TECHNISCHE UNIVERSITÄT WIEN
Vienna | Austria

COP24 · KATOWICE 2018
UNITED NATIONS CLIMATE CHANGE CONFERENCE

Event | Austrian Pavilion, COP 24, Hall E – #1 | 2018/12/06, 10.00-12.00

New Technology and Innovation for De-carbonisation and Sustainability

- Innovations for energy systems in industry
- Innovations in green energy supply – Integration of biogas upgrading into PtG, Decentral supply of green H_2, Thermochemical conversion of biomass residues to green fuels, electricity and heat
- More technologies from TU Wien to reduce CO_2-emissions
- Experience with systems for renewable energy supply – EGGER Holzwerkstoffe, Kohlbach Energieanlagen , M-U-T

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Innovations for energy systems in industry - Modeling - Components - Operation

Univ. Prof. René Hofmann

Institute of Energy Systems and Thermodynamics

Innovations for Energy Systems in Industry

… 1/3 of world energy consumption is needed by industry

this share can be reduced significantly …

Questions to be answered …

Industry

Systemic

- Demand for renewable generation / Sectoral Coupling Gas, Electricity, Heat / Need for flexibility

Technology

- Storage tanks, heat pumps, etc. / New production processes / Network technologies (e.g. DC)

Market

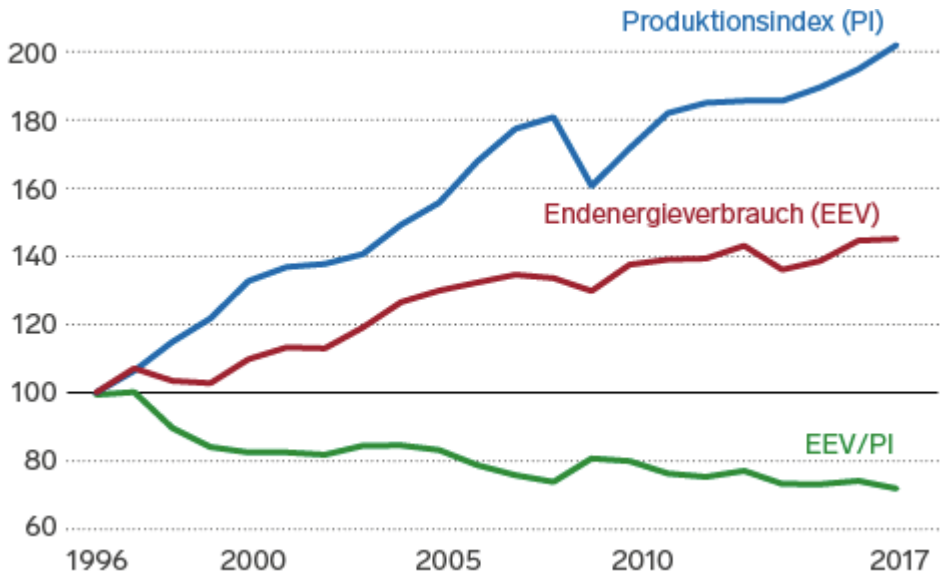
- Which market design? / What is the object of markets? / Where are the boundaries of local energy communities? / New business models

Infrastructure

- Energy networks (gas, electricity, heat) / Industrial energy infrastructure / Production processes and plants

Content Source: (15)

Industry needs 1/3 of Austria's Energy Demand …



Source: Österreichische Energieagentur

- Industry approx. 30% energy consumption in Austria
- 60% energy-intensive industry
- Energy intensity -1.6% p.a. (1996– 2017)
- Strong dependence on energy imports

Energy productivity → Production index rises stronger than energy consumption of industry.

Content Source: Energie in Österreich 2018, https://www.bmnt.gv.at/service/publikationen/energie/energie-in-oesterreich-2018.html bmnt; (16) - www.nefi.at

Renewables 4 Industry

Goals and Tasks

1. Current situation/outlook for 2050 of renewable generation (industrial) primary energy demand.
2. Identify / quantify key industrial processes load shifting potential.
3. Comparison of existing with necessary flexibility options
4. Presentation of current el. grids /market designs requirements for 2050.

Project

Three-part discussion paper

Two stakeholder workshops

Technology policy recommendation

Strategic research agenda

Results

Actual situation /outlook renewable energy requirements

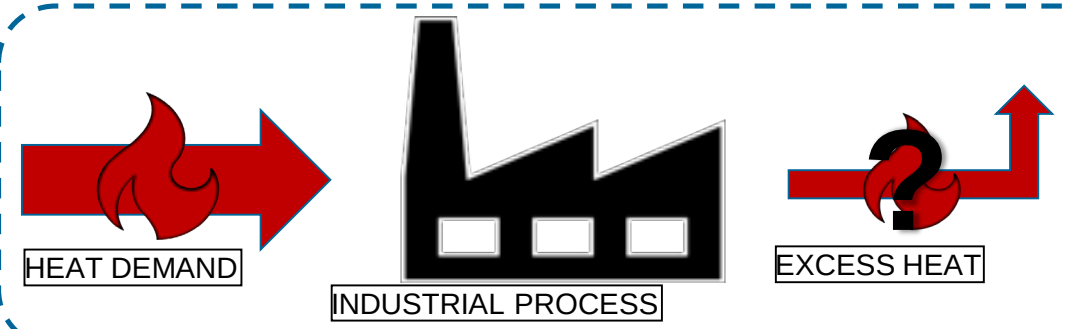
- ✓ Today's domestic demand cannot be covered with the entire Austrian, technical renewable potentials!
- ✓ Energetically industry could be supplied exclusively with renewable electricity.
- ✓ Capacities show a large demand for daily and annual storage facilities.

Decarbonization pathways application of renewable electricity, gases, thermal and biogenic fuels, increasing primary and final energy efficiency

CONCLUSION: there is not "the" single path

Industrial Excess Heat Recovery

IEA-IETS Annex 15

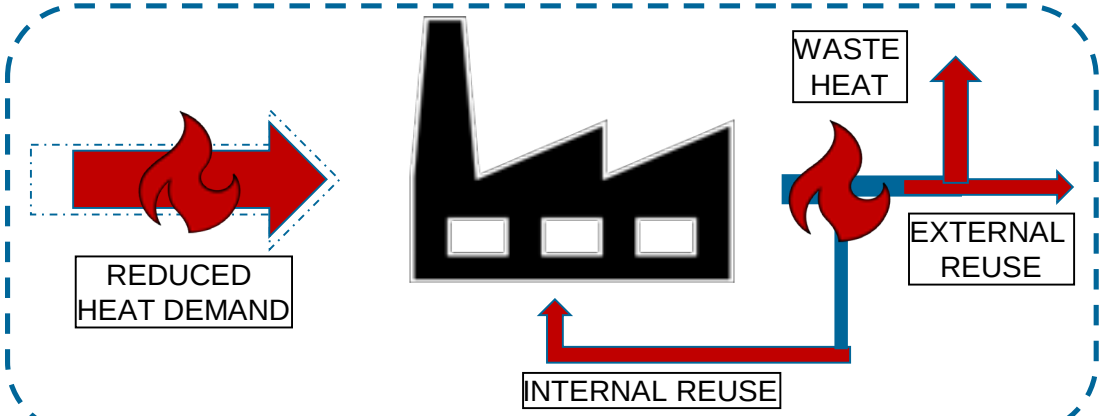


How to perform an **inventory**?

How to **derive potentials** for excess heat usage?

INVESTMENT
DECISION

Impact of Policy-Instruments on Excess Heat and its usage?



Technologies for excess heat usage

Bundesministerium Verkehr, Innovation und Technologie

klima+ energie fonds

Industrial Excess Heat Recovery

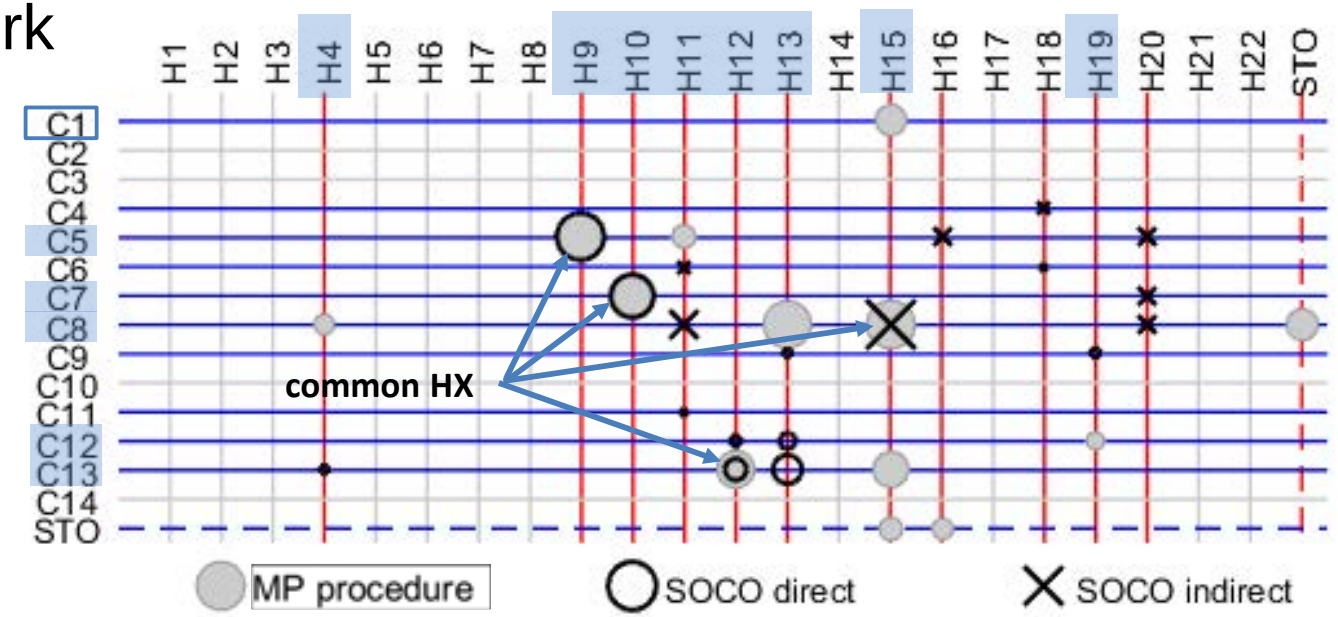
How to **derive potentials** for excess heat usage?

Example: Dairy Factory (AEE INTEC)

Comparison of AIT PI Framework (Mathematical Programming) & (Solar)SOCO

- 37 Process streams
- Changing operating states
- Stream data for 3 weeks

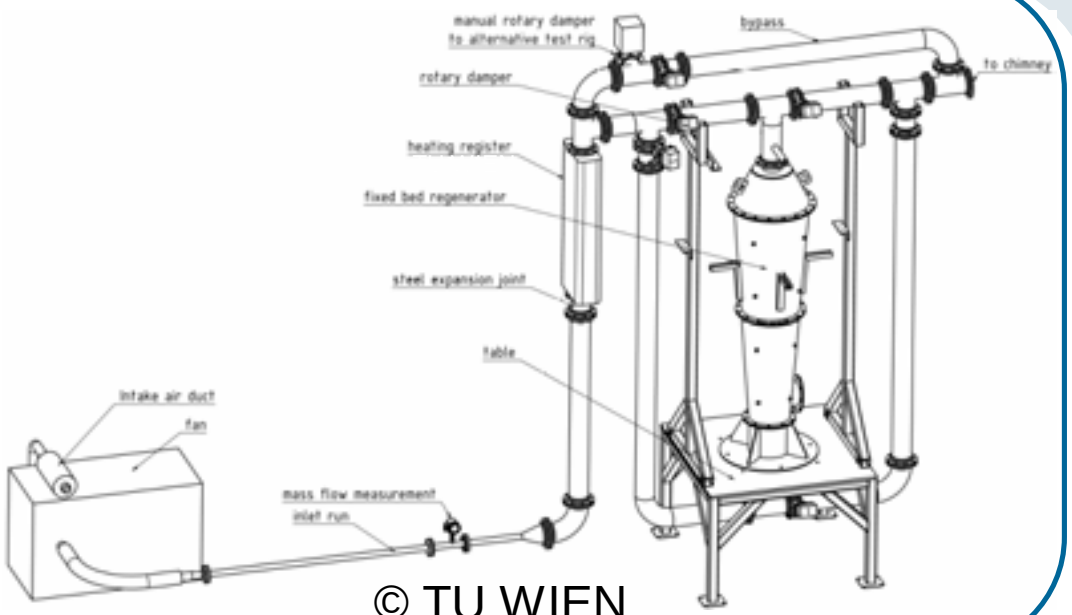
- Storage integration
- Heat exchanger network synthesis



Thermal Energy Storage Technologies

Active and Passive Regenerators

P=15 kWth
Tmax = 300 °C
Vmax = 100 m3/h



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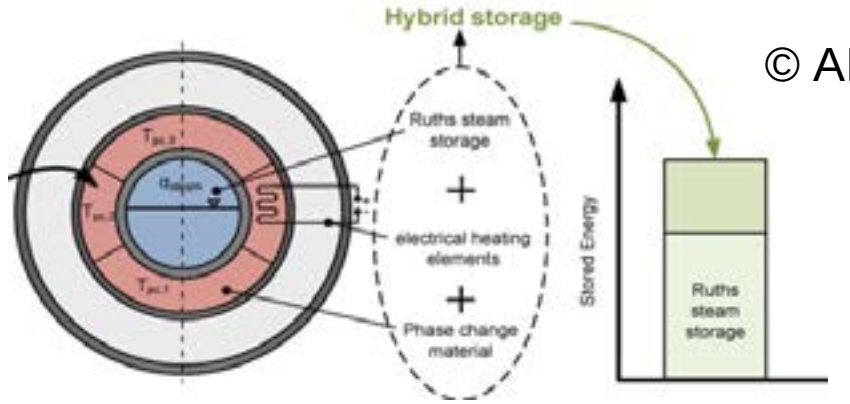
Hybrid Energy Steam Storage

Up to 30% more stored energy
in the hybrid storage
compared to Ruth's steam accumulator



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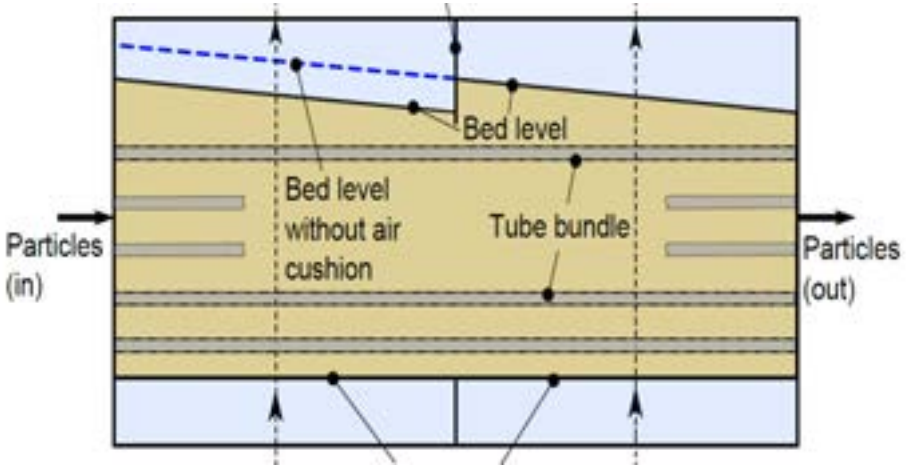
Content Source: (25) – (29)

