Energy Systems
and Technology
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TECHNISCHE
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# CLARA Project Overview

**Jochen Ströhle**

**2nd Public Workshop**
**25 April 2023**

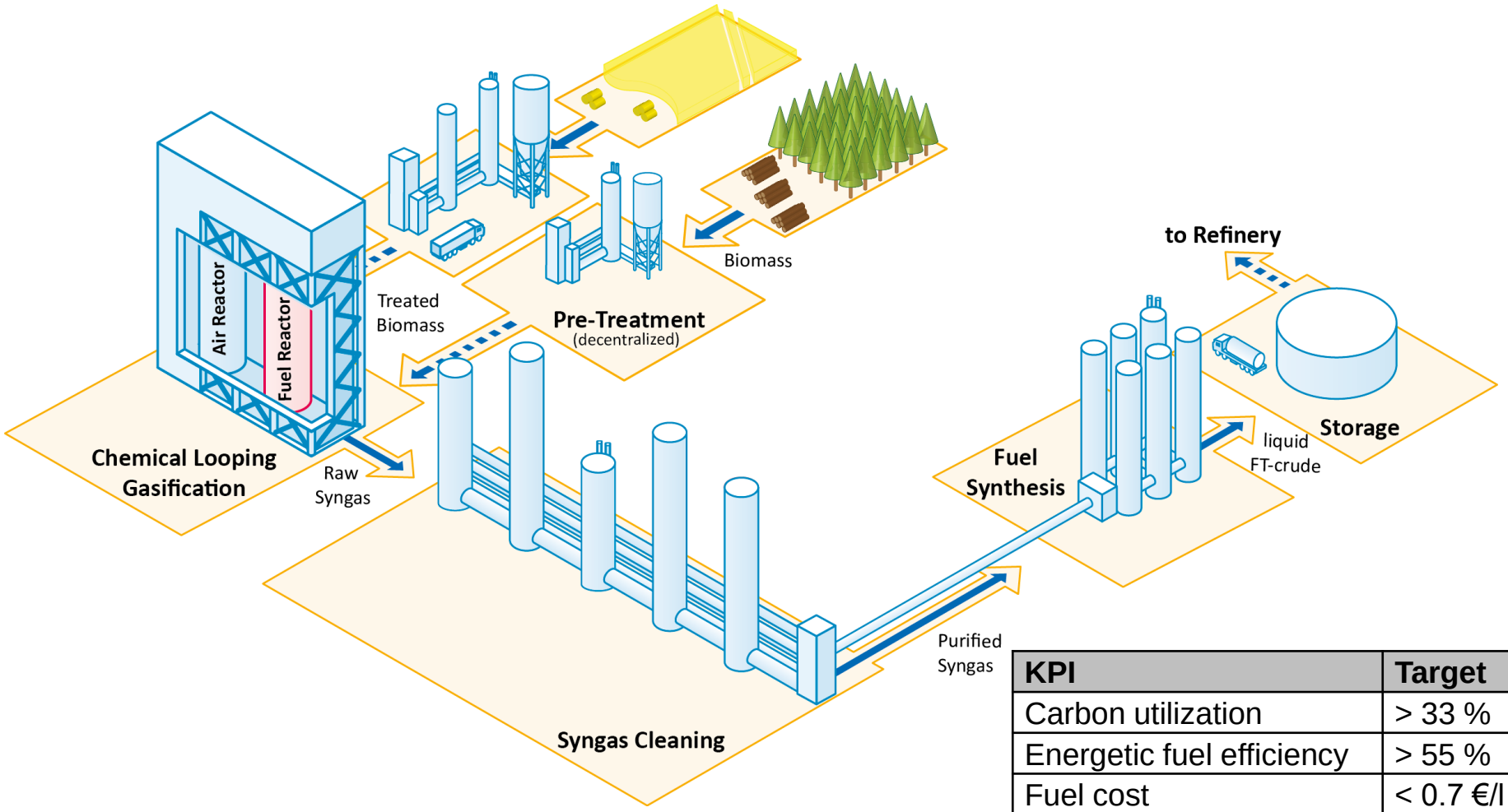
ETIP Bioenergy
European Technology and Innovation Platform

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No *817841*.

