

Sustainable resources and energy from organic waste

susteen
Technologies
sustainable resources from waste

Thermo-Catalytic Reforming TCR®

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www.susteen-tech.com



Susteen Technologies is a spin-off venture from Fraunhofer-Gesellschaft e.V.



- Commercializing innovative carbon-based waste conversion technology
- Developed by Fraunhofer-Gesellschaft e.V. – Europe’s largest application-oriented research organization
- Based in Sulzbach-Rosenberg, Bavaria, Germany
- Subsidiaries in UK and Canada
- Collaborating with international industrial and research partners

Sustainable resource solutions from carbon-based waste streams



- **Converting a wide range of carbon-based wastes**
- **Dropping into existing value chains**



... into renewable gas, oil and char
... with alternatives for fossil downstream applications

2020: Over 5 bn. t/year of addressable dry organic waste potential globally

Image source: Fotalia (kanvag, Kwest)

A flexible, integrated waste-to-resources solution ...



Agricultural residue



Municipal organic waste



Industrial organic waste



Thermo-Catalytic Reforming (TCR®)



Syngas



Oil



Char



Power



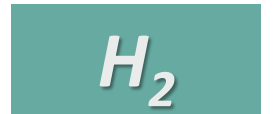
Heat



Agriculture



Fuels



Hydrogen



Chemicals

Image source: Fotalia (dk-fotowelt, animafloa, Moreno Soppelsa, barbara31, Fotomanufaktur JL, karepa, Gina Sanders, Lukas Gojda, maho, weerapat1003, industrieblick)

Current focus: Flexible municipal organic waste-to-energy solution



Agricultural residue



Municipal organic waste



Industrial organic waste

Flexibility in organic waste management

- Suitable for mixed waste materials and batch processing
 - Suitable for treatment of plastics content
- Suitable for variable water content and particle sizes
 - Decentralized waste management



Syngas



Oil



Char



Power



Heat



Agriculture



Fuels

H_2

Hydrogen



Chemicals

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Our Technology Platform – Thermo-Catalytic Reforming (TCR®)

Developed by Fraunhofer UMSICHT



Key Innovations

- Self-replenishing catalyst
- Tar avoidance
- Robust for industrial use
- Flexible input & output
- High energy efficiency
- Low emissions – no solid combustion

For a video illustrating the TCR® process please refer to the following link: <https://www.youtube.com/watch?v=i2Lx0XxQqsk>, © 2014 Fraunhofer UMSICHT

Producing sustainable resources in quality for many applications

Biochar



Char in hard coal quality

- Dry, storable and transportable
- High carbon content
- Mineral content depending on feedstock
- Free of toxic organics



Power



Heat & Cooling



Agriculture



Animal Feed



Barbeque Char

Syngas



Clean, hydrogen rich syngas

- Up to 50% hydrogen content
- High energy content
- Good C/H ratio for synthesis applications
- Free of tar, dust and aerosols



Power



Heat

H_2

Hydrogen



Fuels



Chemical feedstock

Biocrude Oil



Refinable oil in engine quality

- Suitable for engine applications
- Suitable for refining
- Low acidity
- No tar or wax
- High heating value
- Miscible with fossil oil and fuels



Engines



Power



Heat



Fuels



Chemical feedstock

Ongoing demonstration projects

Energy efficient recycling of sewage sludge Bavarian energy research program



- Industrial TCR® prototype for 7 t/day
- Power & heat generation on dual fuel engine (MAN D26)
- High phosphate ash from char gasification
- Demonstration of continuous operation

Drop-in fuels & hydrogen from sludge EU Horizon 2020



- Industrial TCR® plant for 12 t/day in Rotterdam
- Refining of TCR® oil to drop-in Diesel and Gasoline – DIN EN 590 and DIN EN 228
- Hydrogen separation from TCR® syngas
- Engine and vehicle testing of fuel products