Thermal Energy Storage Technologies

SeLaTES = Sensible and latent thermal energy storage for industrial waste heat utilisation

sandTES
(Active particle thermal energy storage)



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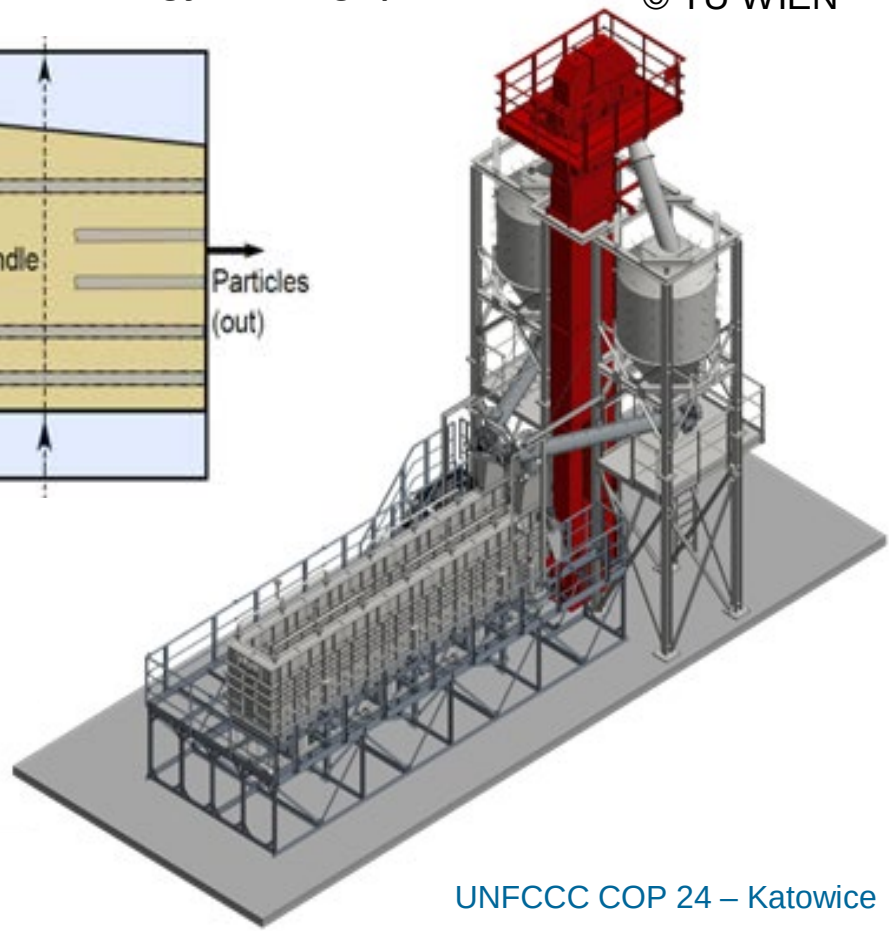
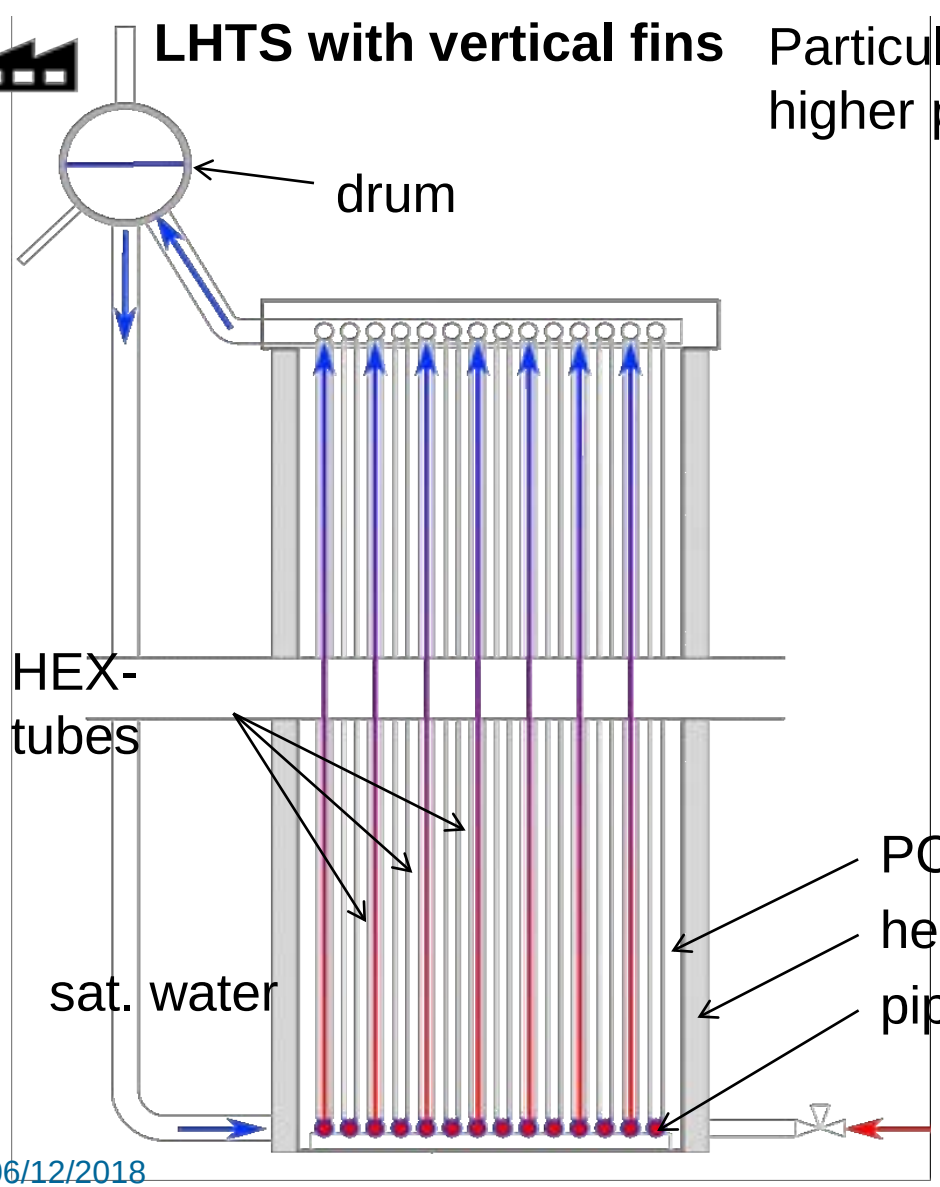


Thermal Energy Storage Technologies

LHTS with vertical fins

Particularly suitable for steam storage at higher pressures and longer storage periods



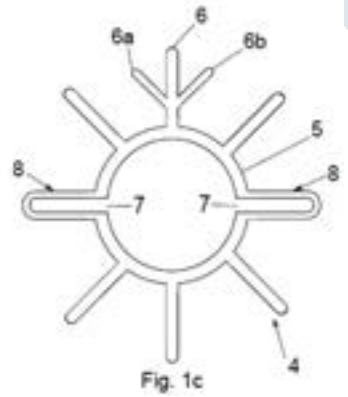


Fig. 1c

PCM with Steel/Alu- finned tubes

Finned -tubes

- ✓ NaNO3
- ✓ Alu
- ✓ Steel

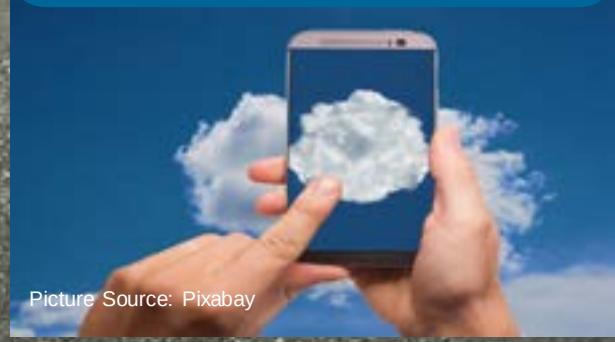
Digital Transformation of the Industrial Energy Supply

Data handling and treatment

Design optimization and planning

Power Market and sector coupling

Operational optimization



Innovations for energy systems in industry

Smart Industrial Concept!

Cooperation Doctoral School

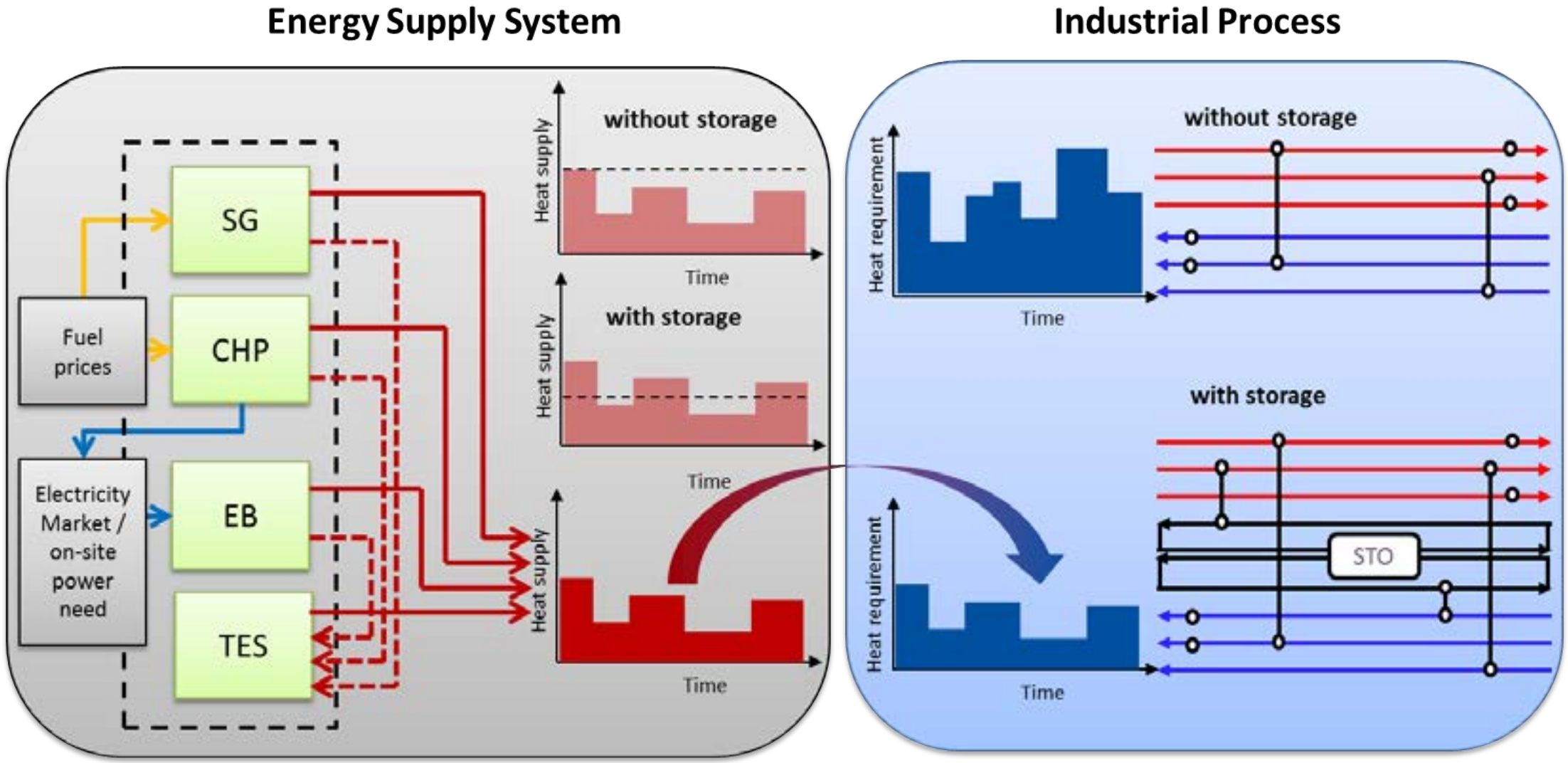
Holistic Approach with Digitalization of Industrial Processes and Applications for 2050 and beyond

SIC! in a Nutshell

https://sic.tuwien.ac.at

- ✓ Added value through specific use of data
- ✓ Development of methods for energy-optimized operation of industrial plants
- ✓ Optimum system design for future environment
- ✓ Consideration of mutual interaction industry ↔ energy networks

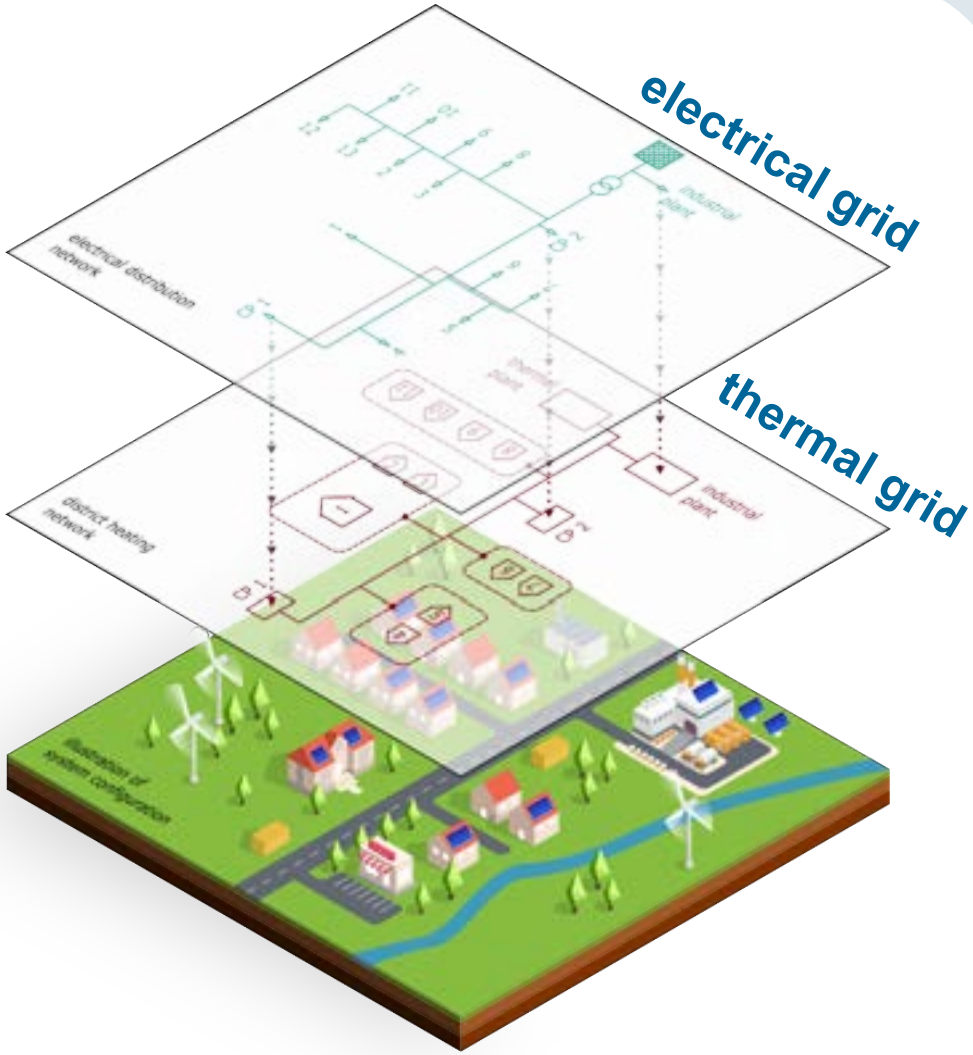
Intelligent Design/Operational Optimization