# Agenda

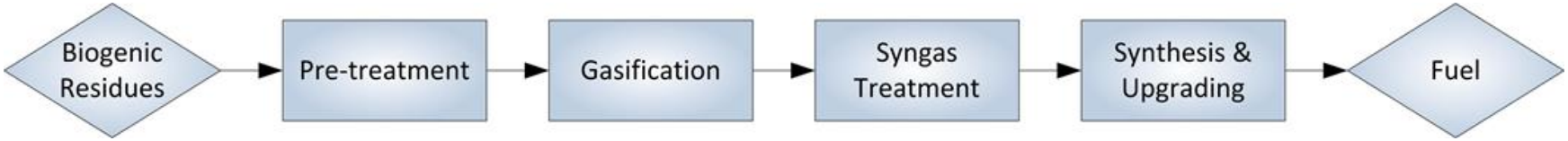
| | | |
|---|---|---|
| 09:00 – 09:15 | Introduction<br>• Welcome<br>• Project Overview | J. Ströhle (TUDA) |
| 09:15 – 10:45 | Presentations - CLARA<br>• Pilot Testing<br>• Commercial Process Design Concept<br>• Socio- and Techno-Economic Assessment | CLARA Consortium |
| *10:45 – 11:00* | *Coffee break* | |
| 11:00 – 12:30 | Presentations - External<br>• Jet fuel production from residues and wastes via hydrothermal liquefaction: Results and perspectives from the EU projects HyFlexFuel and CIRCULAIR<br>• Gasification as key enabling technology for advanced biofuels<br>• R&D and commercial application of HTW Gasification | V. Batteiger (Bauhaus-Luftfahrt)<br>N. Dahmen (ETIP Bioenergy)<br>D. Toporov (GID) |
| *12:30 – 13:30* | *Lunch* | |
| 13:30 – 14:30 | Panel Discussion<br>• Enabling the Clean Energy Transition with 2nd Generation Biofuels | |
| 14:30 - 16:00 | Pilot Plant Visit<br>• Introductory presentation on pilot plant<br>• Pilot plant visit in small groups | B. Epple (TUDA) |

# Overall Concept




| KPI | Target |
|---|---|
| Carbon utilization | > 33 % |
| Energetic fuel efficiency | > 55 % |
| Fuel cost | < 0.7 €/l |
| $CO_2$ emissions | < 0 |
| Cold gas efficiency | > 82 % |
| Carbon conversion | > 98 % |

# Technologies

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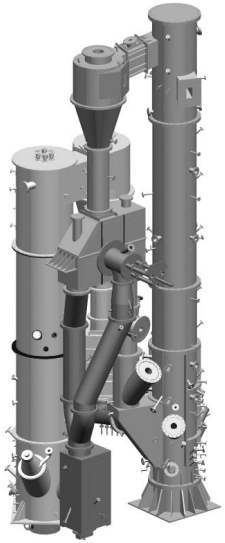
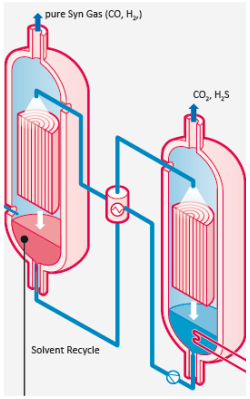
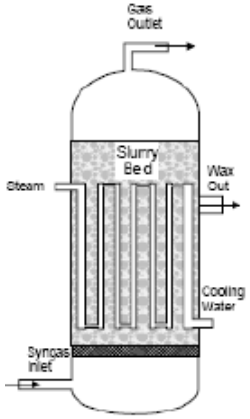




