Energy Efficiency Solutions

Siemens Energy

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Olaf Bernstrauch, Innovation Manager
Daniel Hofmann, Head of Plant Integration R&D Gas Services

Honestly – I though it is easy…

WIKI: **Efficiency** is the often measurable ability to avoid wasting materials, energy, efforts, money, and time in doing something or in producing a desired result.

Power from fuel
Low emission
Zero emission
Unmanned operation
Utilizing waste
Making money

Energy Efficiency Solutions
Combined cycle power plants
Mods and upgrades
New gas turbines

Electricity
Heat
Transport
Operation
Development

Globalization

Demographic change

Urbanization

Climate change

Digitalization

... are drastically changing the world we live in.

These changes have started at different places and at different speeds

November 2020

March 2021

Climate change as the most important megatrend leads to more and more countries aiming for Net Zero

- Net zero achieved (2)
- Net zero embedded in law (6)
- Net zero proposed in legislation (6)
- Net zero in policy document (16)
- Net zero target under discussion (>100)
- No action taken

Generating the best specific solutions for business applications

Evaluating and integrating existing assets

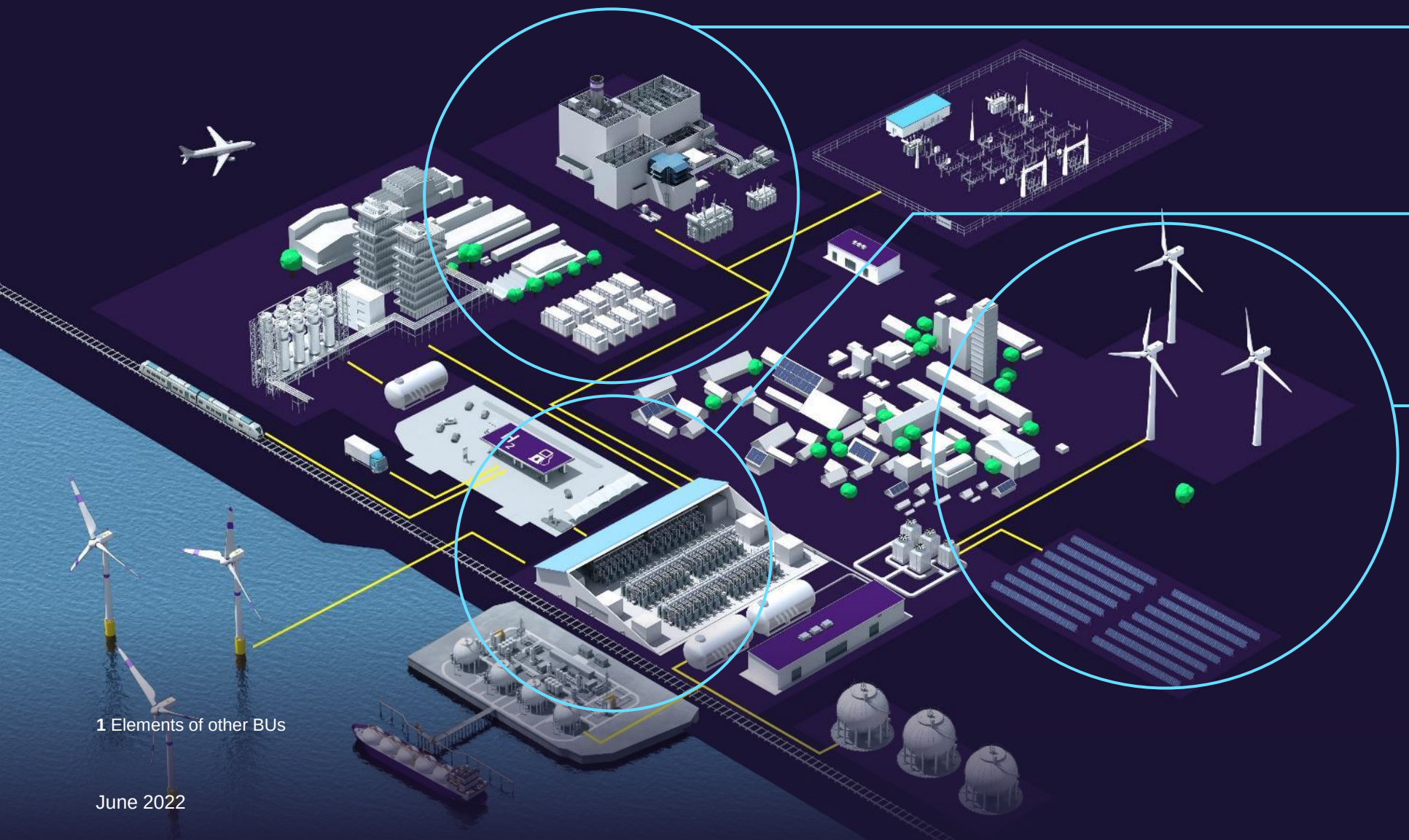
This leads to

new challenges

for all energy market players.