Innovations for energy systems in industry

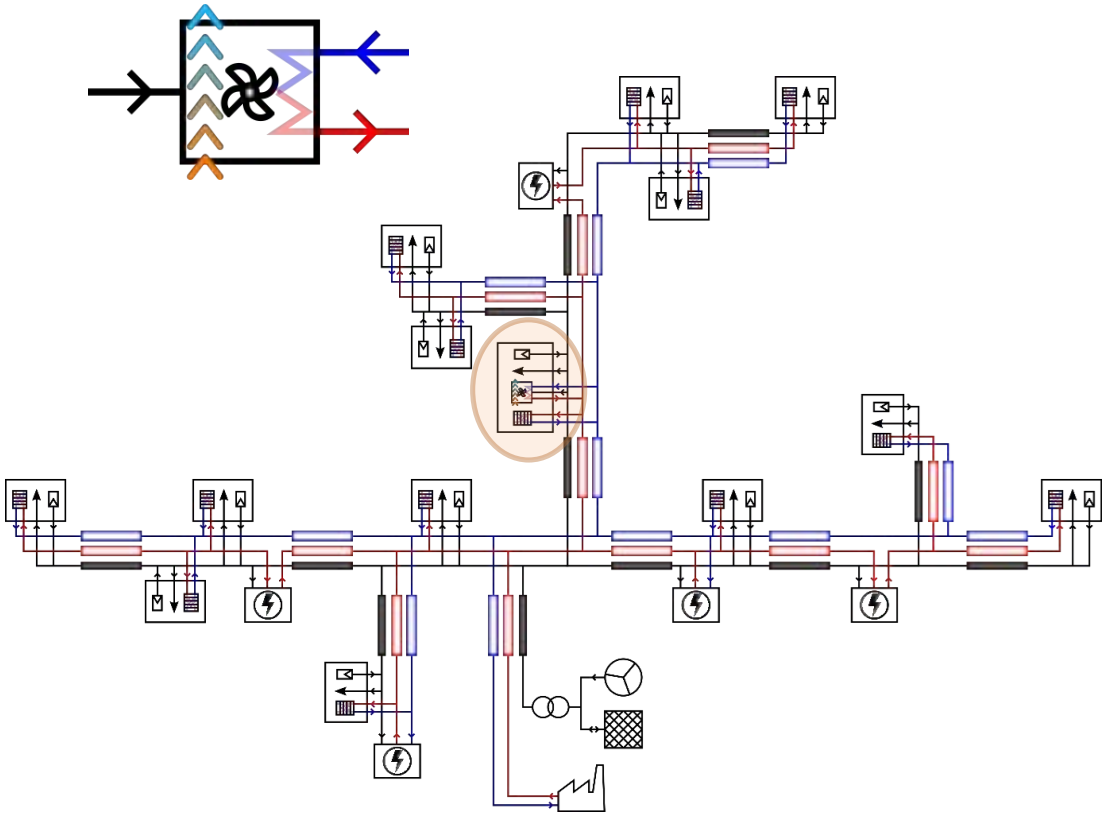
Planning and operation of intelligent coupled district heating and electricity distribution networks

- ✓ Increasing share of volatile renewables in electric grid
- ✓ Need for decarbonization of heating sector
- ✓ Trend towards smart energy networks and energy communities
- ✓ Decentralized prosumers and storages
- ✓ Exploiting hitherto unused synergies between networks

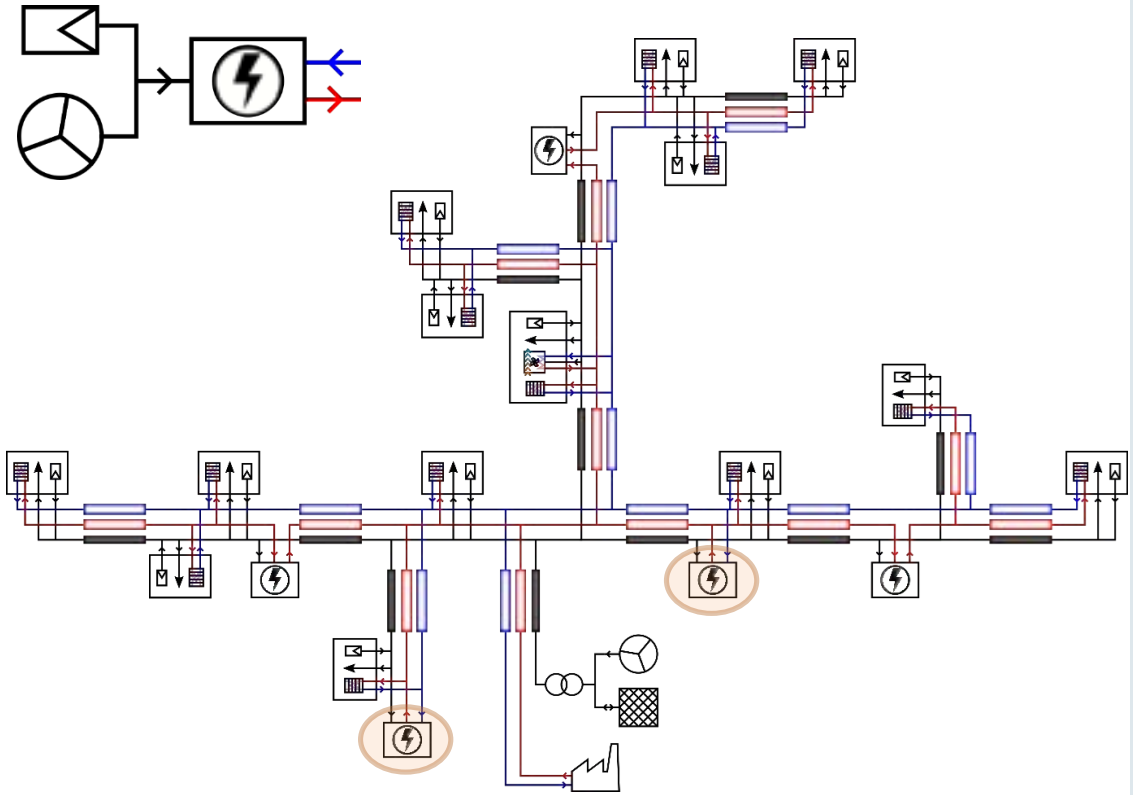


Case Study: Coupling points

Heat pump utilizing waste heat



Electric heater integrating surplus wind and PV



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Conclusions

- ✓ **Holistic optimization approach** for the energy supply of industrial plants taking into account production-process-related fluctuations and energy markets
- ✓ **Potential of storage** for load shifting and peak shaving in industrial processes is high, but always a question of economy.
- ✓ **Process integration requires** a very good understanding of both the technology and the process side.
- ✓ **Modeling of storage technologies** to understand transient thermal problems and applications

✓ **Design optimization**
✓ **Operational optimization**

Instruments for load flexibilization in industrial processes.

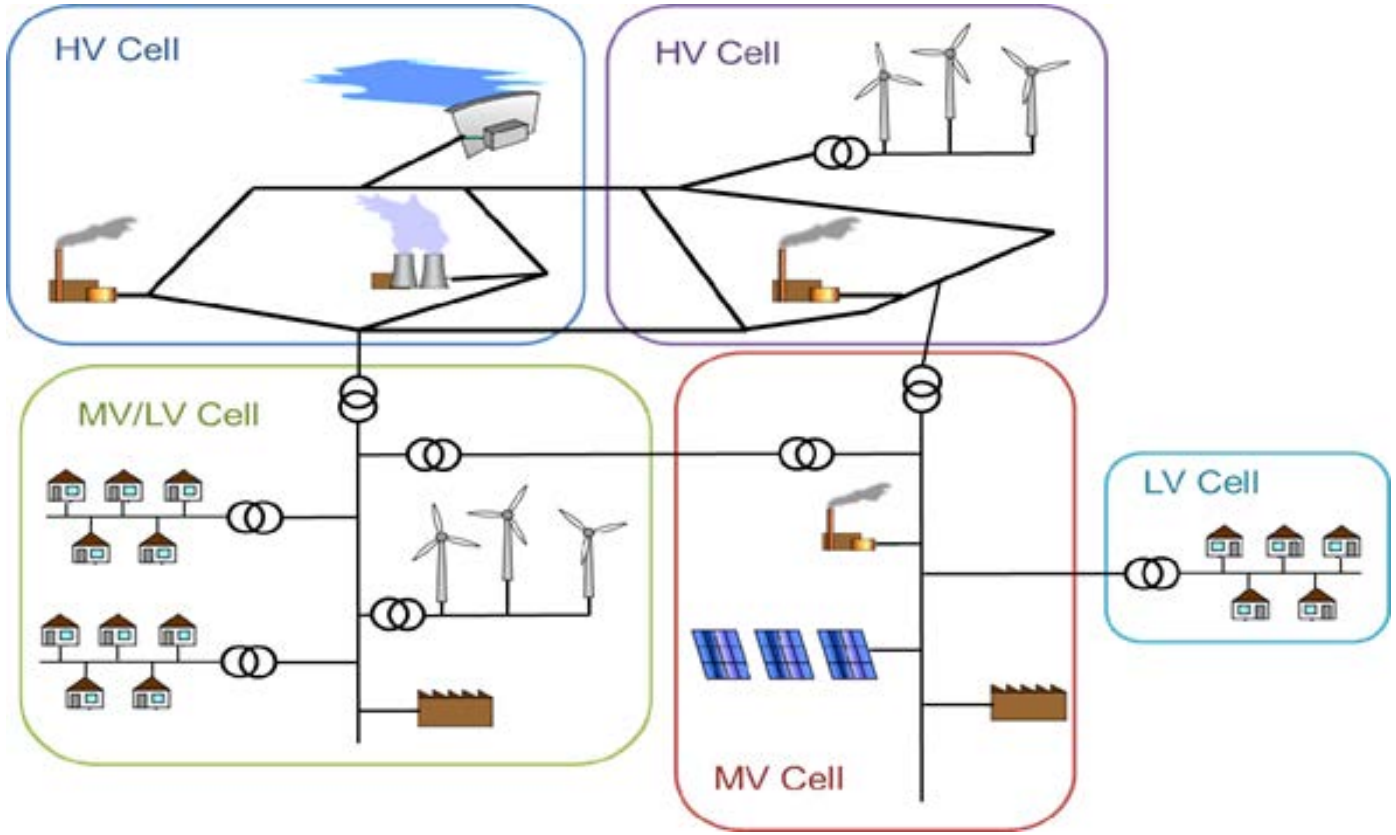
Current Challenges/Impacts on Hydropower Plants

Changes in Market and Energy Mix – Future Grid Models

- ✓ 3D (decentralization, decarbonisation, digitization)
- ✓ Web of cell

Challenges for Hydropower

- ✓ Short term / daily storage
- ✓ Long term / seasonal storage
- ✓ Grid stability
- ✓ Flow phenomena and mechanical
- ✓ Concept for lifetime analysis



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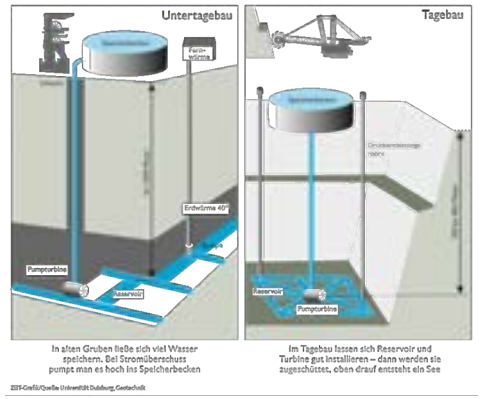
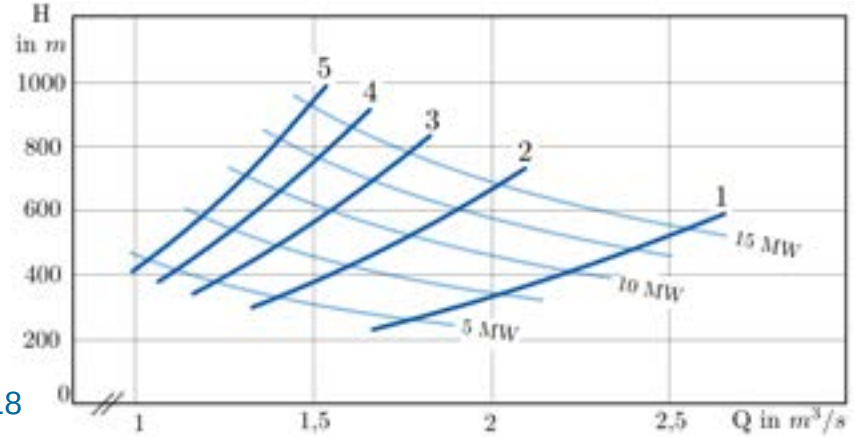
Modular Pump Turbine decentralized Energy-Storage

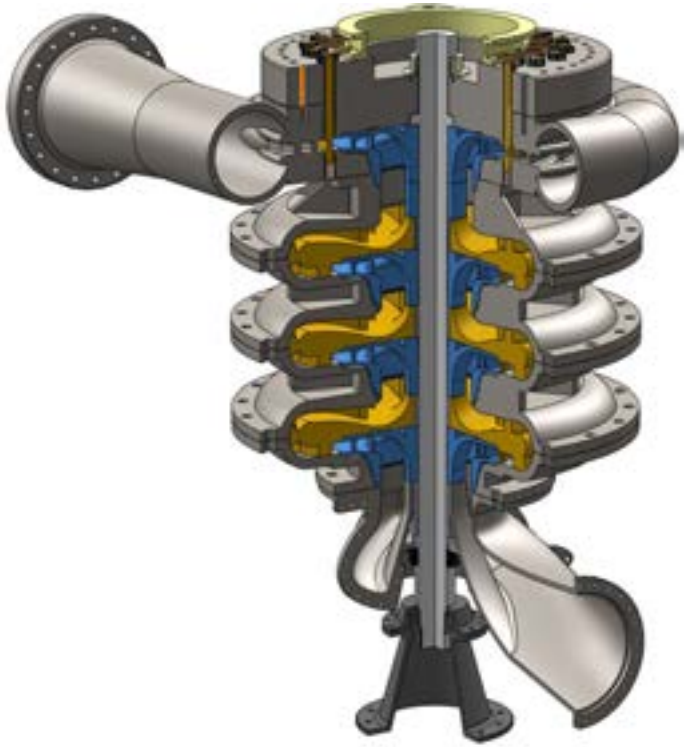
- ✓ Modulare concept hydraulic and electrical
- ✓ +/- 100 % variable speed
- ✓ P = 5-10 MW, H = 250-1000m, Stages = 1-5
- ✓ Very high potential in Europe and World Wide