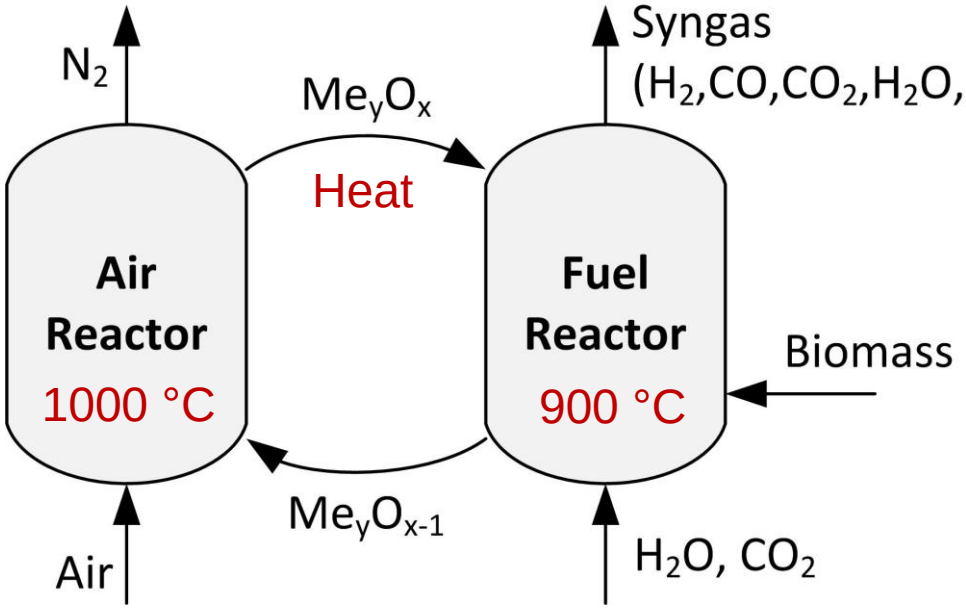



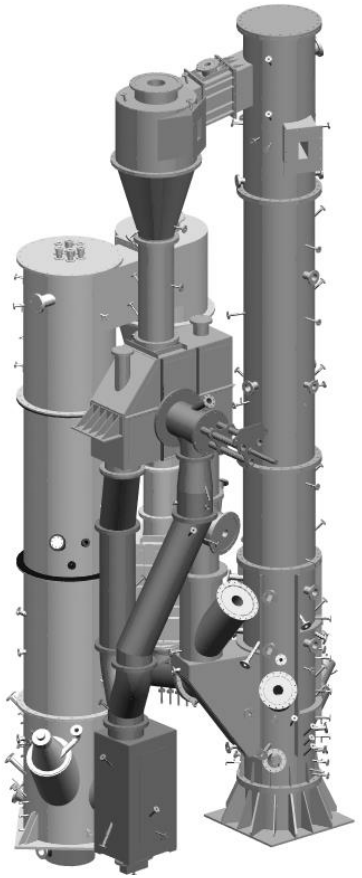

wiki.gekgasifier.com

www.elaflex.de

| Biogenic residues (wheat straw, pine residue) | Torrefaction, leaching, additivation, pelletization | Chemical looping gasification | Amine wash, fine cleaning, sulphur recovery | Fischer-Tropsch synthesis, Hydrocracking | Liquid fuel (Gasoline, diesel) |
|---|---|---|---|---|---|