Understanding and scaling the full spectrum of energy technologies, business models, and revenue streams

Various levers for energy efficiency in your transition journey



Gas turbine power plants

- New build
- H_2 co-firing
- Brownfield transformation
- Seafloat

New application

- Power-to-X
- Hybrid power plant
- Heat pump
- Heat Recycle

Renewable energy

- Solar
- Wind[1]
- Storage[1]

1 Elements of other BUs

The road to decarbonization and energy efficiency

The step-by-step way to a zero CO_2 emissions world

Increase efficiency

- Coal/Oil to Gas Repowering
- Brownfield Engine Exchange
- Efficiency increase
- Upgrades
- Digitalization

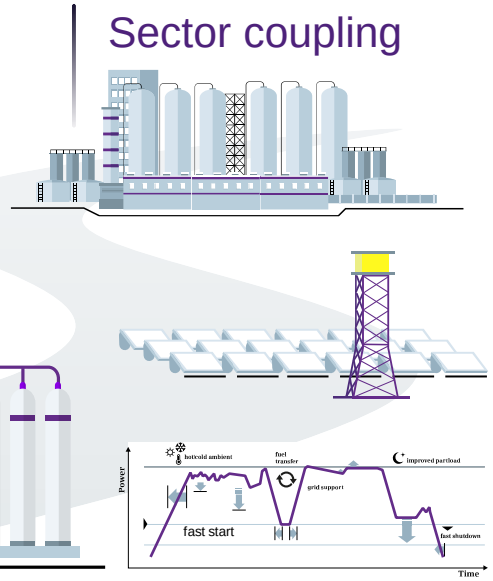
Plant hybridization

- Heat & cooling distribution
- Heat pumps
- Renewable integration

Green fuel

- H_2 Electrolyzers
- H_2 storage
- Co-firing

Sector coupling



Grid stability & inertia

- Synchronous condenser
- Flywheel
- Hybrid operation mode

Flexibility through Storage

- Flex power solutions
- Black start capacity
- Batteries
- Thermal storage
- Hydrogen large scale

Decarb Journey

- **Consultative approach**
- **Energy System Design**

Data based simulation for optimized asset combination to meet capex and emission targets

GUINNESS WORLD RECORDS
RECORD HOLDER

SIEMENS energy

>64%
combined cycle efficiency

85 MW / min
ramp rate

33 KEBH / 1,250 ES
Best-in-class serviceability

50% vol. hydrogen
co-firing capability

880 MW 50Hz
655 MW 60Hz
combined cycle power output

<30%
minimum environmental load (MEL)

593 MW 50Hz
440 MW 60Hz
simple cycle power output

The SGT-9000HL

Guinness World Record: Most powerful 60Hz Simple Cycle Gas Turbine Plant

siemens-energy.com/gasturbines

Decarbonization and energy efficiency on our radar

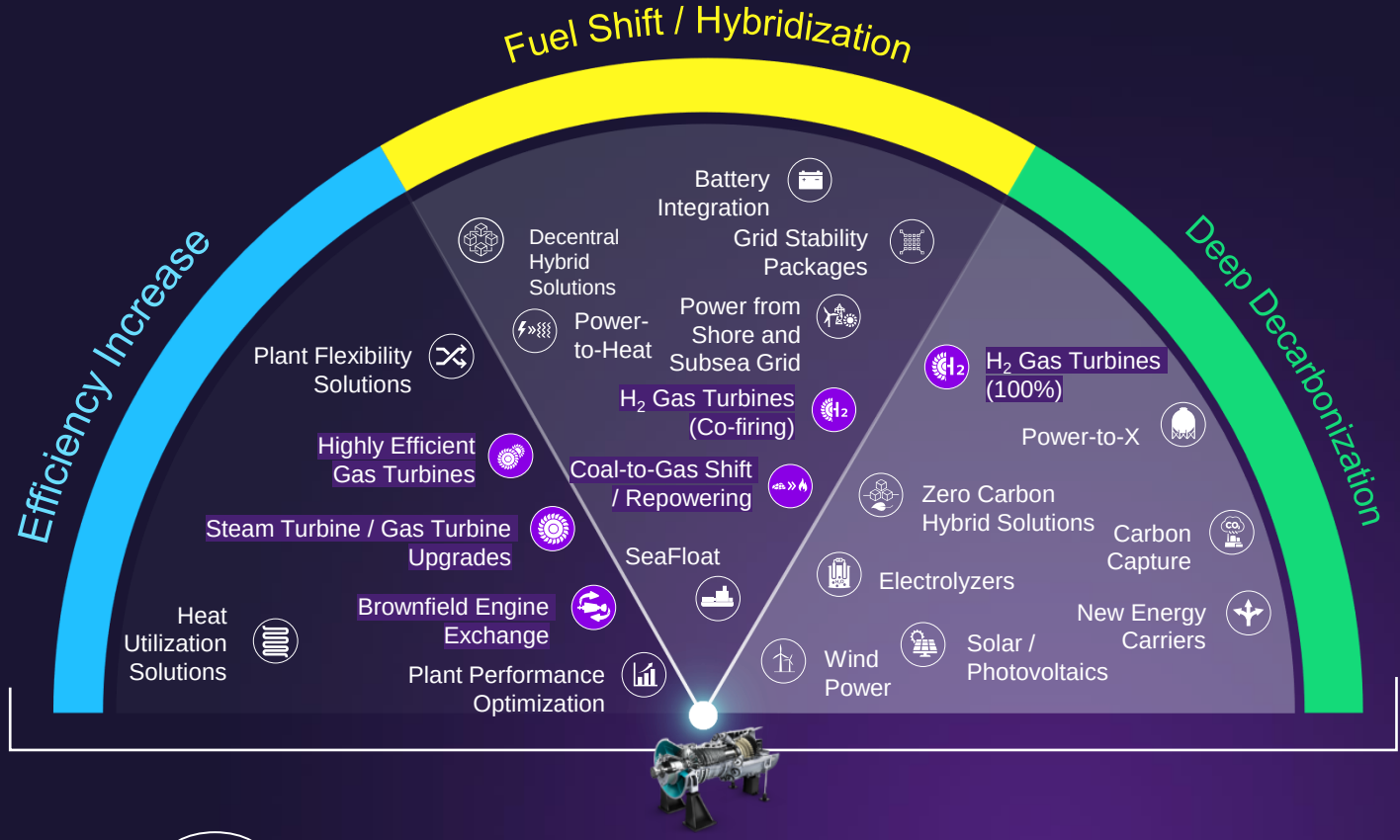
H_2L helps to decarbonize power generation

