Combined Heat and Power technology and market developments

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ETN October Workshop, October 12-13 2022

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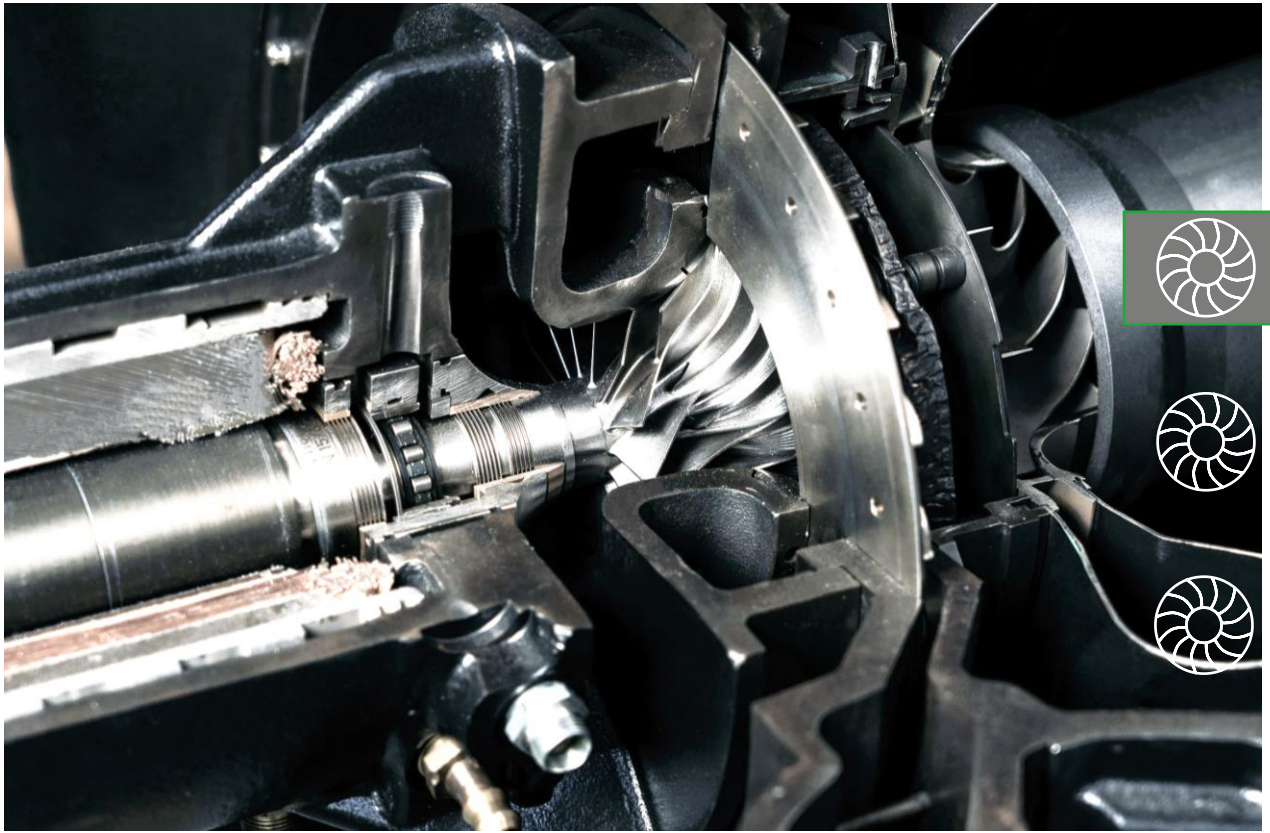
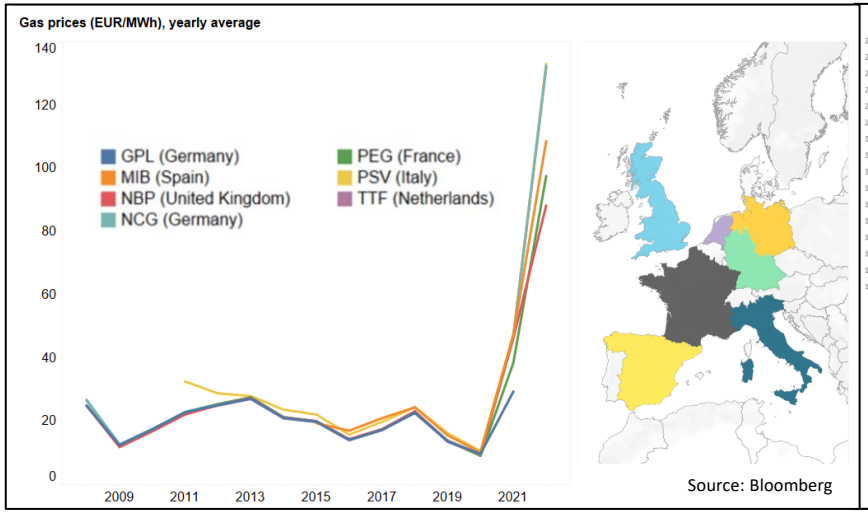