# Chemical Looping Gasification



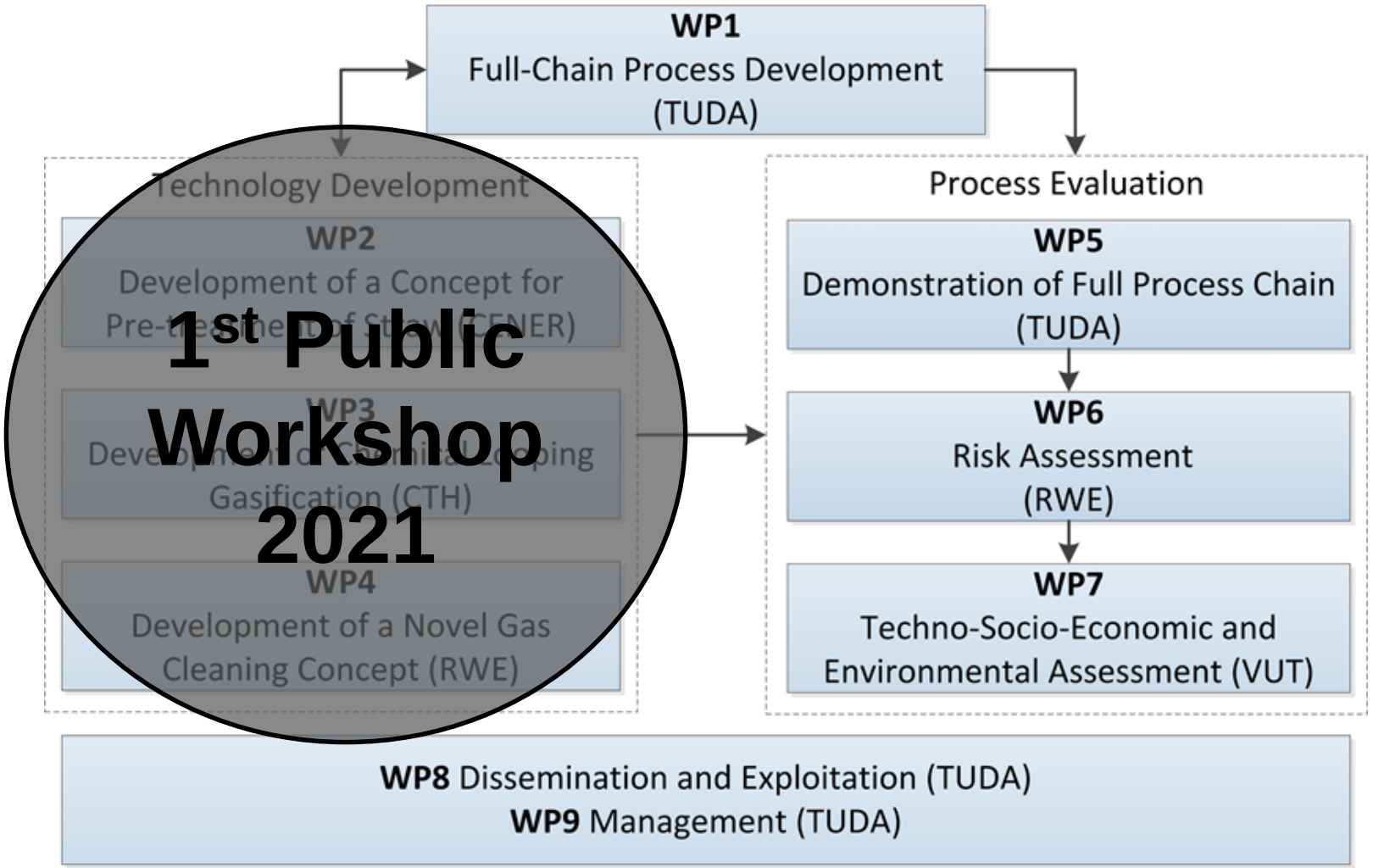



- Oxygen for partial oxidation of fuel is provided by metal oxide
- No air separation unit required (→ high energetic efficiency)
- Catalytic conversion of hydrocarbions/tars by metal oxide (→ high syngas quality)
- All $CO_2$ separated from syngas (→ negative $CO_2$ emissions possible)