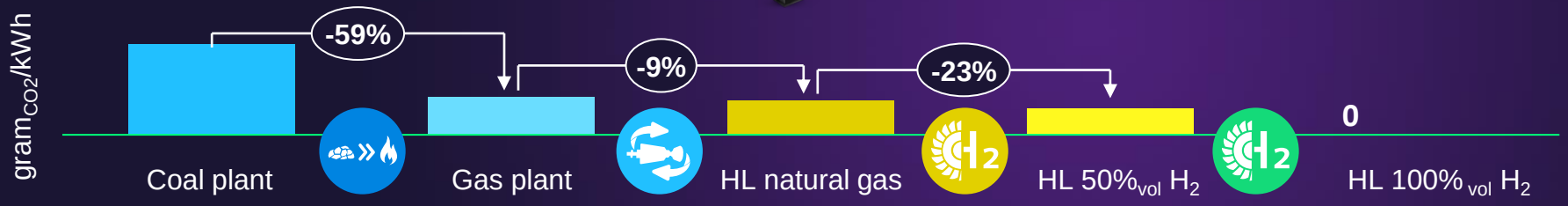
F-class to HL-class
-0.2M t_{CO2} / year

Coal to 5-9000HL
-3.7M t_{CO2} / year

HL-class to 50%$_{vol}$ H_2
-0.5M t_{CO2} / year

HL-class to 100%$_{vol}$ H_2
-2.2M t_{CO2} / year



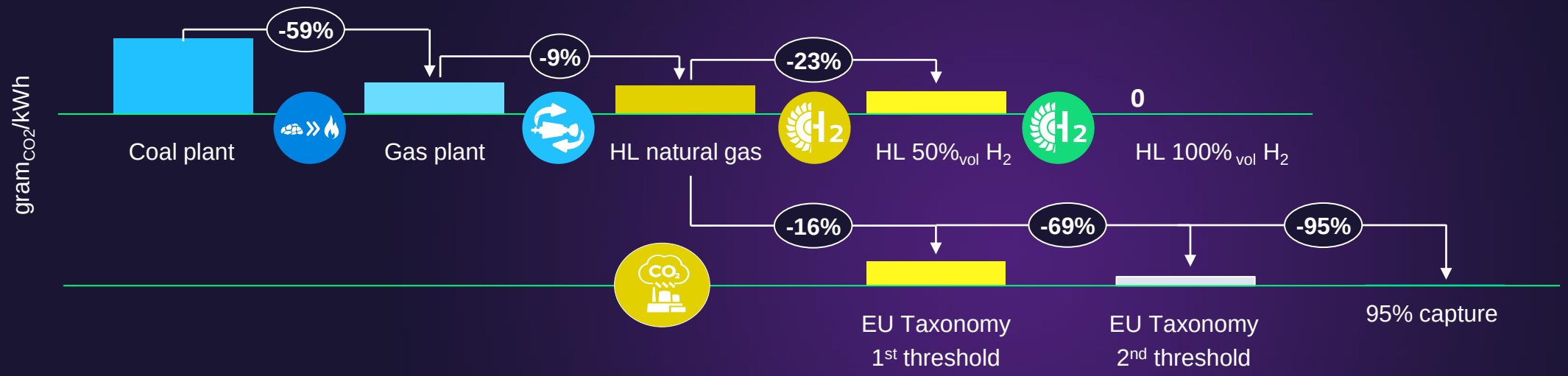


Efficient decarbonization via Carbon Capture

Coal to
95% capture
-5.2M t_{CO2} / year

- Carbon prices are rising
- Political / legislative pressure to reduce emissions
- Carbon networks in development
- Technology in the market today