Bayerisches Staatsministerium für
Wirtschaft und Medien, Energie und Technologie



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

Pilot plant in operation - commercial scale prototype in construction



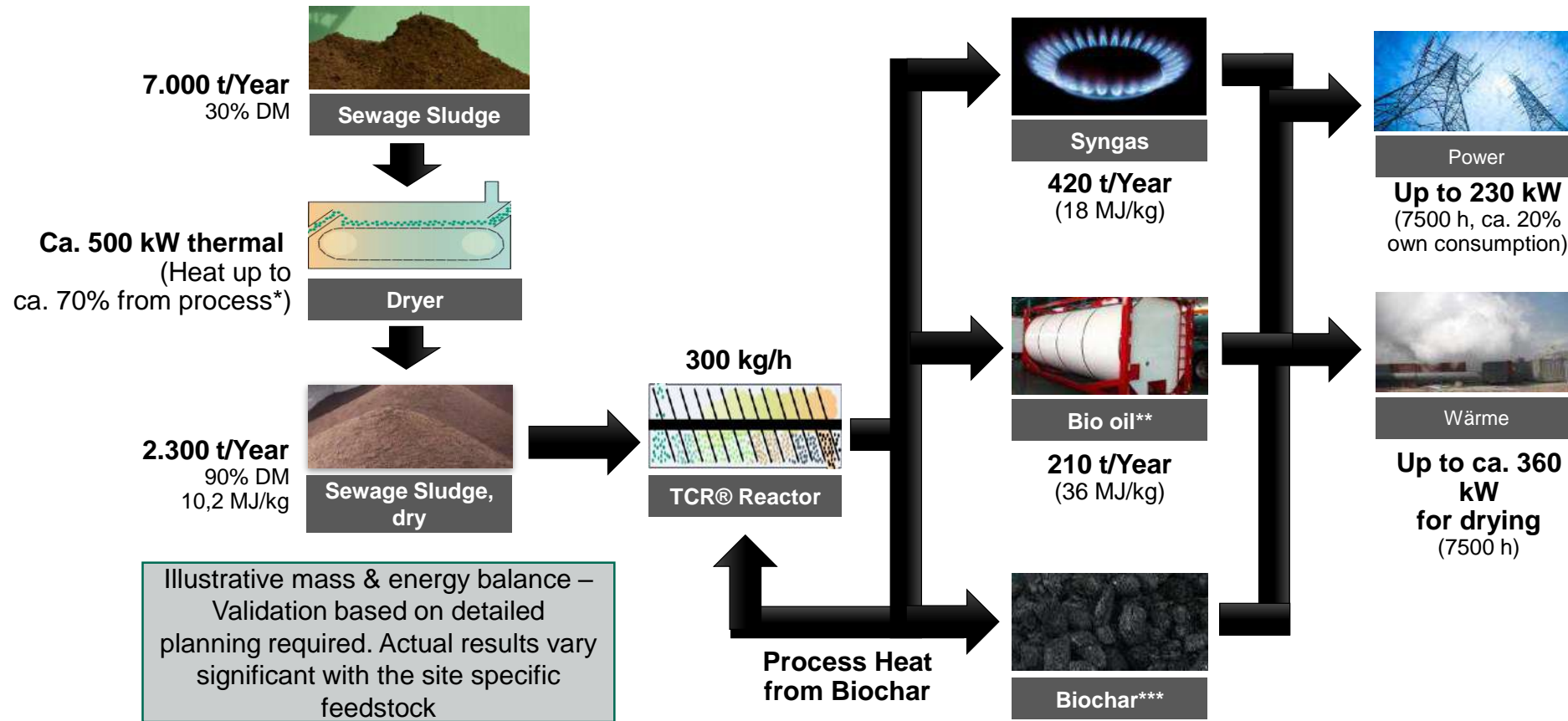
Containerized pilot plant in operation



Commercial scale prototype for 7 t/day of sewage sludge in commissioning

Energy efficient recycling of sewage sludge

Application scenario



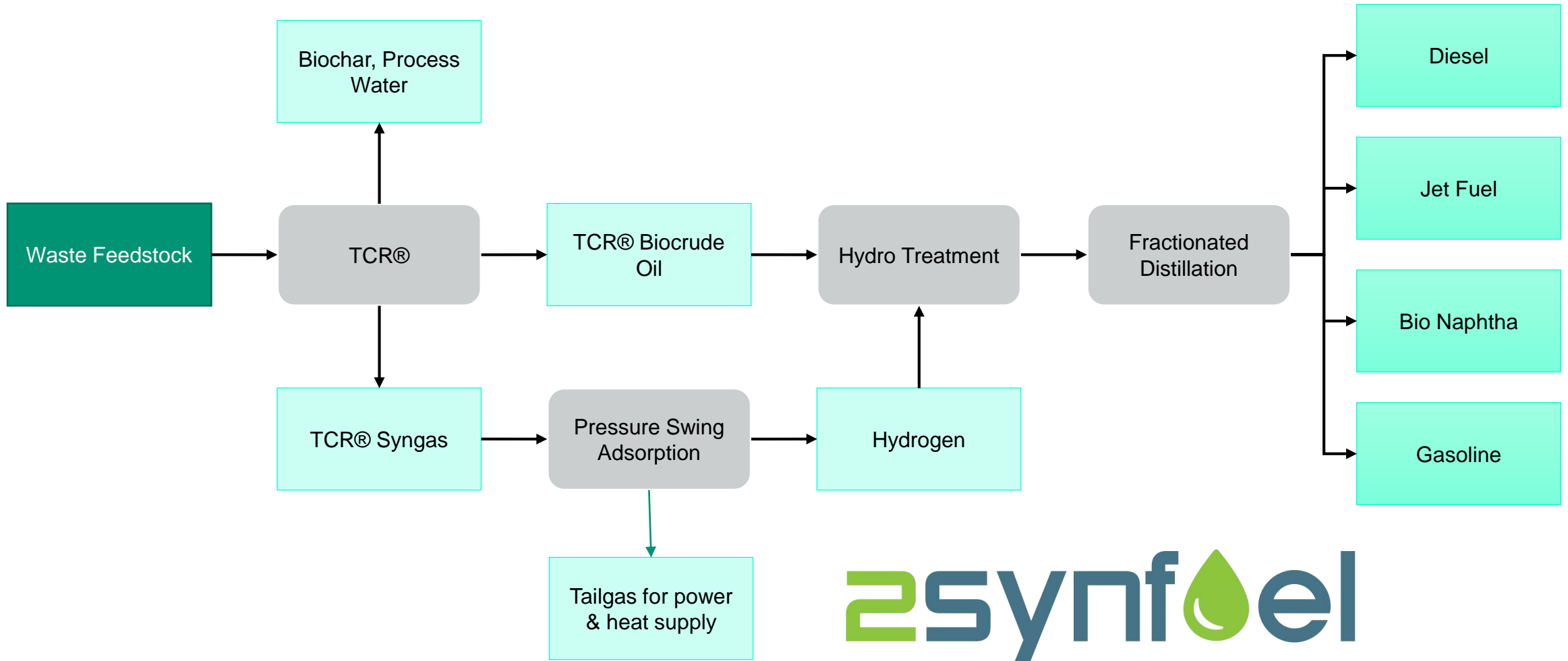
* Heat for sewage sludge drying from CHP plant and process heat recovery (based on technical analysis with 0.8 kWh/kg water drying efficiency)
 ** Bio oil with approx. 10-20% of bio diesel mixed in (ca. 40 t/year)
 *** Biochar is gasified in optional reactor module for process heat generation and CHP)
 **** Additional ca. 500 t/year process water for treatment

Decentral processing of Sewage Sludge – TCR® and Mono Incineration

	Digestion – Incineration	TCR
Reference	Sewage sludge plant Rügen 2017	Projection based on pilot data
Process	Anaerobic digestion Dewatering – thermal drying Mono Incineration	Dewatering – thermal drying Thermo-catalytic reforming
Feedstock Capacity (dry matter)	2500 tpa	3700 tpa
CAPEX	14 Mio. EUR – 5.6 k€/tpa	5-8 Mio. EUR – 2.2 k€/tpa
Power Capacity	330 kW – based on primary sludge	500 kW – based on primary sludge
Phosphate recovery in ash	62% usable product ash 38% fly ash to landfill	100% usable product ash – no slag

Refining TCR® biocrude oil through industry standard technology

Industrial demonstration through 2synfuel project



2synfuel

Technology Advantage

Feedstock flexibility

Suitable for most types of biomass and other carbon-based materials

Over 50 different types of feedstock tested successfully

Product quality and flexibility

Top quality biochar, biocrude oil and syngas

60% of product energy storable and transportable

Downstream flexibility

Industrial robustness

No maintenance and product cleaning issues from tar and dust

Robust with variable feedstock, particle size, and water content

Energy efficiency

More than 80% primary energy efficiency

Innovative efficient process heating technology – patent filed

Economic solution

Decentralized and industrial scale applications

Capital cost 25-50% below waste incineration

Risk reduction through flexibility

Susteen Technologies

Thank you for your interest!

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