# Objectives

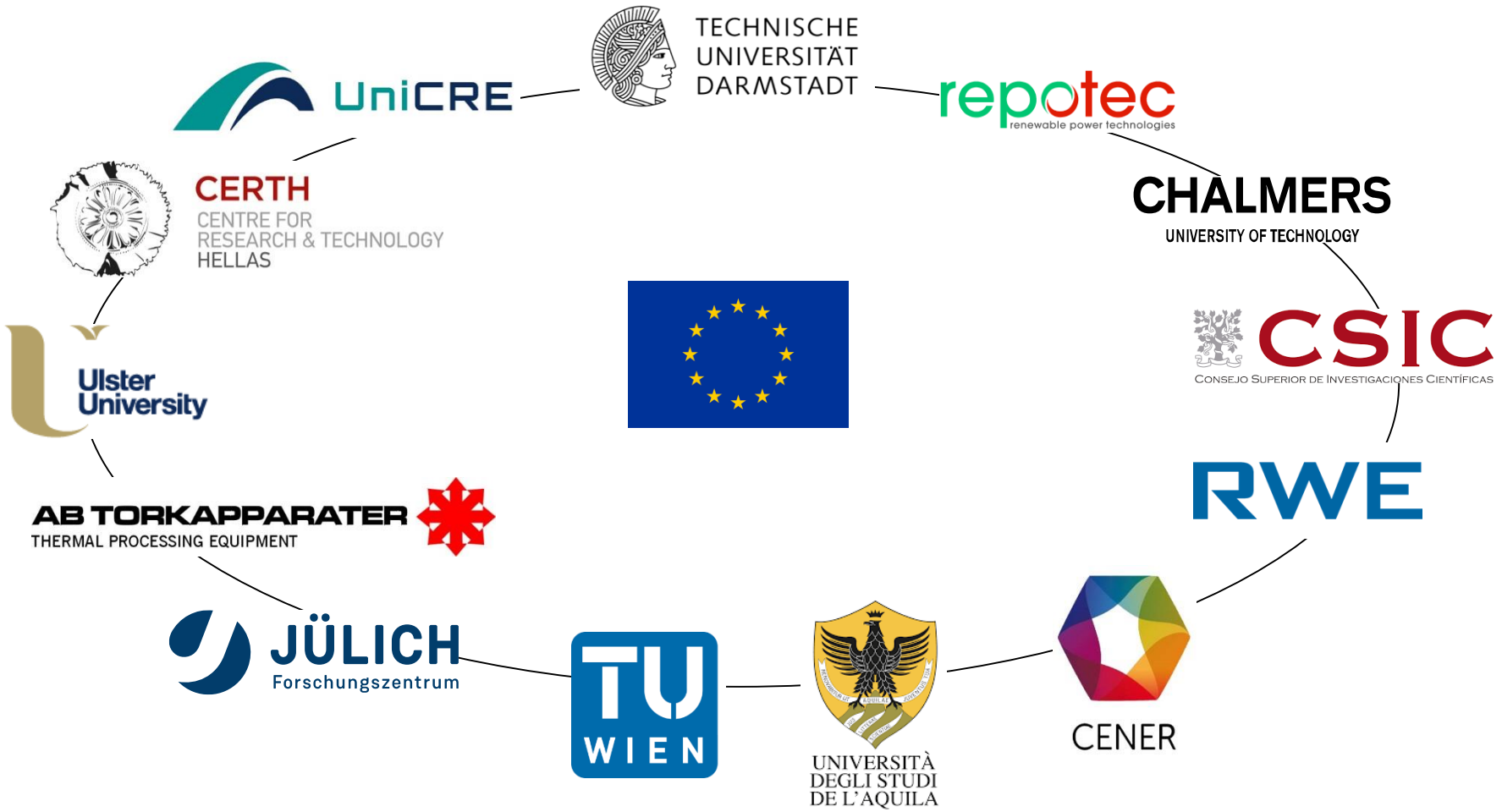
1. Develop and test a concept for **CLG of biogenic residues**
2. Develop concepts for **pre-treatment of biogenic residues**
3. Develop and test a **new syngas cleaning technology** to reduce CAPEX and OPEX of syngas treatment by 50 % (compared to Rectisol$^{TM}$)
4. **Demonstrate the full process chain** using a 1 $MW_{th}$ CLG unit
5. Demonstrate and optimize **road transport drop-in biofuels production** via catalytic hydrocracking of FT-wax
6. **Scale up** to **industrial size** (100 – 300 $MW_{th}$, 30,000 – 100,000 t/y fuel) using adequate **models** validated at pilot scale (targets see KPIs)
7. Estimate the **cost structures** including dynamic cost development due to technological learning, and explore the **market potential** for biofuels by CLG
8. Assess **risks** and suggest possibilities for risk mitigation
9. Determine **impact** of biomass-to-fuel chain on **environment** and **society**

# Project Structure




**1st Public Workshop 2021**

# Consortium


UniCRE
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UNIVERSITY OF TECHNOLOGY
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AB TORKAPPARATER
THERMAL PROCESSING EQUIPMENT
RWE
JÜLICH
Forschungszentrum
TU WIEN
UNIVERSITÀ DEGLI STUDI DE L'AQUILA
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# Questions?