Conventional CHP

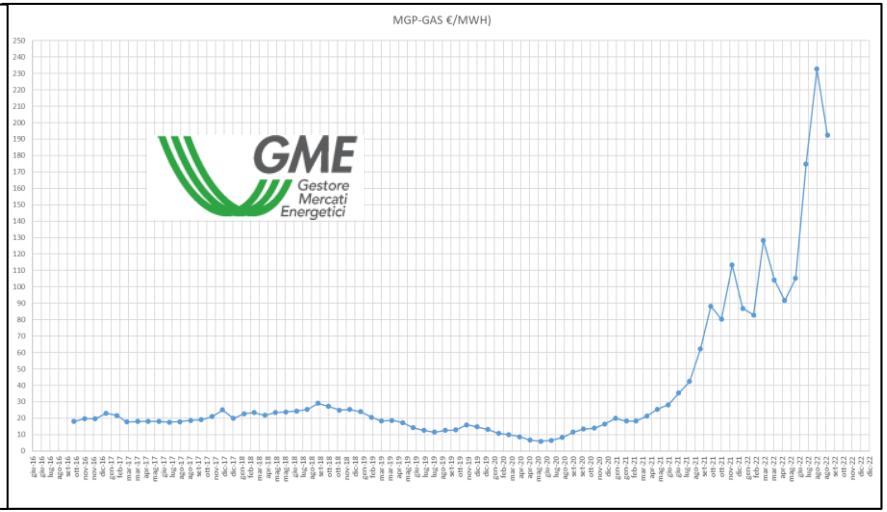
Fuel Flexibility

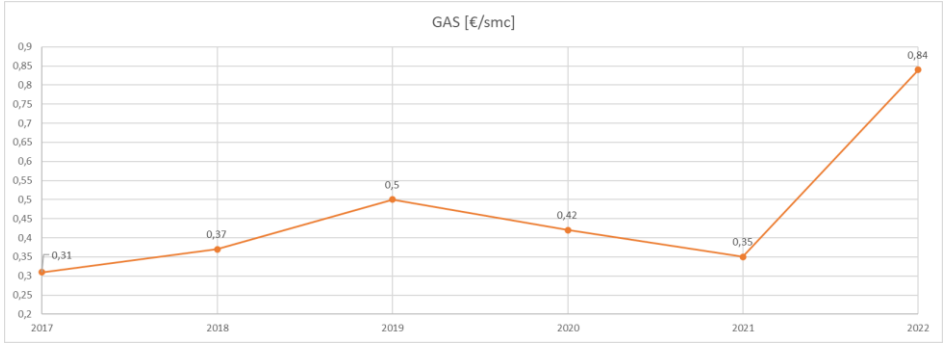
Energy storage

Conventional CHP applications: *Gas prices*

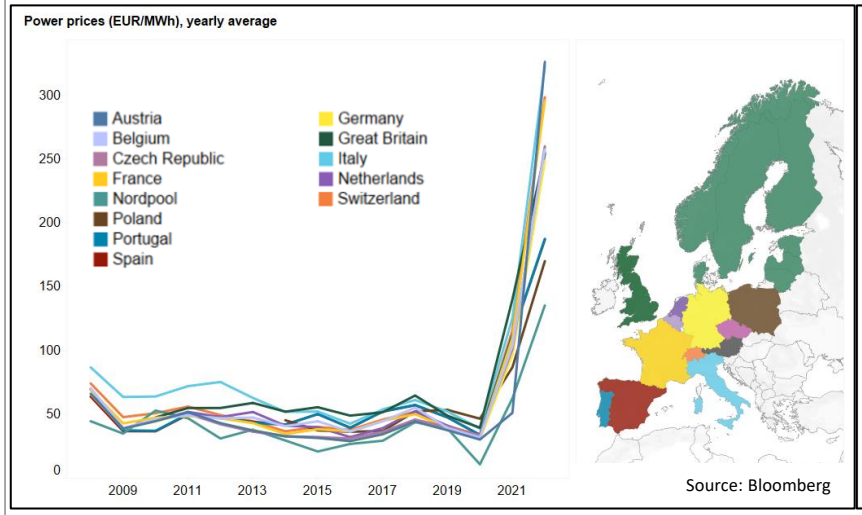


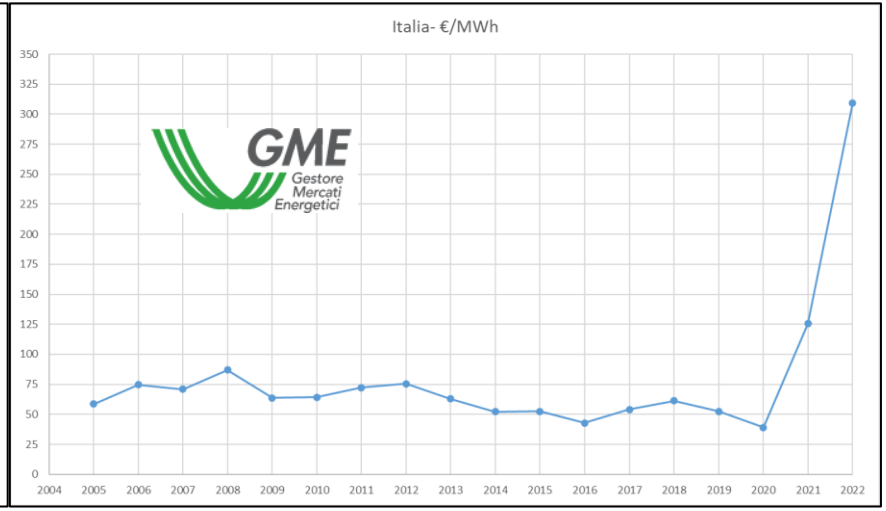
Source: Bloomberg

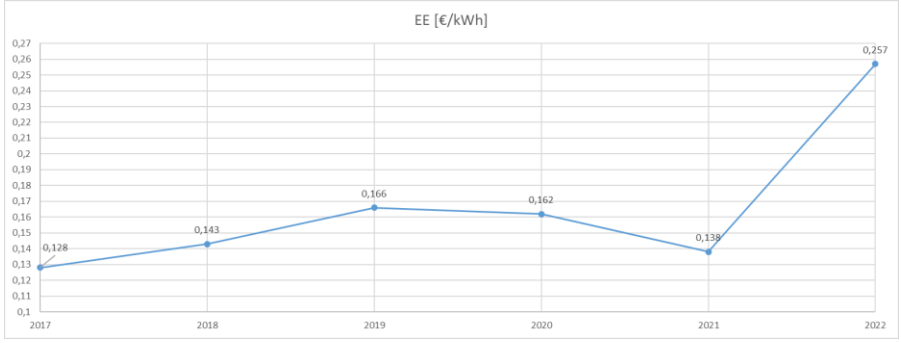




Conventional CHP applications: *Electricity prices*





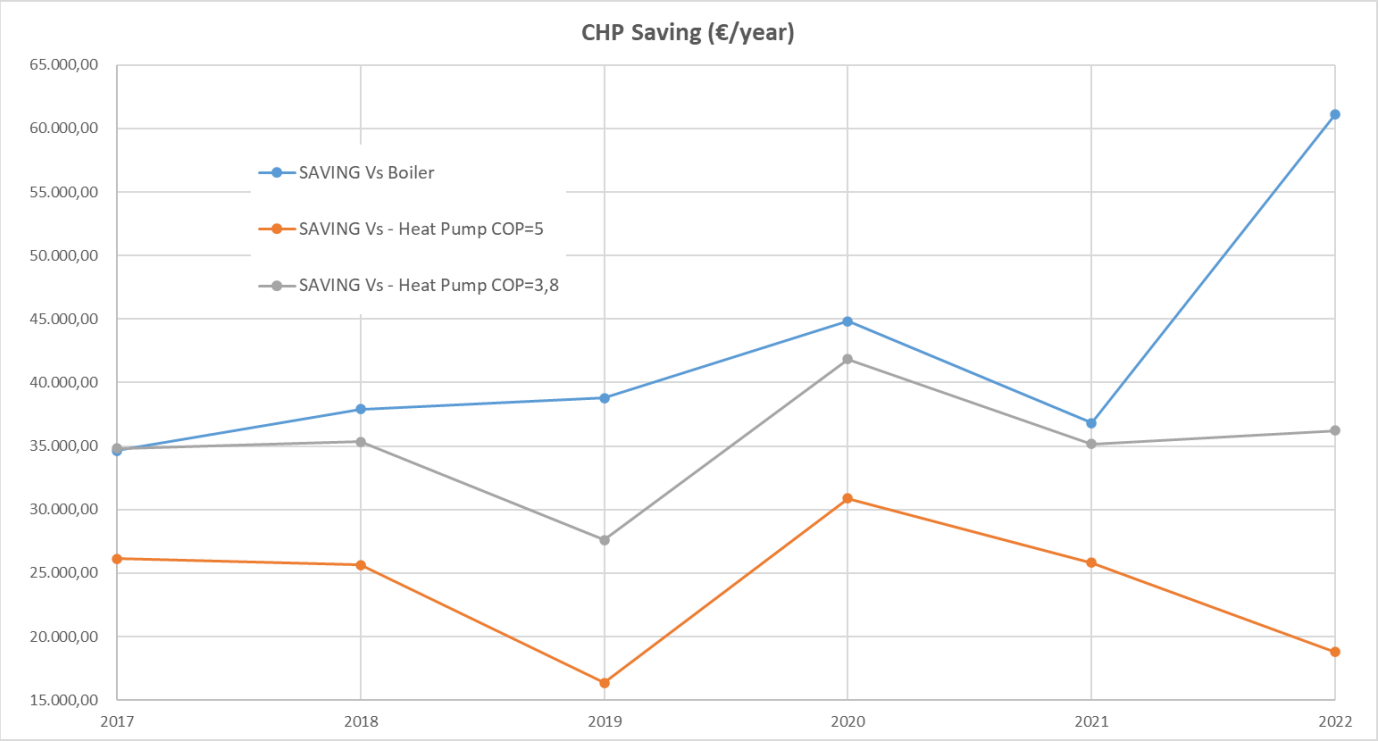


