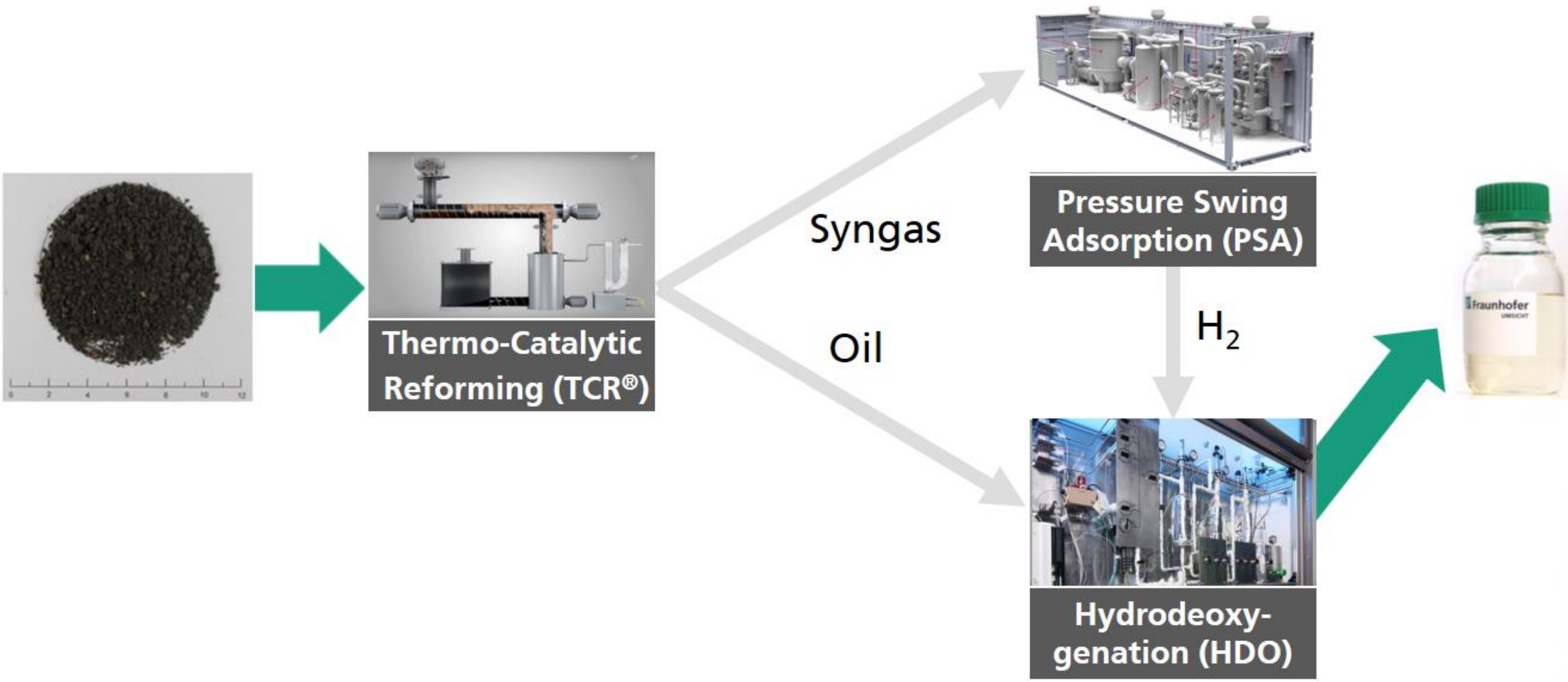
TO-SYN-FUEL
Core components



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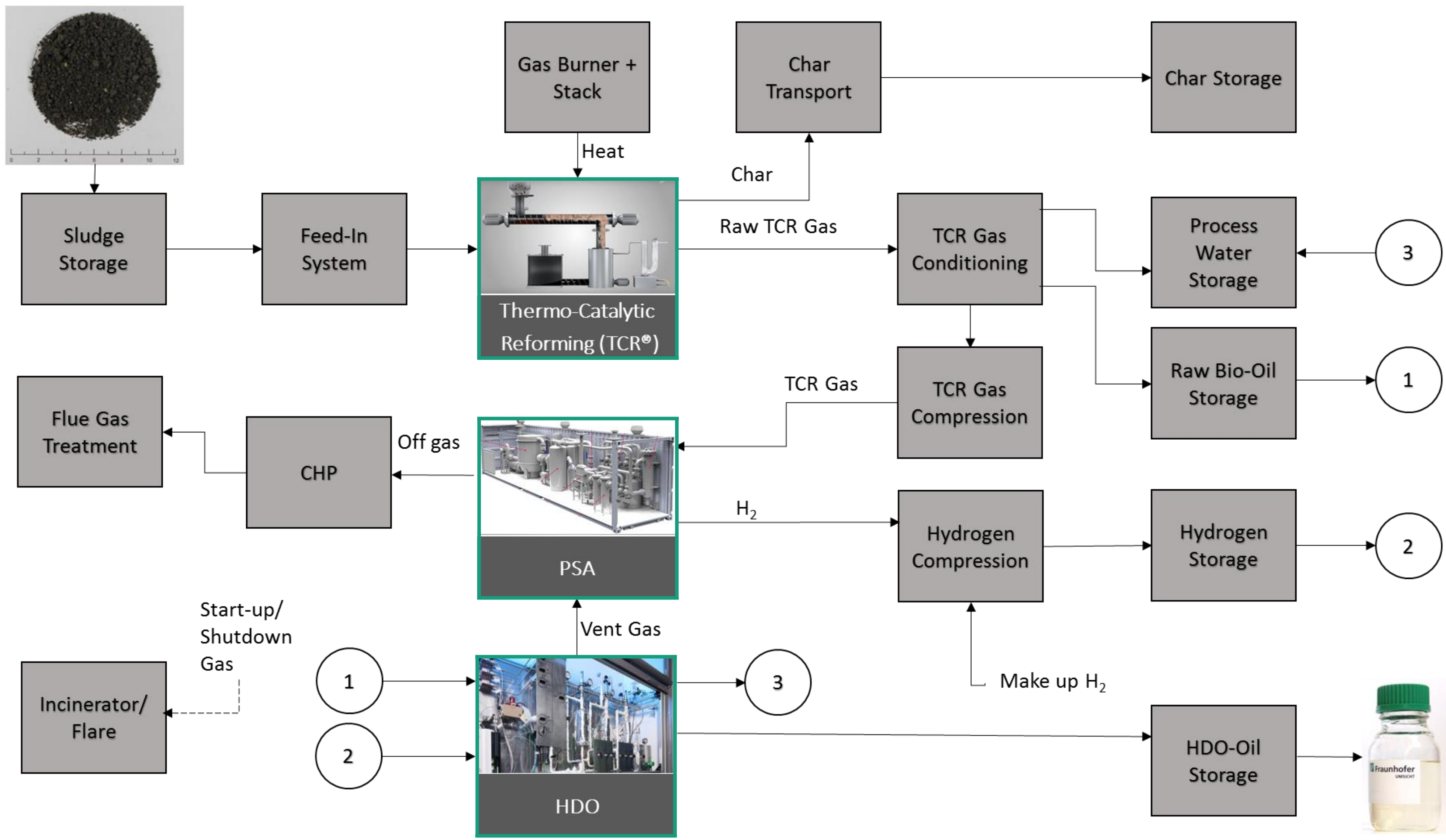
TO-SYN-FUEL
Engineering Scope



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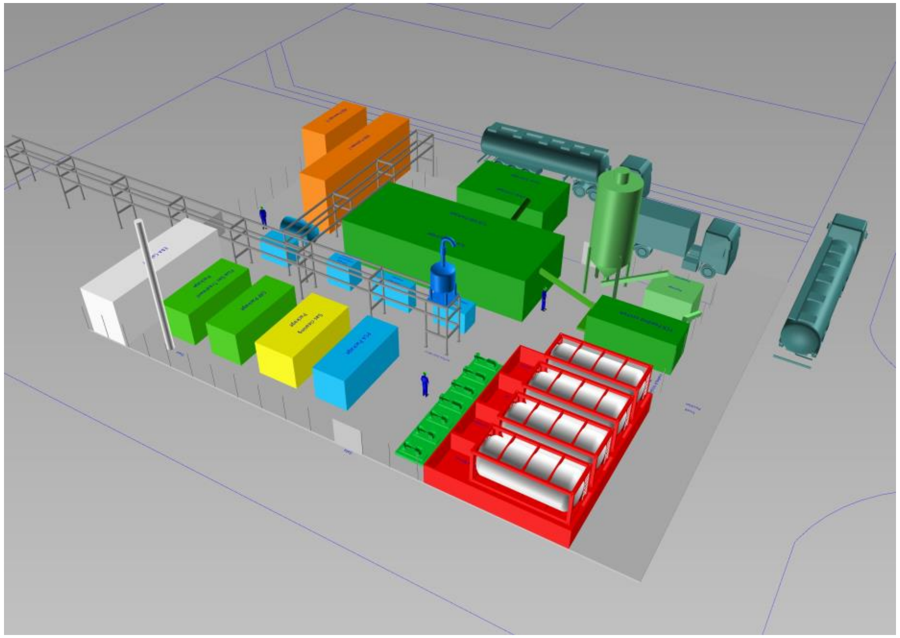
TO-SYN-FUEL
Next steps

■ Construction phase	Q1/2018
■ Commissioning phase	Q1/2019
■ Demonstration phase	Q2/2019-2021

- 7000 h of operation
- 300 kg/h of sewage sludge
- 200 t of HDO liquid fuels



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TO-SYN-FUEL
Stakeholders engagement

If you would like to become more involved with the project platform and include your organisation details in the TO-SYN-FUEL Stakeholder Database, please use the Stakeholder Registration Form.

http://www.tosynfuel.eu/?page_id=2489

Keep in touch with the project to learn about the development of best practices regarding market implementation, commercialization and deployment of new technologies and processes.

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Thank you very much for your attention

2synfuel

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grand agreement No 745749.

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