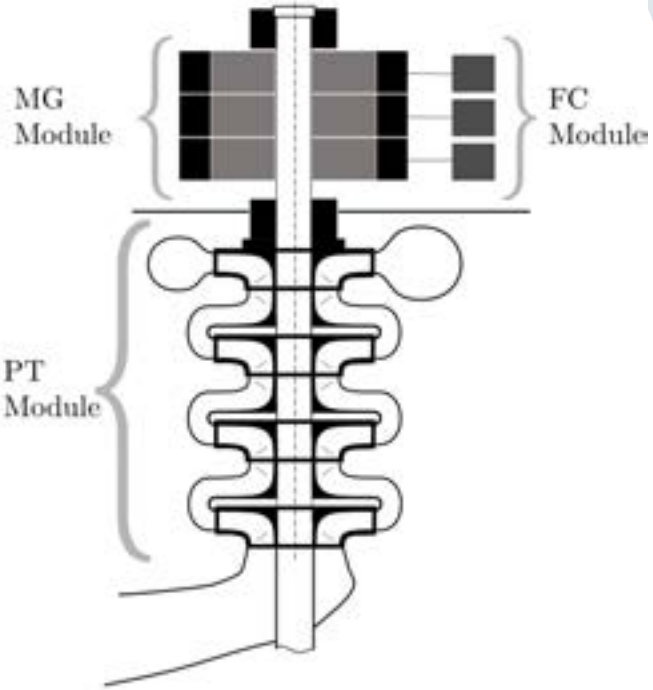
Artificial lakes for snow production



Shut down coal mine







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Thank you for your attention

Institute for Energy Systems and Thermodynamics

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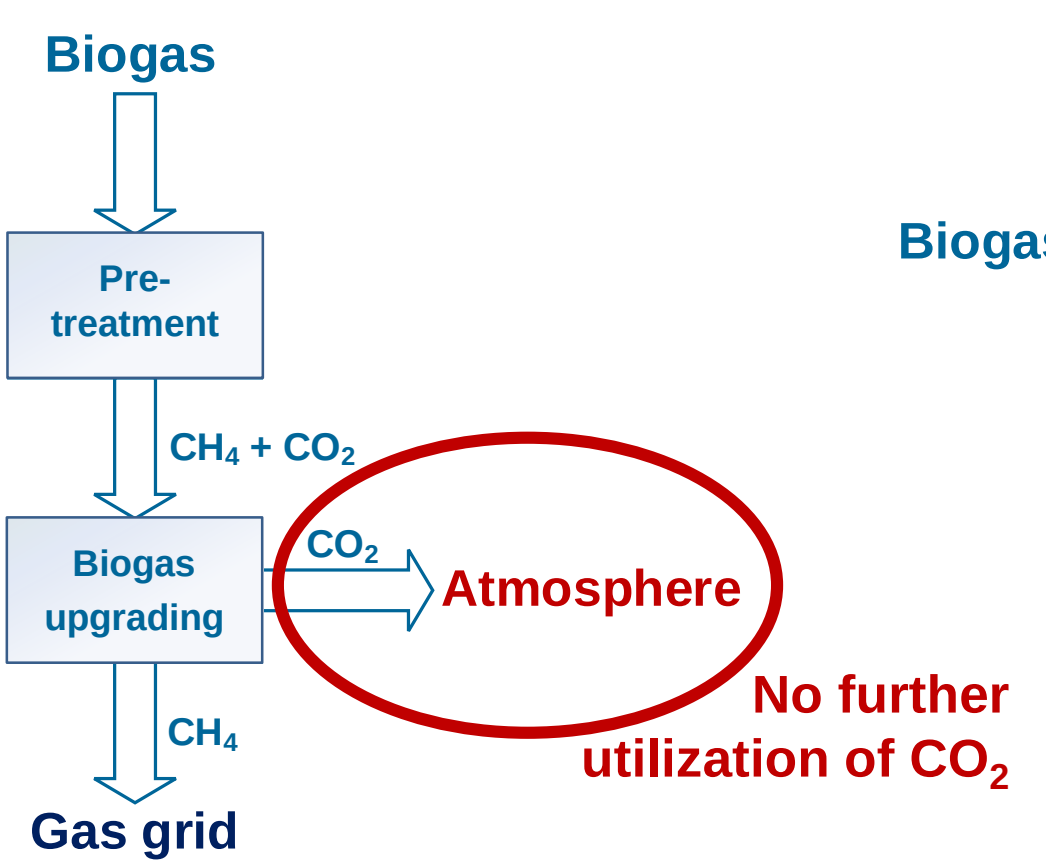
Innovations in green energy supply:
- Integration of biogas upgrading into PtG
- Decentral supply of green H_2

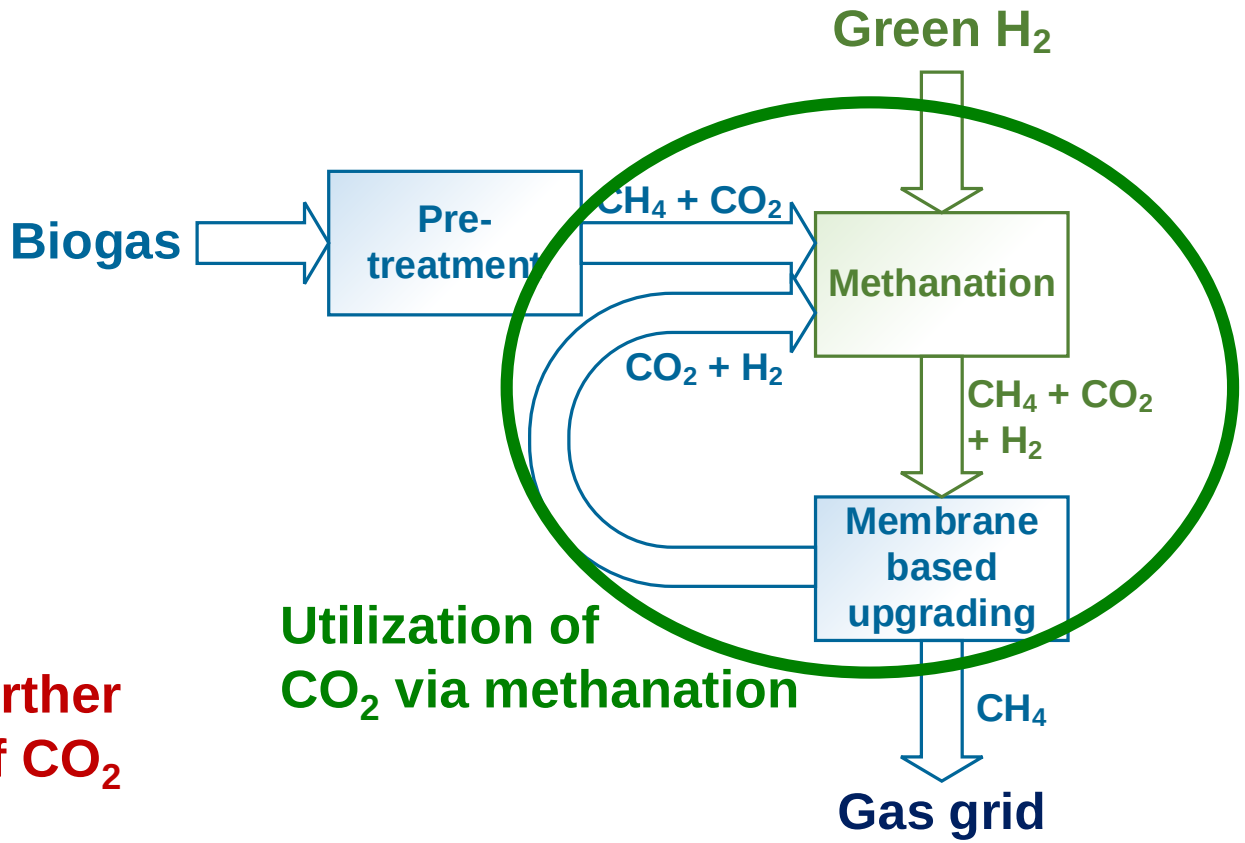
Simone M. Spitzer, Prof. Michael Harasek

Institute for Chemical, Environmental
and Biological Engineering

Closing the CO_2 loop

Today's biogas upgrading vs. Integration in PtG





Biogas vs. Biomethane

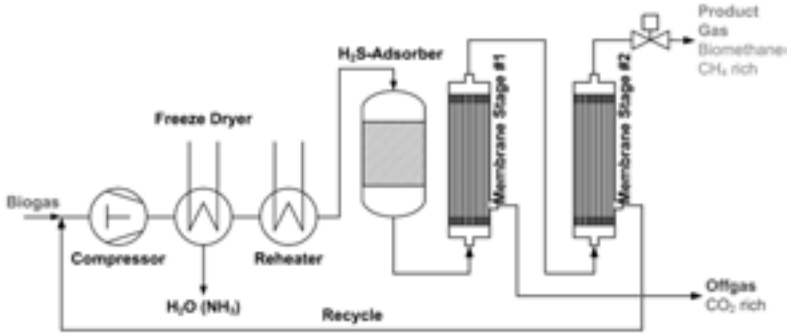
Benefits of upgrading biogas to biomethane

- **Biogas**
  - CH_4 and CO_2 + water vapor and impurities (e.g. H_2S, NH_3…)
  - Combustion in a CHP gas engine for heat and power production
  - Not competitive on the electricity market
  - Phasing out of feed-in tariffs in e.g. Austria and Germany
- **Biomethane**
  - Cost effective upgrading technology from TU Wien
  - Purified CH_4 with min. 96 vol.% very low content of impurities
  - More flexible product – e.g. utilization as renewable natural gas substitute or as vehicular fuel
  - Primary energy savings for the national economy

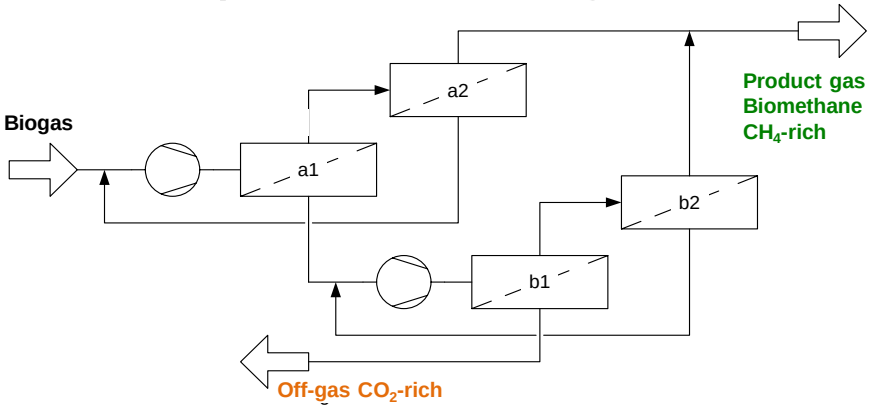
Innovation for biomethane

Optimization of biogas upgrading

- ✓ Early process design:



- ✓ New process design:



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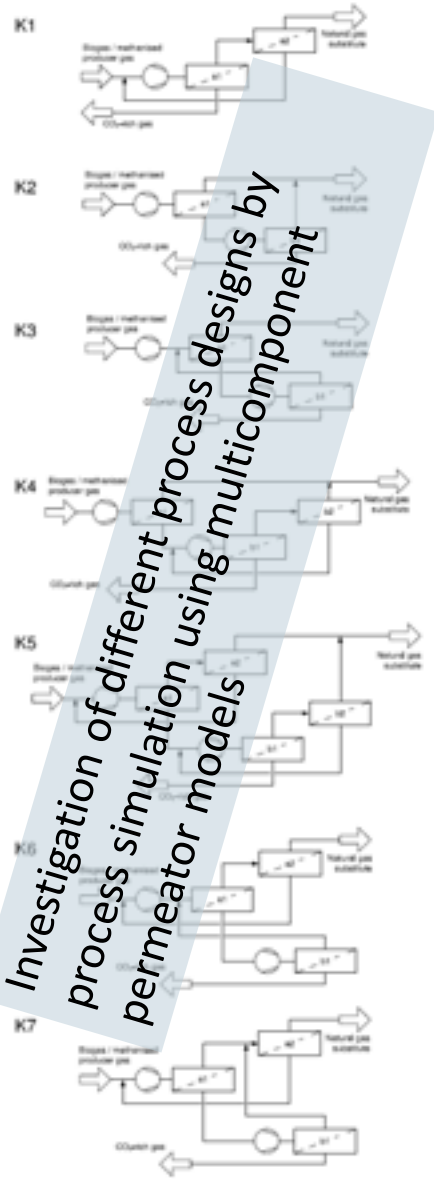


Investigation of different process designs by process simulation using multicomponent permeator models

Efficient biogas upgrading on industrial scale

Mobile gas upgrading for small scale production

Flexible biogas upgrading

- **Flexible process design**
  different biogas qualities, easy adaption to various and/or fluctuating biogas compositions – in same mobile upgrading facility
- **Membrane separation system**
  for high methane output
- **Small and lightweight**
  to be transportable
- **Adjustibale to national biomethane quality criteria** (e.g. Brazil)

A service offered by the City of Vienna

Innovations for PtG & for delivery of H_2

Closing the loop – CO_2 as valuable C-source

- **Present**
  - Biogas upgrading separating biogas into CH_4-rich and CO_2-rich stream – CO_2-rich stream not further used
- **Partial utilization of CO_2**
  - Power-to-Gas / Methanation: CO_2 from biogas as C-source, if excess energy is available for H_2 production
  - CO_2 separation, but no H_2 separation from product (e.g. scrubbers) – no recycling of excess CO_2 and H_2
- **Full utilization of CO_2**
  - Storage of excess CO_2 for conversion to CH_4, when excess energy is available
  - Membrane based CO_2 and H_2 separation from product – recycling of excess CO_2 and H_2

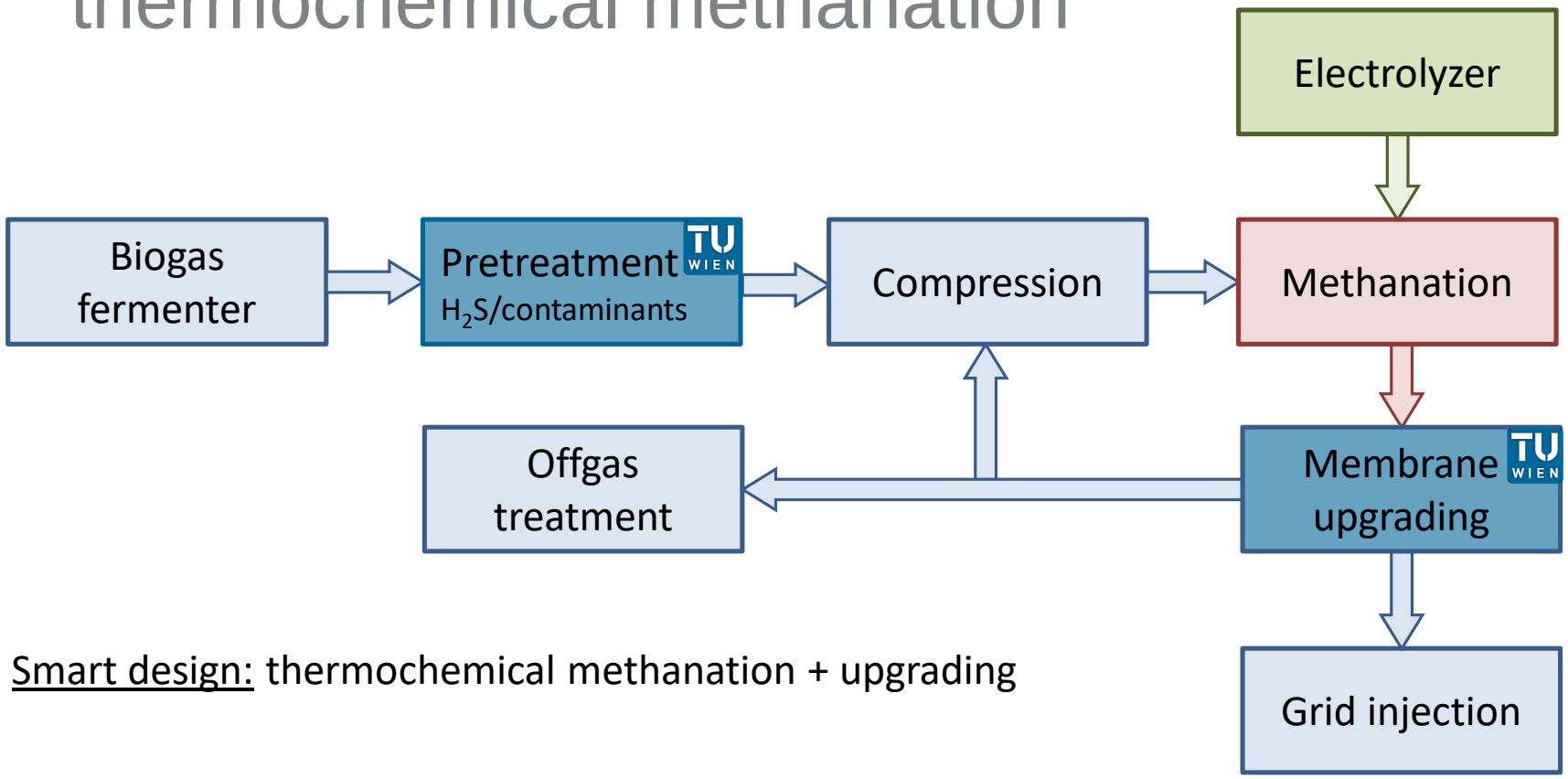
New technology for PtG

Increased CH_4 output from existing/new biogas plants

- **PtG:** Renewable H_2 from excess electricity by electrolysis – H_2 used as reducing agent in subsequent methanation
  - Bio-methanation (Krajete process or similar) or
  - H_2 injection into biogas fermenters or
  - Thermochemical methanation (Sabatier process)
- **Biogas from residues as CO_2 source for methanation**
  - Partial or full conversion of CO_2 from biogas to methane – dependent on CO_2 storage and amount of excess power