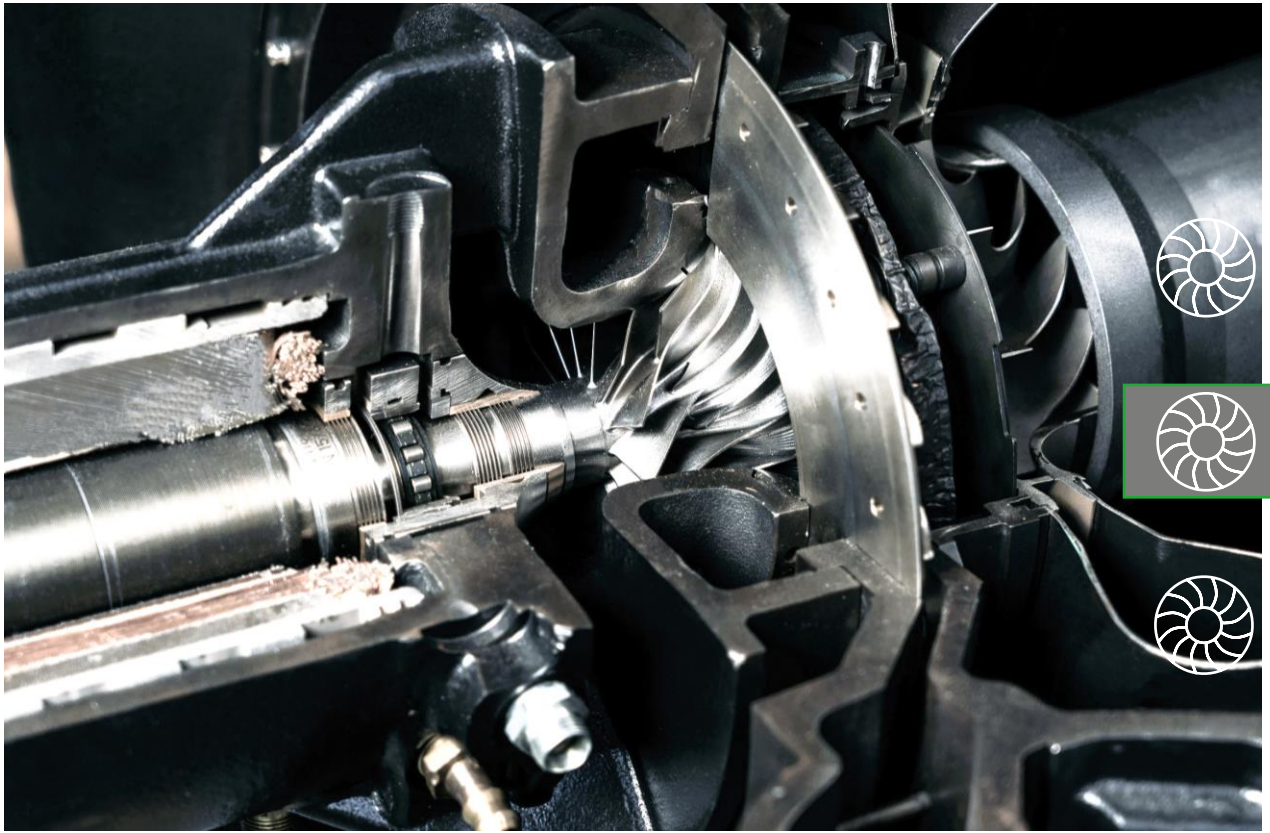
Conventional CHP applications: *Saving*

	2017	2018	2019	2020	2021	2022
MGT Operating [hours par year]	6500	6500	6500	6500	6500	6500
Electrical Power Average [kWel]	100	100	100	100	100	100
Thermal Power Average [kWth]						
EE [€/kWh]						
GAS [€/smc]						

Cost CHP
TOTAL NO CHP - Boiler
TOTAL NO CHP - Heat Pump COP=5
TOTAL NO CHP - Heat Pump COP=3

SAVING Vs Boiler
SAVING Vs - Heat Pump W/C