- Write in chat (to all or to Paul Dieringer)

# Thank you for your participation

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No *817841*.

# Key Performance Indicators

| KPI | Target |
|---|---|
| Carbon utilization | > 33 % |
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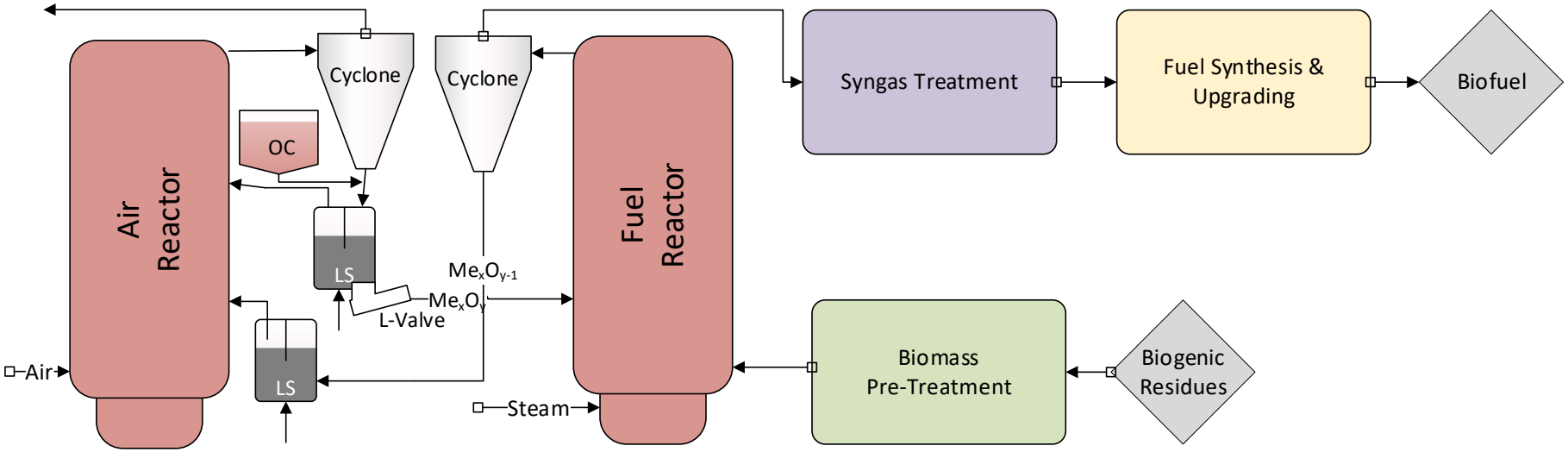

# Key Performance Indicators

| KPI | Definition | Target | Means of verification |
|---|---|---|---|
| Carbon utilization | Fraction of carbon in initial feedstock that is converted to the fuel | > 33 % | Carbon mass balance of the entire BtL chain by full-chain tests and process simulations |
| Energetic fuel efficiency | Fraction of chemical energy in initial feedstock that is transferred to the fuel | > 55 % | Mass and energy balance of entire BtL chain by full-chain tests and process simulations |
| Fuel cost | Cost for production of transport fuel considering revenues from sale of power, heat, $CO_2$, and others | < 0.7 €/l | Techno-economic assessment of entire BtL chain |
| $CO_2$ emissions | Net emissions of $CO_2$ per produced fuel considering $CO_2$ storage | < 0 | Life cycle analysis of entire BtL chain |
| Cold gas efficiency | Fraction of chemical energy in feedstock that is transferred to syngas in the gasifier | > 82 % | Mass and energy balance of gasifier by pilot tests and process/CFD simulations |
| Carbon conversion | Fraction of carbon in feedstock that is converted to gas in the gasifier | > 98 % | Carbon mass balance of gasifier by pilot tests and process/CFD simulations |