Combining biogas upgrading and PtG

Power-to-Gas mode – thermochemical methanation



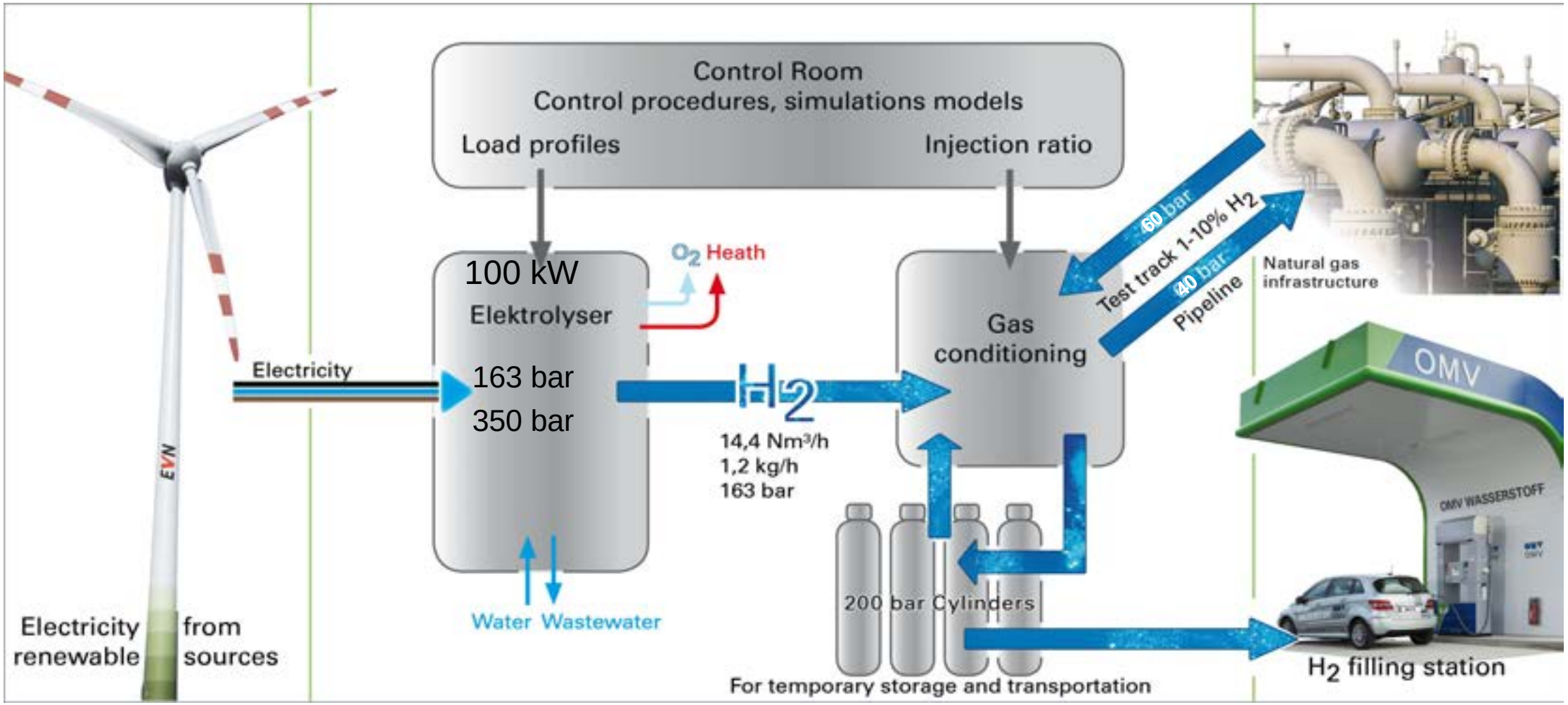
Smart design: thermochemical methanation + upgrading

Summary - biogas upgrading

- **Integration of biogas upgrading and Power-to-Gas**
  - reduced investment costs for filter/ membrane unit
  - increased CH_4 output by using CO_2 from biogas as C-source for methanation
  - various process options / partial load operation of electrolyser + methanation
  - direct feed of pretreated biogas + permeate recycle to methanation unit
  - add-on PtG integration - using TU Wien membrane technology
- **Mobile unit**
  - offers decentralized biogas upgrading
  - at reduced investment costs

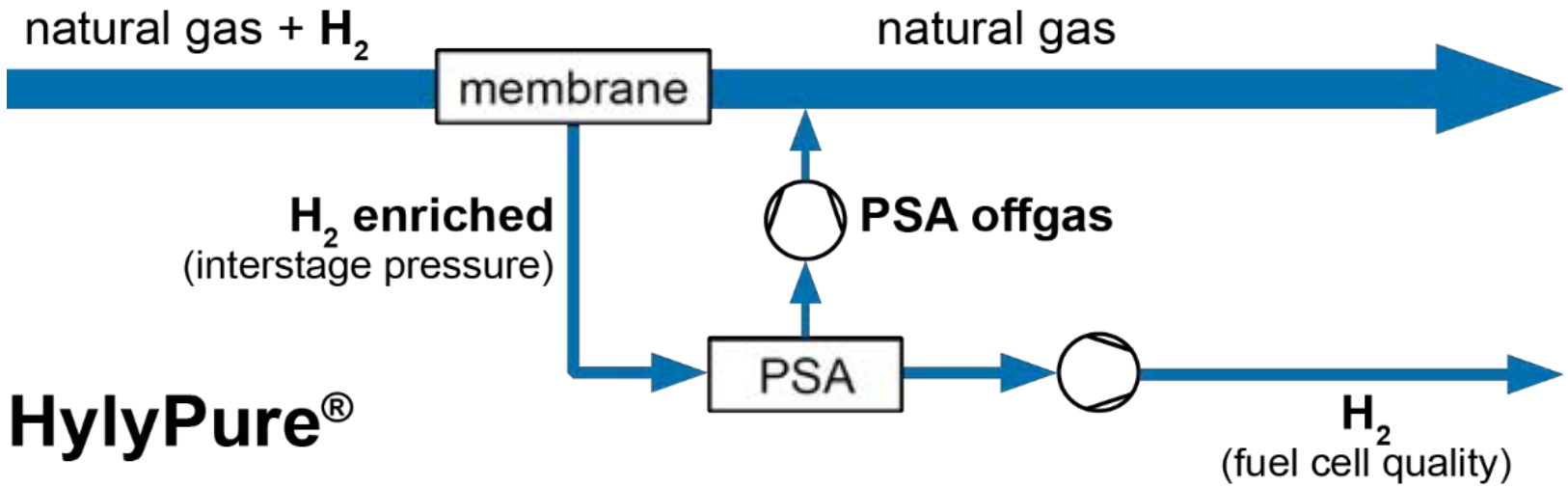
Decentralized delivery of green H_2 - HylyPure®

Supply of hydrogen H_2 via the natural gas grid



HylyPure® - Process

Innovation for extraction of H_2 in high purity



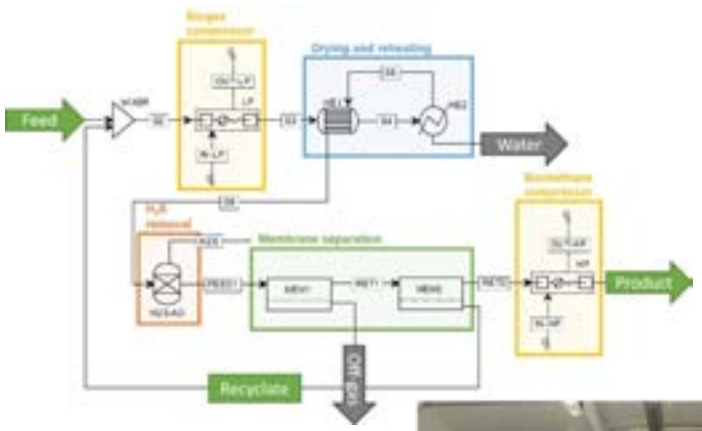
- TU Wien combination of process steps for H_2 in fuel cell quality
  - Membrane gas permeation using H_2-selective membranes
  - Pressure swing adsorption (PSA)
  - Final cleaning stage by adsorption

HylyPure® - Advantages

- **HylyPure®**
  - offers decentralized delivery of green H_2
  - uses existing natural gas grids for transportation
  - extracts H_2 in highest quality - fuel cell quality
  - reduces logistics costs - existing grid instead of trucks

Summary - Innovations for PtG & for delivery of H_2

From concept to lab to industrial plant



Innovations for PtG & for delivery of H_2

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Thermochemical conversion of biomass residues to green fuels, electricity and heat

Dr. Stefan Müller, Prof. Dr. Hermann Hofbauer

Institute for Chemical, Environmental and Bioscience Engineering

Biomass enabling green fuels, electricity & heat

Initial Situation

Energy Policy

- Sustainable energy system & security of supply
- High-performing “low-carbon technologies”

Current situation

- High prices for biomass
- Economic pressure on plant operators

Target for the technology development:

- Fuel flexibility & product flexibility

Wood chips

Fuel samples TU WIEN

Biomass enabling green fuels, electricity & heat

Measures to take based on Paris agreement [1]

- **-50%** reduction of fossil CO_2-emissionen every 10 years.
- **+100%** increase of CO_2-free energy supply every 5 years.
- Active removal of carbon dioxide from atmosphere.

Research Question

- Which application of gasification technology from TU Wien would lead to the most reasonable contribution with respect to the energy policy of the European Union as well as the aims of the Paris agreement?

[1] Rockström J. in: Science, Nr. 6331, 2017

Vision for gasifiation technology

RESOURCES

Wood chips

Biogenic residues

Industrial waste materials

Homogenius municipal waste

Sewage sludge

Rising technological challenges for gasification and gas cleaning technology

PRODUCTS

Heat

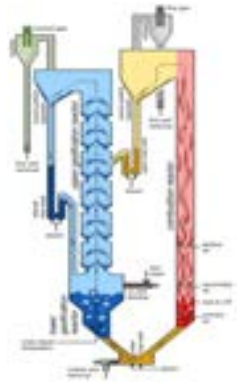
Electricity

Hydrogen

Synthetic natural gas (SNG)

Liquid fuels & chemicals

Process- and technology development



concept idea	cold flow model	pilot plant	demonstration plant	commercial plant

supported by process simulation

first calculations, mass- & energy balances	process development & data for basic engineering	support of start-up procedures and plant optimization

simulation-models; fuel analysis data; experimental results; plant parameters; operation-data

Development at lab-scale aiming at fuel flexibility

Biomass enabling green fuels, electricity & heat

Production of electricity & heat at industrial-scale

Replacement of high quality wood chips

SNG-Production: From lab-scale to industrial-scale

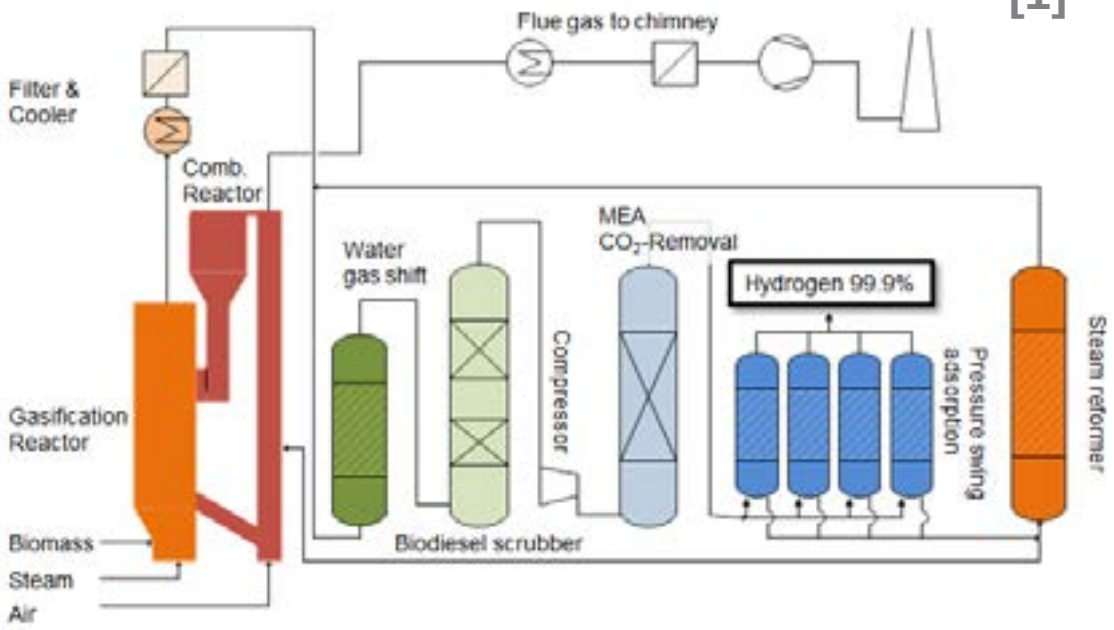
Biomass enabling green fuels, electricity & heat