SAVING Vs - Heat Pump A/C





Conventional CHP

Fuel Flexibility

Energy storage

Fuel flexibility: Methanol, Why?

Available
Methanol is chemical building block and **available** from fossil, bio or synthetic **production**.

CO2-neutral
Fully supports Targets of **Paris Climate Agreement**

Renewable
Green electrons, water and **captured CO2** for the production of synthetic methanol

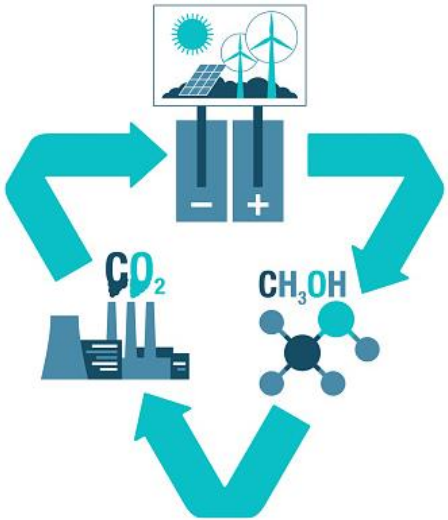
Independent
Autonomous electrical and thermal power production independent from the grid.

Ready to use
Methanol uses **today's** infrastructure for storage and transportation

Safe & Controllable
Methanol is **much safer** than crude oil or other synthetic fuels

Clean
Burning Methanol with clean emissions and **no soot or particles**

Reliable
Industrial **prove** multifuel-turbine, **>20 years** of lifetime, **easy maintenance**