HL-class to
95% capture
-2.1M t_{CO2} / year



Capable for the future, our gas turbine power plants are already H_2 ready

- For new CCPPs not requiring immediate H_2 operation, an optimized configuration can be offered that takes future H_2 retrofit into account ("H_2 ready plants")
- While keeping front-end investments low, the plant can already be prepared to be retrofitted at a later stage
- Depending on H_2 co-firing time roadmap and requirements, optimized equipment configurations will be offered

Areas	Equipment/Systems considered
Fuel Supply	Materials, sizing, aux. fuel, metering, additional systems ...
Fire/Ex Protection	Fire/Ex protection concepts, sizing of systems
HRSG	Materials, temperatures, purging requirements
Safety	Safety Integrity Levels definition and design
Certification	Certification by independent party

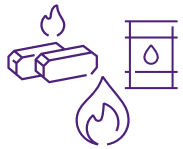
Brownfield Transformation – The efficient path to a decarbonized future for existing power plants

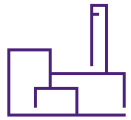
Approach

- **Integrated solution** approach
- Concept and execution roadmap for complete decarb path with **Energy System Design**
- Focus on **reusing or repurposing existing** assets to generate new revenue streams
- Start with **bridging technologies** and reduce up to 70% CO_2
- Complement with **deep decarb** technologies to reach net zero

Decarb journey

Energy System Design (ESD)





	Coal/ Oil/Gas fired Steam turbine plant	**Fuel Shift/Repowering/ conversions** To build a highly efficient CCPP or SynCon	**Hybridization of exiting Power Plant** Integrated solution	**Net Zero Energy System**
Gas turbine power plant		• Fuel Switch: Coal/Oil to Gas Repowering (C2G) • Grid Stability Conversions (RGS) • Modernizations & Brownfield Engine exchange (BEX)	+ Integrate Electrolyzers, H_2 co-firing, other green fuels + Energy Storage + Heat Pumps + Integration of Renewables	• Sector coupling with green H_2 • 100% H_2 fired CTs • CHP/Storage • Carbon Capture

Starting point of transformation with bridging technologies

Complementing with deep decarbonization portfolio to reach net zero

Brownfield Transformation Portfolio	Coal/Oil to Gas repowering incl. Feasibility & Engineering study	Rotating Grid Stability Conversions	Brownfield Engine Exchange	Gas/Steam turbine & Generator Modernizations	Hybridization of existing power plants

Energy System Design Study: Data-driven scenario evaluation to decide on optimal combination of technologies on the decarb path

Decarb Journey

Generate a holistic decarbonization concept for power generation utilities starting with available bridging technologies including future proof portfolio on a step-by-step implementation approach.

Value based decision making

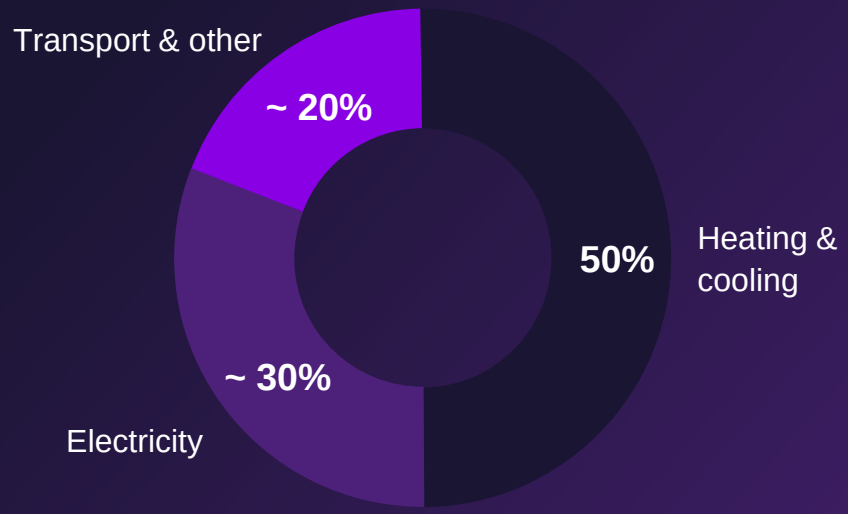
Site specific decarbonization concepts get optimized considering business case for existing and new revenue streams.

Avoid stranded assets

Reuse of existing infrastructure has strong sustainability and economical value increasing job security at the same time.