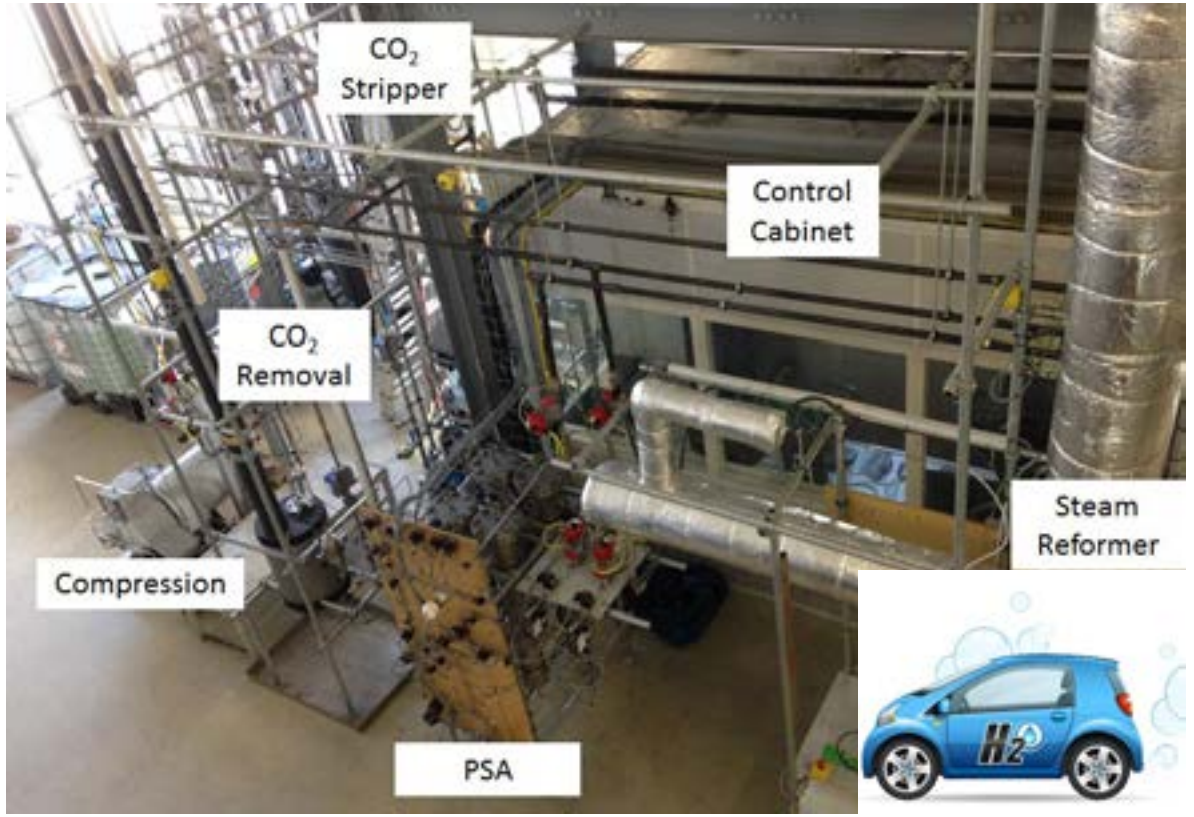
Production of green fuels and chemicals at lab-scale

Biomass enabling green fuels, electricity & heat

Production of pure hydrogen at lab-scale

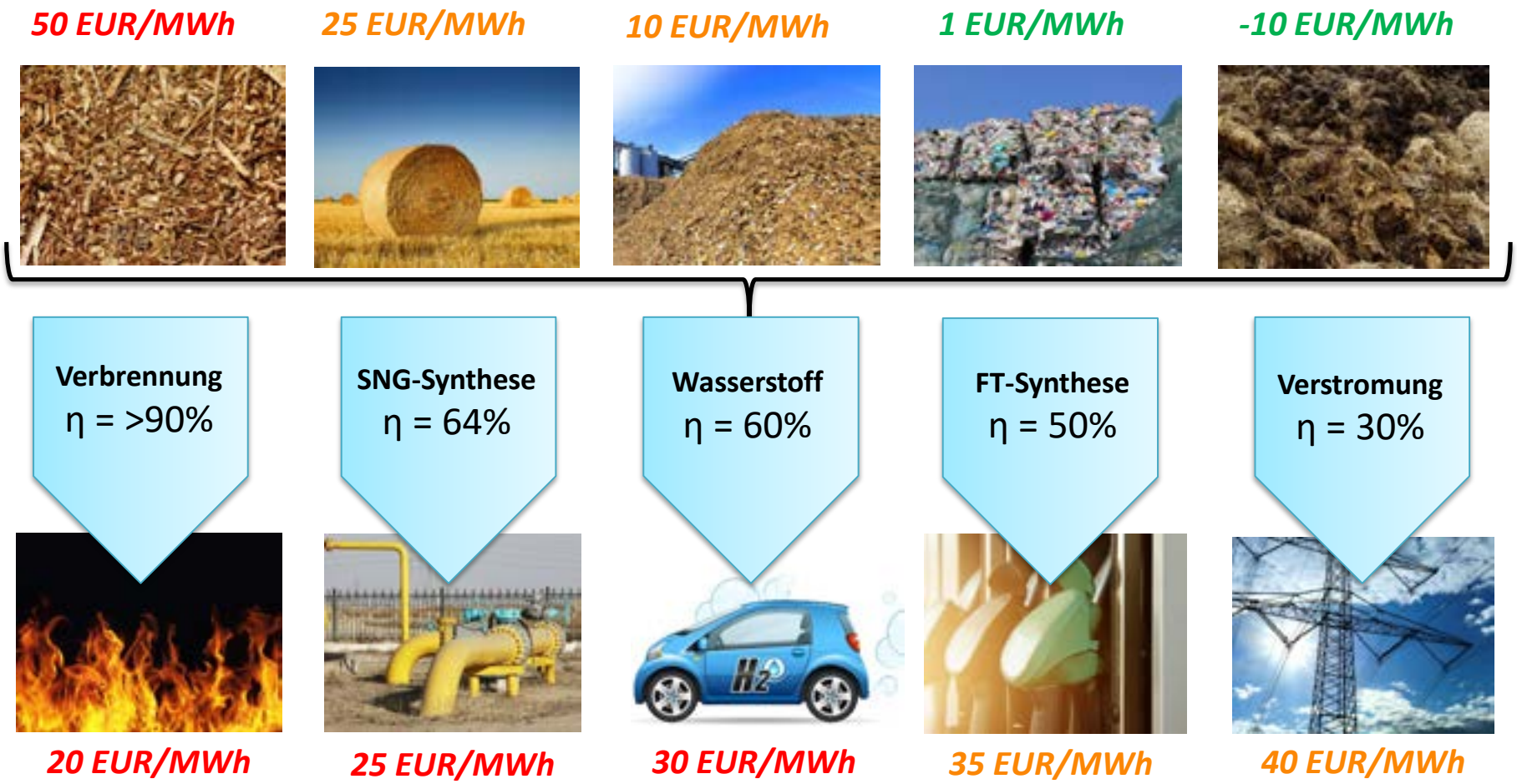
[1]





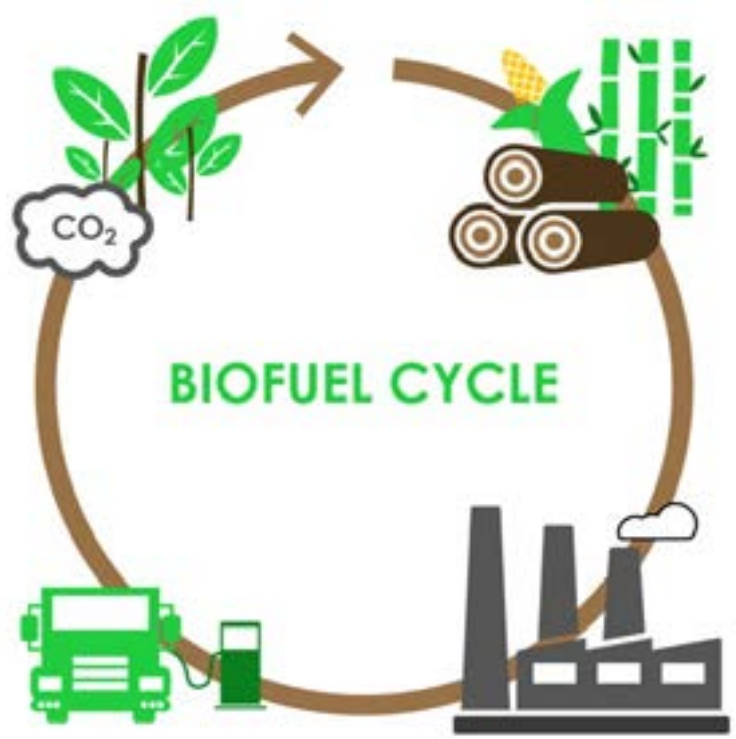
Biomass enabling green fuels, electricity & heat

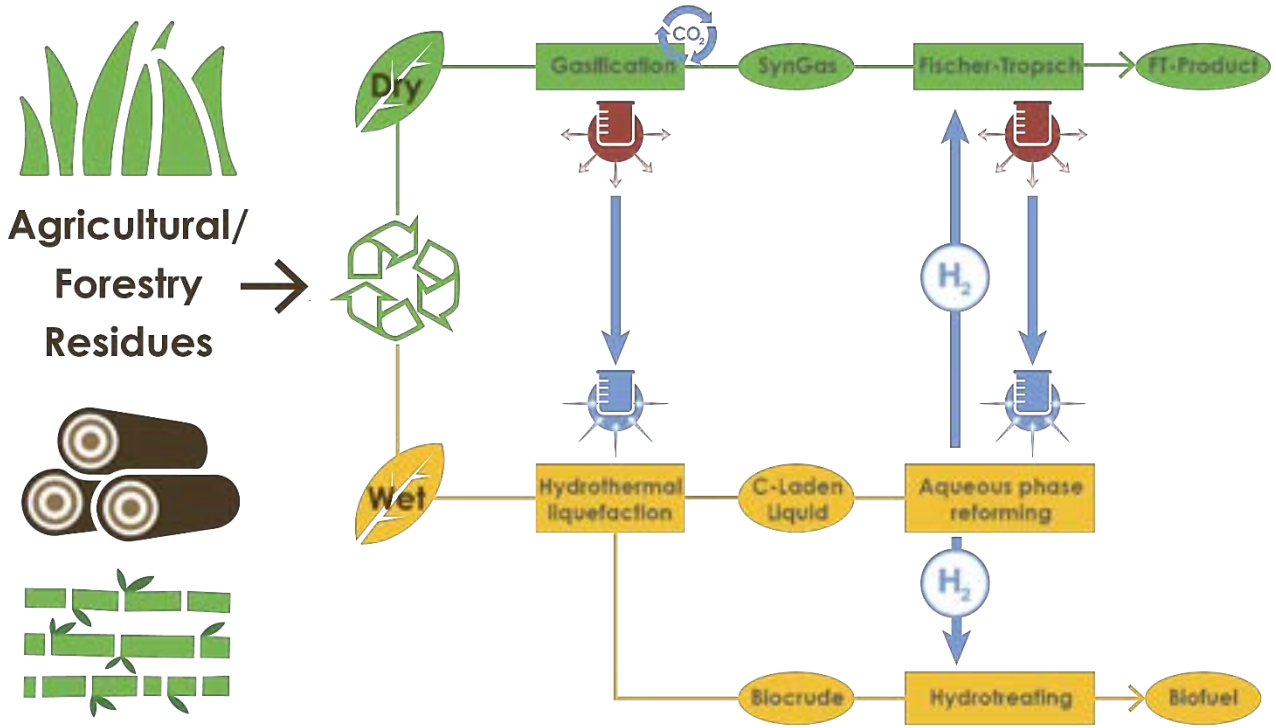
Economic view and expected efficiencies



Biomass enabling green fuels, electricity & heat

Heat to Fuel





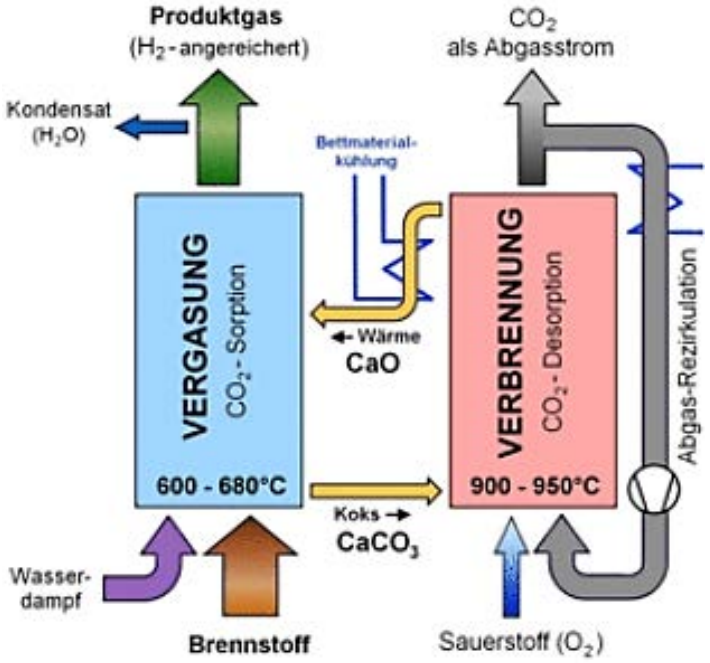
This project has received funding from European Union's Horizon 2020 research and innovation programme under grant agreement n° 764675

www.heattofuel.eu

Biomass enabling green fuels, electricity & heat

Renewable Steel Gas

voestalpine
EINEN SCHRITT VORAUS.



- Gas supply for energy intensive industry

Conclusions & Outlook

- A broad range of technological approaches already available to reach the goals of Paris Agreement.
- Furthermore, biomass conversion technology offers suitable interfaces for a coupling with other forms of renewable energy such as sun-, wind- or water-power.
- The current political and economical framework so far is not sufficient to enable the technology-implementation with the desired impact and at a relevant speed.
- Quick accelaration of activities is necessary based on a cooperation between public- and private sector.

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UNITED NATIONS CLIMATE CHANGE CONFERENCE

Event | Austrian Pavilion, COP 24, Hall E – #1 | 06/12/2018, 10.00-12.00

More technologies and Know-how from TU Wien to reduce CO_2-Emissions

Peter Heimerl

TU Wien – Research Marketing

More technologies to reduce CO_2-Emissions

New process for cost efficient CO_2 capture

- new separation technique – cost and energy efficient
- supplies pure CO_2 for industrial and agricultural use
- based on solid particles in multi-stage fluidized bed columns
- compact design and high efficiency at moderate costs
- demonstration at pilot scale: 1 tCO_2/ day

Dr. Gerhard SCHÖNY

Thermal energy storage – compact, highly dynamic, easy-to-handle

- utilising waste heat from 150°C to 400°C
- cost-effective materials – also for long-term storage over several months
- to prevent cold starts of combustion engines and avoid their emissions – for cars, lorries, ships, construction machinery, traction engines
- to utilise waste heat in heat-intensive manufacturing and processing industries and in the energy sector

Prof. Dr. Andreas WERNER

More technologies to reduce CO_2-Emissions

Modular pump turbine for regional power supply and energy management

- flexible storage for volatile electrical energy from 0.5 to 15 MW
- system efficiency of 70–80%
- stabilisation of medium-voltage grids
- highly efficient and cost-effective

Prof. Dr. Eduard DOUJAK

***LINK* – unique approach to power supply and smart grids**

- large scale integration of decentralized generation and storage options
- secure, reliable and sustainable operation in normal as well as in emergency cases
- drastic reduction of the exchanged data – i.e. thus bypassing today's ICT challenges
- smooth and modular implementation in existing power grids
- strong support to decarbonisation of the power industry

Prof. Dr. Albana ILO

More technologies to reduce CO_2-Emissions

Desulphurisation tehnology for biogas and other product gases

- reliable process to remove H_2S from gases containing methane and hydrogen
- highly efficient, dynamic, compact – for fluctuating sulphur content
- simple integration into existing systems, small construction volume
- use of simple and common chemicals
- moderate investment and operating costs

Prof. Dr. Michael HARASEK

More technologies to reduce CO_2-Emissions

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MORE FROM WOOD.

EGGER


E EGGER

The World of EGGER

Furniture/interior design

Building products

Flooring

Approx. 9,200
employees

Approx. 2.68
EUR billion turnover

Production sites
18 plants worldwide
2 in planning / construction


Consumer
Wood material production and further processing
EGGER enviromental cycle
Recycling
Sawmill
Biomass power plant
Sustainable forestry


E EGGER
Renewable Energy in Production

EGGER production plants in Europe

Biomass boiler

× 10

Production plants that generate renewable heat

& turbine

× 5

Production plants that generate renewable heat & renewable electricity

Direct CO2 emissions EGGER Group (ETS)

EGGER production plants in Europe

Biomass boiler

× 10

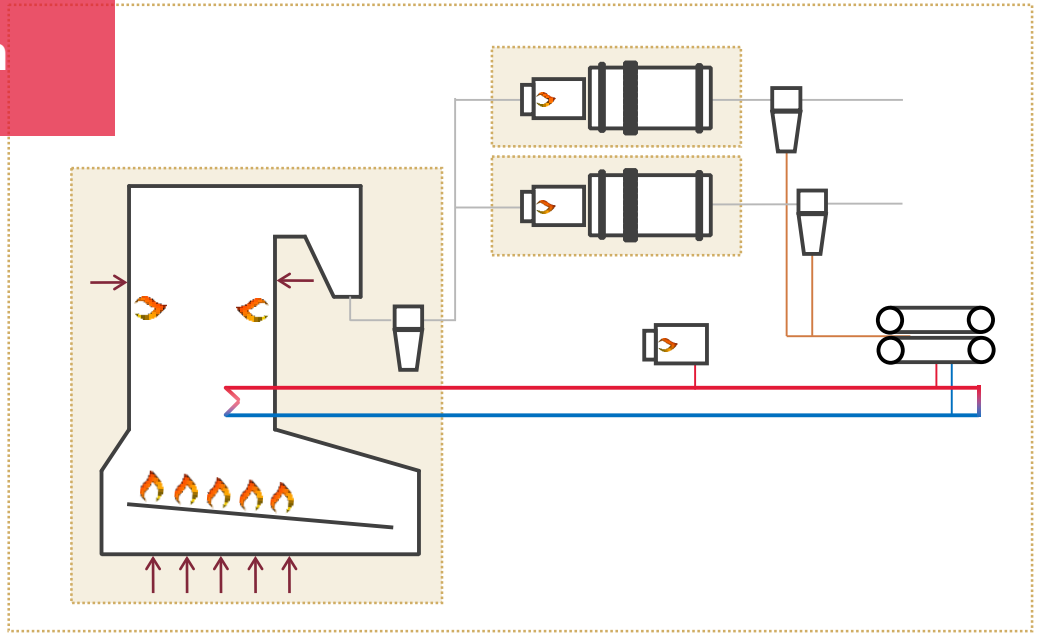
Production plants that generate renewable heat

& turbine

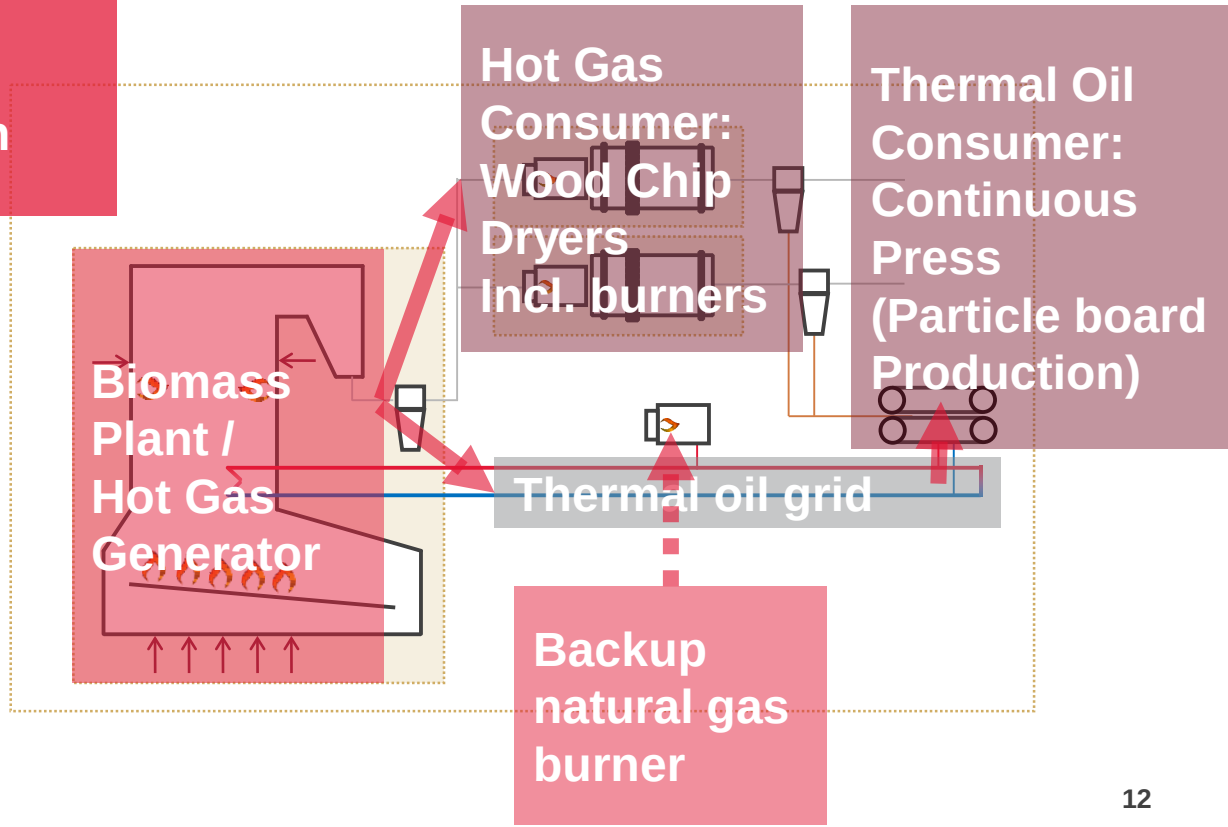
× 5

Production plants that generate renewable heat & renewable electricity

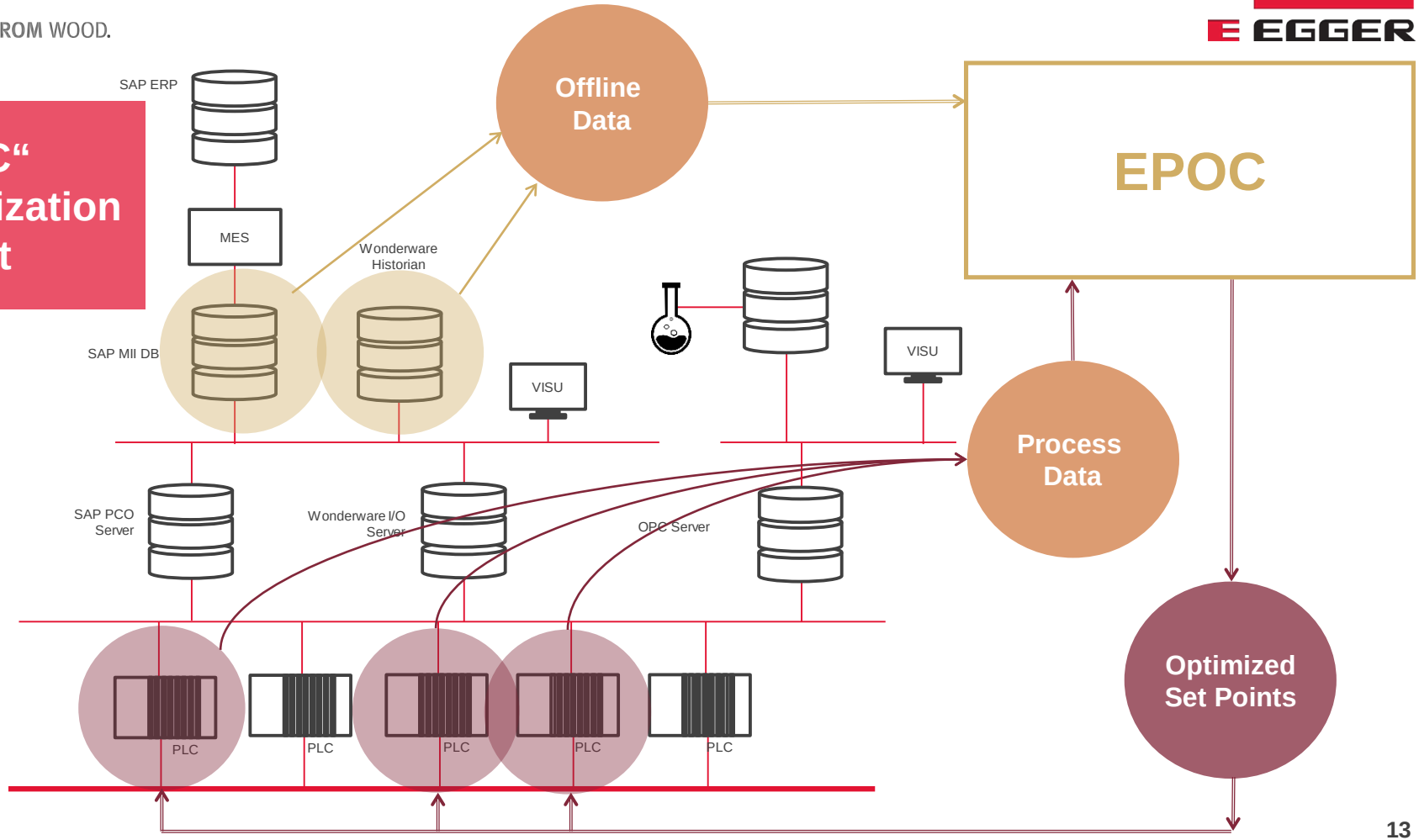
Process scheme: Typical energy system in wood-based panel production



Process scheme: Typical energy system in wood-based panel production



„EPOC“ Optimization project



Project benefits

- Emission reduction
  - - 40% CO
  - - CO2 fossil
    - - Natural gas consumption
      - Optimized operating conditions
      - One maintenance shutdown less, each year
- Better process quality in dryer
- Better wood chip quality after drying

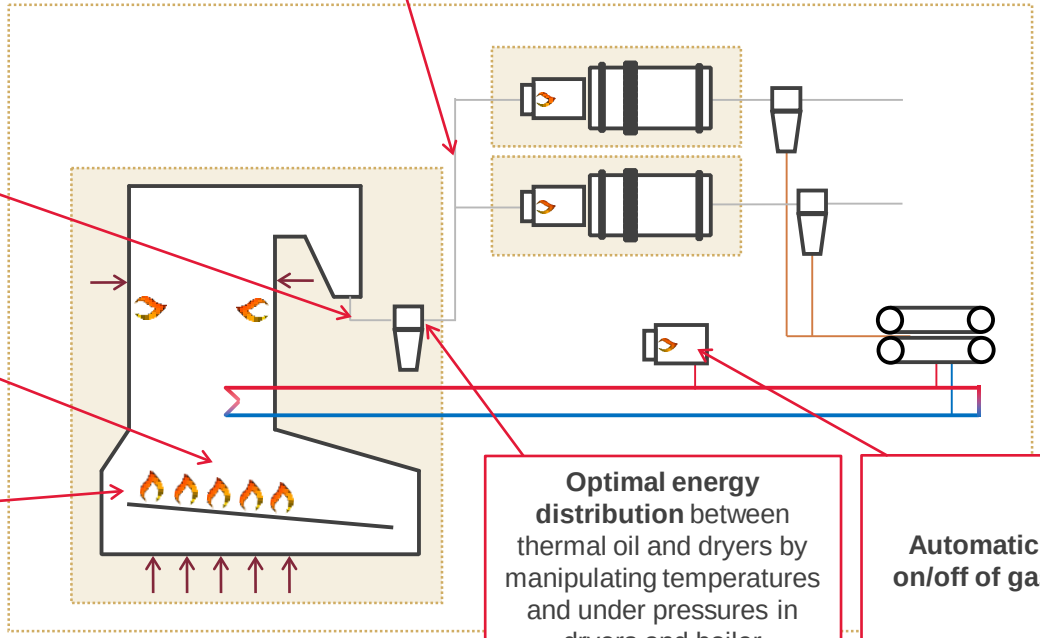
Measures derived from EPOC insights

Advanced control of temperatures/pressures to **stabilize process** and prevent temperature peaks → fouling

Decrease boiler outlet temperature to reduce fouling on boiler walls

Installation **of humidity sensor and water injection** to control fire position and stabilize combustion process

Automatic adjustment of fire position to facilitate optimal heat transfer to thermal oil and reduce combustion temperature



Optimal energy distribution between thermal oil and dryers by manipulating temperatures and under pressures in dryers and boiler

Automatic switch on/off of gas burner

Add. Info

www.egger.com/environment

Sustainability report

Environmental Product Declarations, Manufacturer Declarations on Wood origin, Certificates, …


Thank you!

KOHLBACH

SUSTAINABLE AND
EFFICIENT ENERGY
FROM WOOD

Facts And Figures About Kohlbach

- Family business since 1945
- About 200 employees
- More than 2,000 Installations in 30 countries, with a heat output 400 kW – 15,000 kW
- In-house R&D, design and project management
- Assistance from the initial project idea throughout the entire development
- In-house manufacturing and local service partner

HISTORY

1946 **Founding by Jakob Kohlbach.** Post-war era, everything was tight. Even by then supposedly worthless post-war scrap was being converted into usable products.

1955 **The first of many patents**: Wood drying and room heating in a single chamber: With the first of many subsequent patents, today's production programme was started.

1970 Kohlbach makes a name for itself in neighbouring countries: Already, **over 50%** of the complete turnover is generated through the **export** of systems.

1978 Kohlbach, **further innovation**: Jakob Kohlbach developed a moving grate for wet fuel - later further developed and known as system K8 „Allrounder“.

1986 **New company structure**: Jakob Kohlbach retires. The company is reorganised into Kohlbach GmbH & Co.

2000 The **ISO 9001 quality management** is enhanced through environmental management and acknowledged through receiving the **EMAS- certificate** from the minister for the environment in person.

2009 The major **business award** "Der Primus" for the "Stille Größe" [Quiet Grandeur] category was awarded to the Kohlbach group.

2011 Kohlbach opened the **new Factory in Bleiburg**. With a manufacturing depth unique in this industry, Kohlbach confirms its high demands for quality, reliability and expertise.

2016 With still strong energy as in the past **70 years** the Kohlbach Group continues its work with a new structure and implement **Projects on all continents with great success**.

PHILOSOPHY

- We are an Austrian company that manufactures biogenic energy solutions for the **international market**. With our work we bear an **economic, environmental and social responsibility** for present and future generations.