Industrial Heat Pumps
Enabling the decarbonization of heat …

Final Energy Consumption EU28

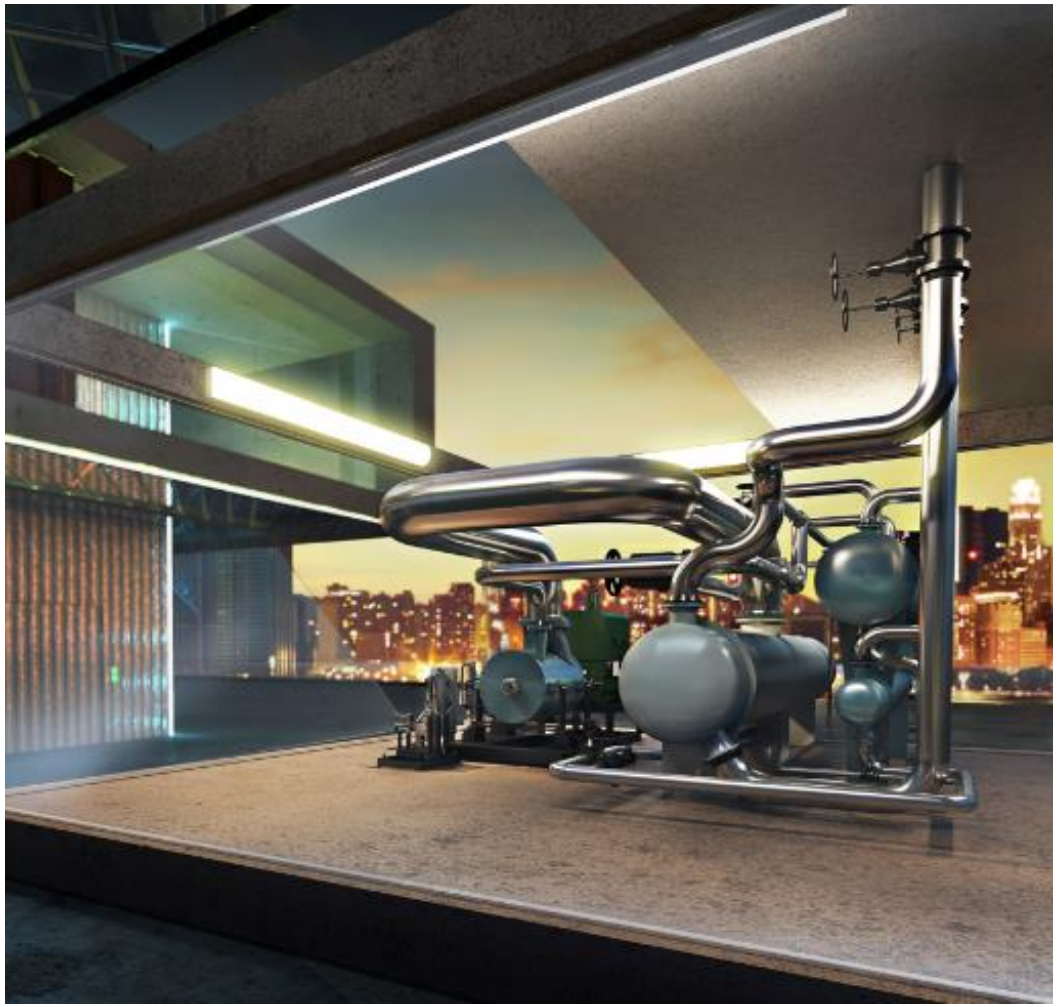


50%
of final energy use is heat

- More than double comparing electricity

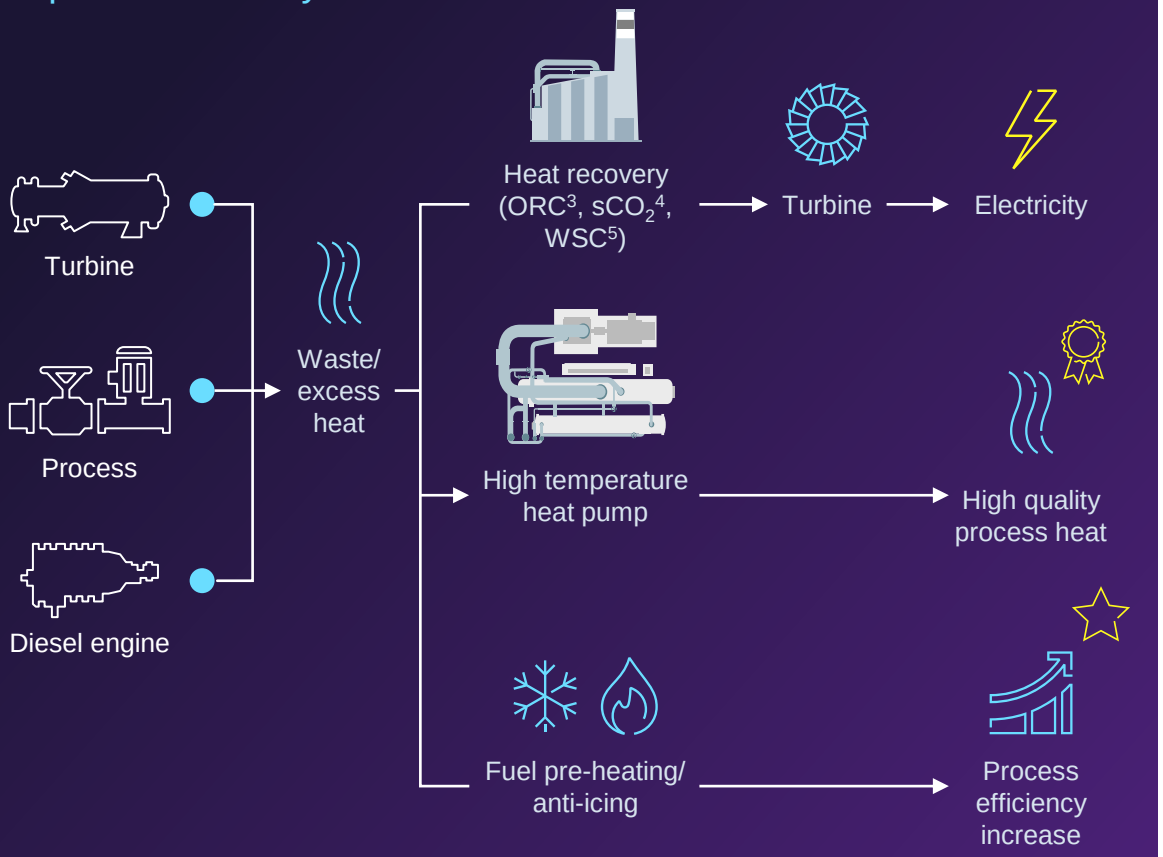
2/3 heat
is produced from fossil fuels

- ~40% of energy related CO_2 emissions



… and utilize heat
Power and heat generation without incremental emissions

Power and quality heat from all kinds of waste heat in process industry



Features

Re-electrification

Heat recovery units:
- HRSG[1], steam turbines and BoP for high temperatures
- WHRU[2], turbines and BoP for medium temperatures

Transfer media:
- WSC[5] – all ranges
- sCO_2[4] Cycle for medium temperature operations
- ORC[3] for water-free and low temperature operations

High quality process heat

High temperature heat pumps

Increased process efficiency

Fuel preheating and anti-icing with waste heat

Sustainability impact

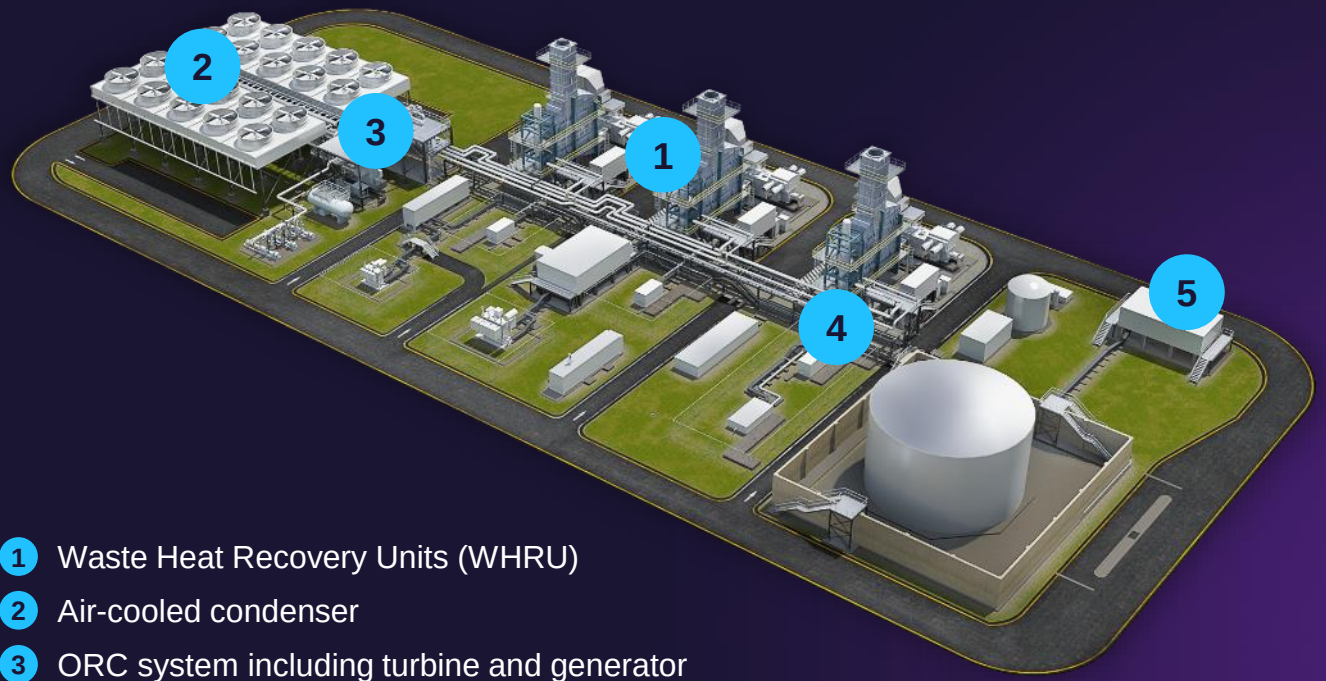
- Decreased fuel consumption
- Energy without additional CO_2 -, CO-, NO_x - or SO_x emissions

1 HRSG – Heat Recovery Steam Generator | **2** WHRU – Waste Heat Recovery Unit | **3** ORC – Organic Rankine Cycle | **4** sCO_2 – Supercritical carbon dioxide | **5** WSC – Water Steam Cycle

Heat ReCycle solution
A clean and efficient alternative for distributed power generation

SIEMENS energy

Decentral combined cycle power plant, combining gas turbines with Organic Rankine Cycle (ORC) technology



1. Waste Heat Recovery Units (WHRU)
2. Air-cooled condenser
3. ORC system including turbine and generator
4. Interconnecting piping and cabling
5. Instrumentation & Control

Attractive CAPEX and low LCoE
Combining the simplicity of ORC-design and the proven performance of gas turbines result in a cost-effective alternative power plant.

Environmentally sound solution
No water usage, lower emissions and limited noise pollution support a better climate.

Future-proof design
State of the art technology, providing remote and unmanned operations, ready for a new era.

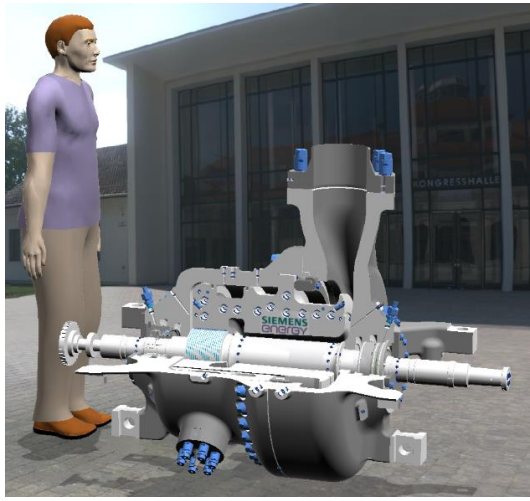
Large-Scale Industrial Waste Heat Recuperation with axial sCO_2 Turbine

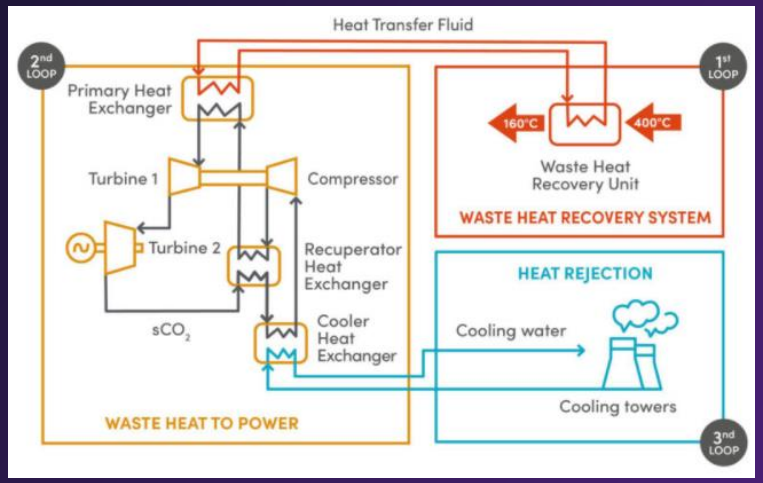
CO2OLHEAT

Unit Scaling
2-100 MW

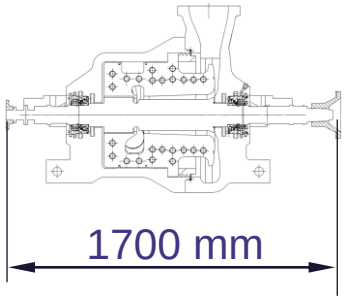
Turbine Performance
Up to 92%

- **Adapting barrel-type turbine design** for high temperatures and pressures, i.e. **high efficiencies**
- Realization and validation of **2 MW demo application** within EU funded project **CO2OLHEAT** *)
- Design **scalable to large power output** for different types of applications

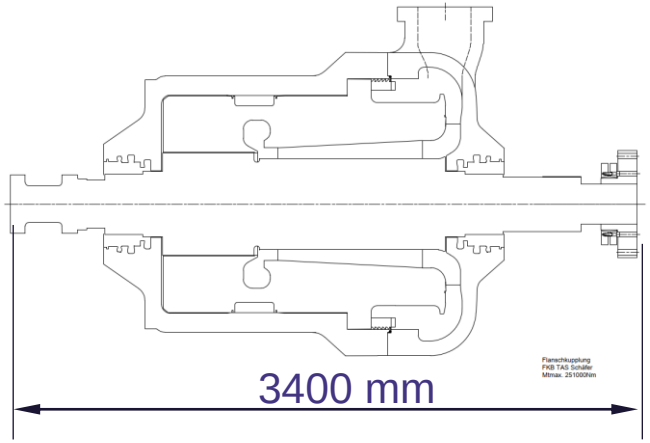




2 MW Demo sCO_2 turbine



Upscaled 50 MW sCO_2 turbine



*) This project has received funding from the European Union's Horizon 2020 research and innovation programme under GA n. 101022831