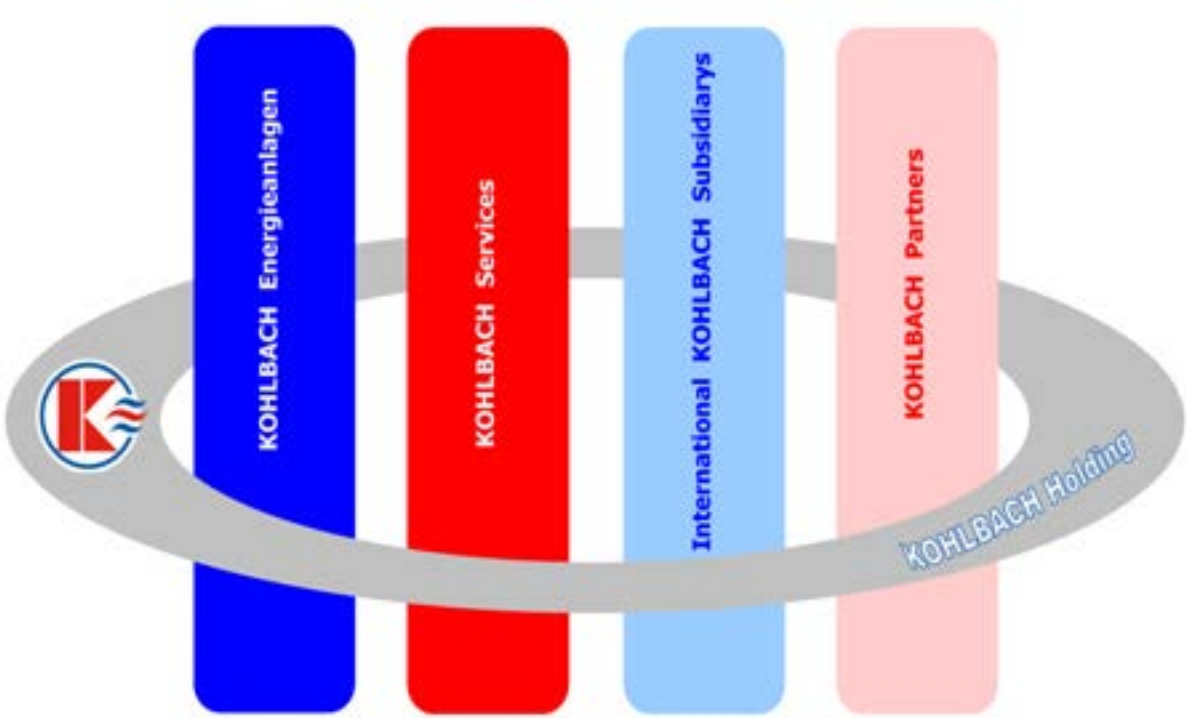
- **"Increase benefit - sustainably"** is our goal in all areas for long-term business. We want to produce adequate and stable profits since this is a prerequisite for the sustainable and successful development of the company. For our environment, for our children, for our employees and for Kohlbach itself.

RELEASE ENERGIES INCREASE BENEFITS

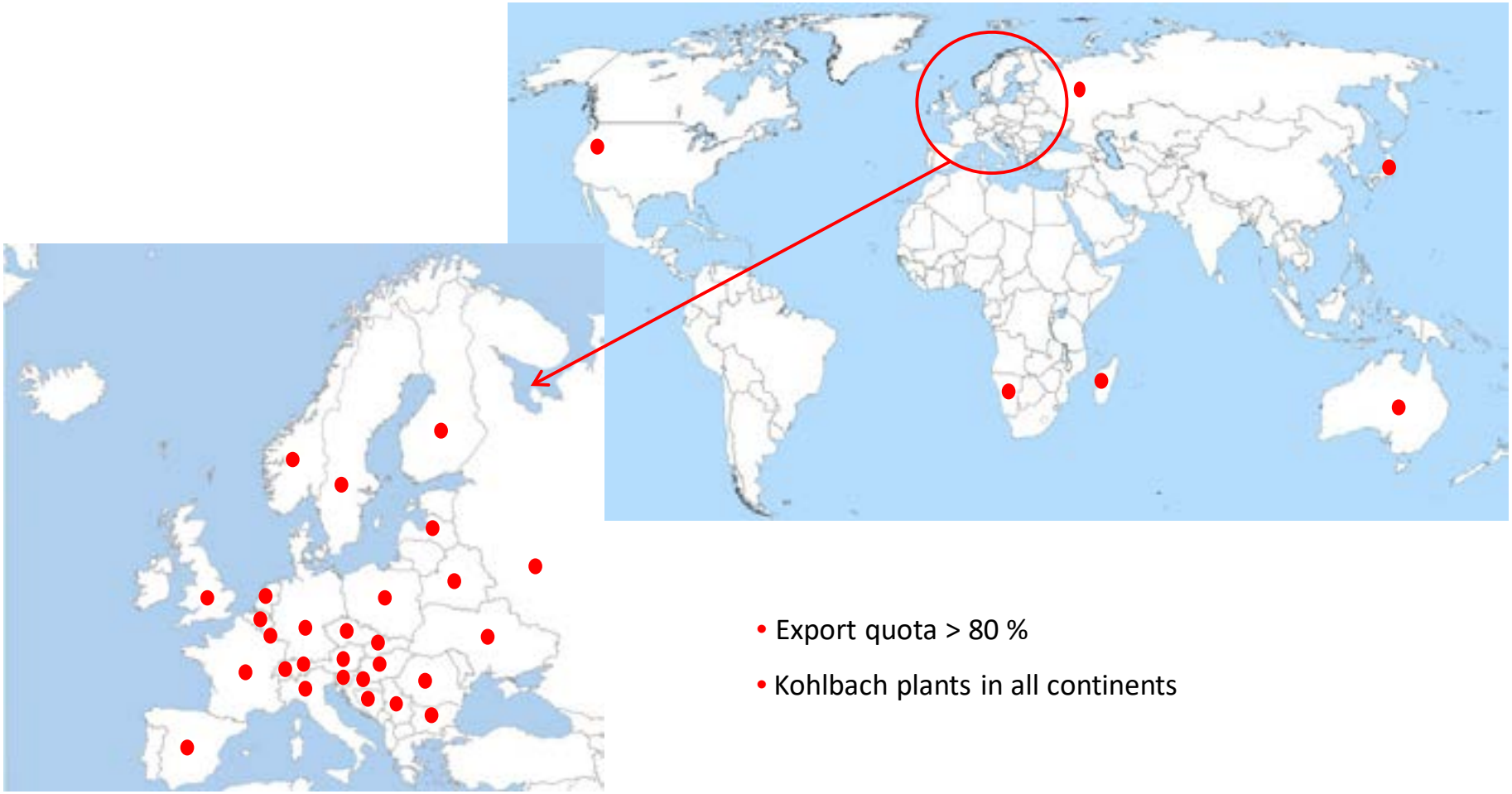
Ideas People Energy by KOHLBACH

COMPANY STRUCTURE

- Austrian company
- Worldwide activities
- Subsidiaries
- License partners
- Partner companies



INTERNATIONALITY



- Export quota > 80 %
- Kohlbach plants in all continents

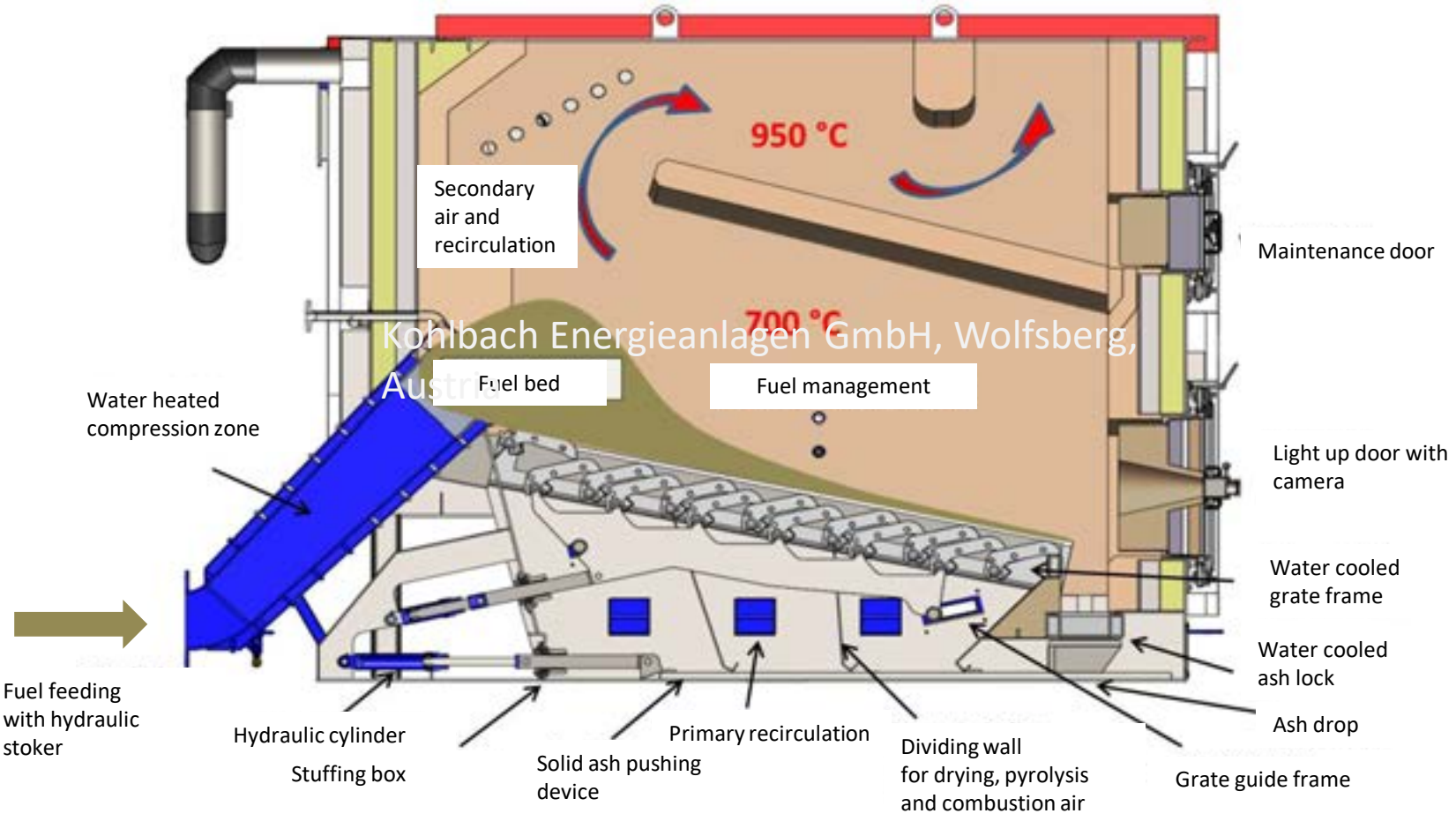
EXPERIENCE, INNOVATION, RELIABILITY

- More than 70 years of **experience** in producing and installing biomass boiler systems
- **Customized solutions** for our customers – heat and cogeneration
- Continuous **innovation** and new technologies for a changing fuel market
- Permanent **improvements** by working together with our customers
- **Highest quality** by latest process and manufacturing technologies
- **Local service and maintenance** by KOHLBACH and our partners
- **24/7** on call service

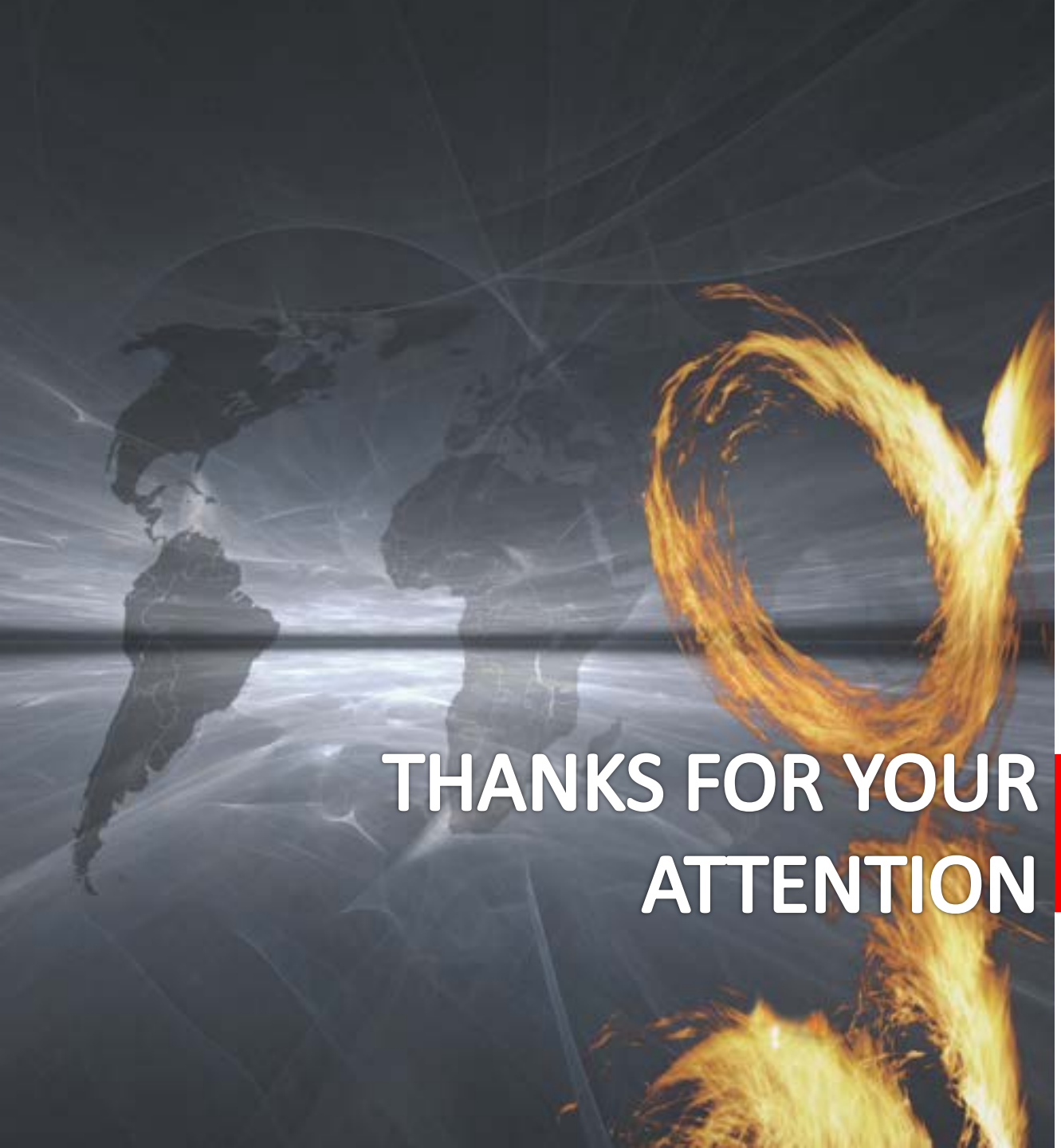
New Manufacturing Plant in Bleiburg

- 8,500 m² Production space
- Latest manufacturing technology
- Own Kohlbach test plant
- Room for training courses

EXPERT IN COMBUSTION TECHNOLOGIES – K8 ALLROUNDER



KOHLBACH IS THE ORIGINAL



THANKS FOR YOUR ATTENTION

KOHLBACH

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MASCHINEN – UMWELTTECHNIK – TRANSPORTANLAGEN Ges.m.b.H

Abdalla Farag, MSc

M-U-T Business Lines

Conveying systems

Municipality Trucks

Environmental Technology

Water Treatment

Education & Training

Decarbonisation of waste collection fleet

- Electric emptying system:
  - less Diesel
  - less noise
  - CO_2 - reduction
  - green marketing

M-U-T as provider for Environmental Technolgy

- studies
- R&D
- Sorting plants
- MBT plants
- Drying plants
- Composting
- Waste transfer
- Financing

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