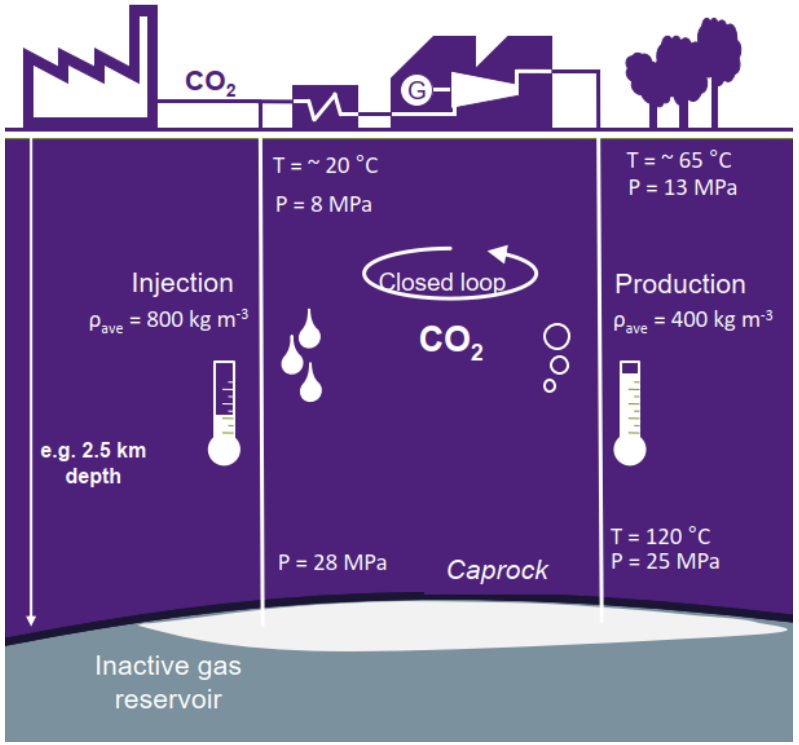
NextGen Geothermal Power (NGP)

Solution Scaling
20-500 MW

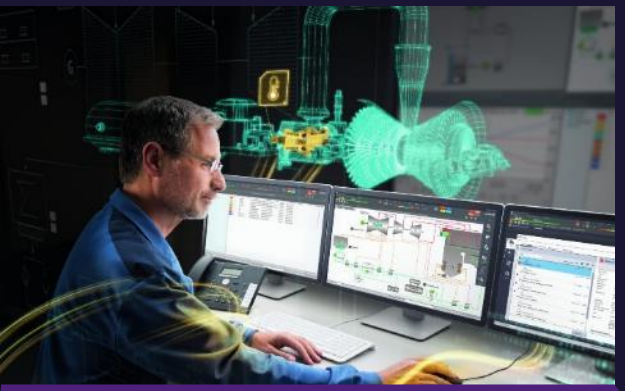
Performance
Strong natural circulation

NGP delivers a CO_2-neutral power plant giving geological storage of CO_2 the opportunity of renewable power generation by:

- **Using emitted CO_2 as working fluid:** provides life cycle for (own) CO_2 emissions
- **Giving depleted reservoirs a second life cycle:** injected CO_2 extracts geothermal heat
- **Providing fully dispatchable renewable power:** geothermal power generation in a closed CO_2 loop supported by strong natural circulation



Delivering outcomes through digital value streams



Proven Controls and Protection

- Building on proven SPPA-T3000 for best-in-class automation
- Maximum data security to ensure smooth operation in day-to-day business

Advanced Diagnostics

- Condition Monitoring, anomaly detection and real time optimization using machine learning
- Providing insights through analytics with Power Diagnostics Services

Innovative Digital Applications

- Enabling access to Siemens Energy via the Omnivise Digital Service Portfolio for increased customer value
- Industry IoT operating system connectivity, visualization, monitoring and optimization

Delivering Managed Services

- Providing expert plant condition assessments with actionable advice
- Impact forecasting with issue resolution and case management

Supplementing operator experience to achieve better performance and plant availability

Summary

There is a multitude of energy efficiency solutions

It may be difficult to find the best path to your goals

We are happy to support you with components, consulting, modelling, solutions…

We want to shape the energy world of tomorrow with you!

Thank you for your attention

Contact page

Daniel Hofmann

Head of Plant Integration R&D

Gas Services

Mobile: +49 174 1531555

daniel.hofmann@siemens-energy.com