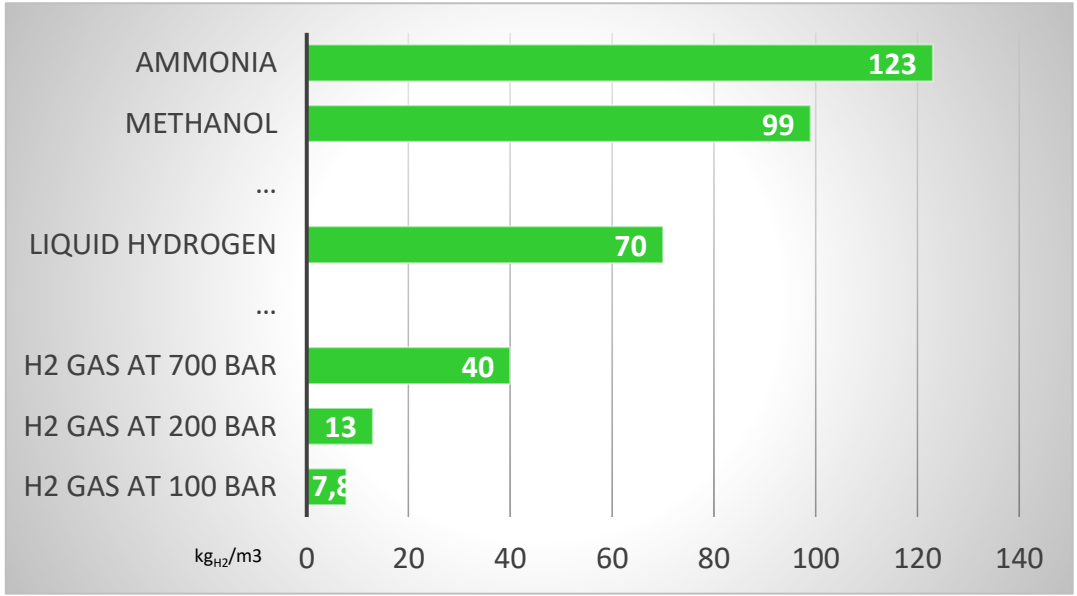


Fuel flexibility: Methanol

Methanol is liquid at room temperature and ambient room pressure

Emitting CO2, moisture and no fine particles when burning

Methanol stores higher volumes of hydrogen than liquid hydrogen at – 253°C

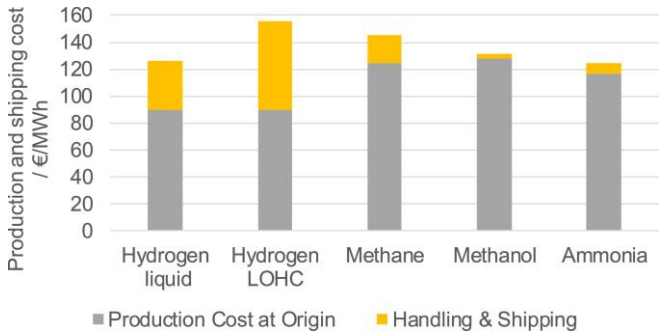


Source: Andersson, J., Grönkvist, S.: Large-scale storage of hydrogen, International Journal of Hydrogen Energy No. 44 (2019) p 11911

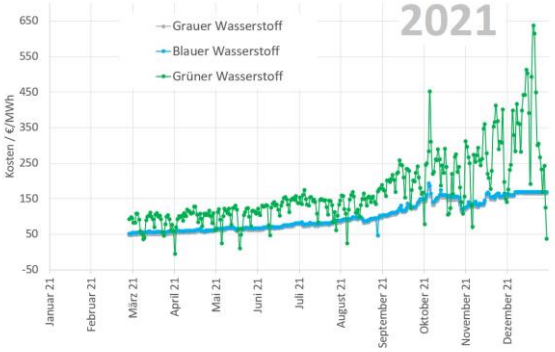
Methanol has a better capacity to store hydrogen that liquid hydrogen

Fuel flexibility: Methanol

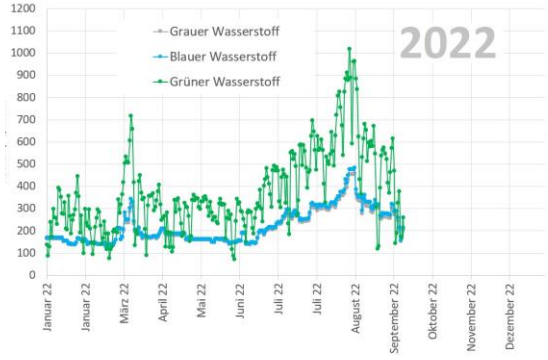
- Methanol is about 40% more expensive to produce than hydrogen.
- Storage and transport of methanol are more than 11 times cheaper than hydrogen!
- Unlike liquid hydrogen, methanol does not need permanent compression



Source: Methanol as a renewable energy carrier: An assessment of production and transportation costs for selected global locations Advances in Applied Energy 3 **(2021)**

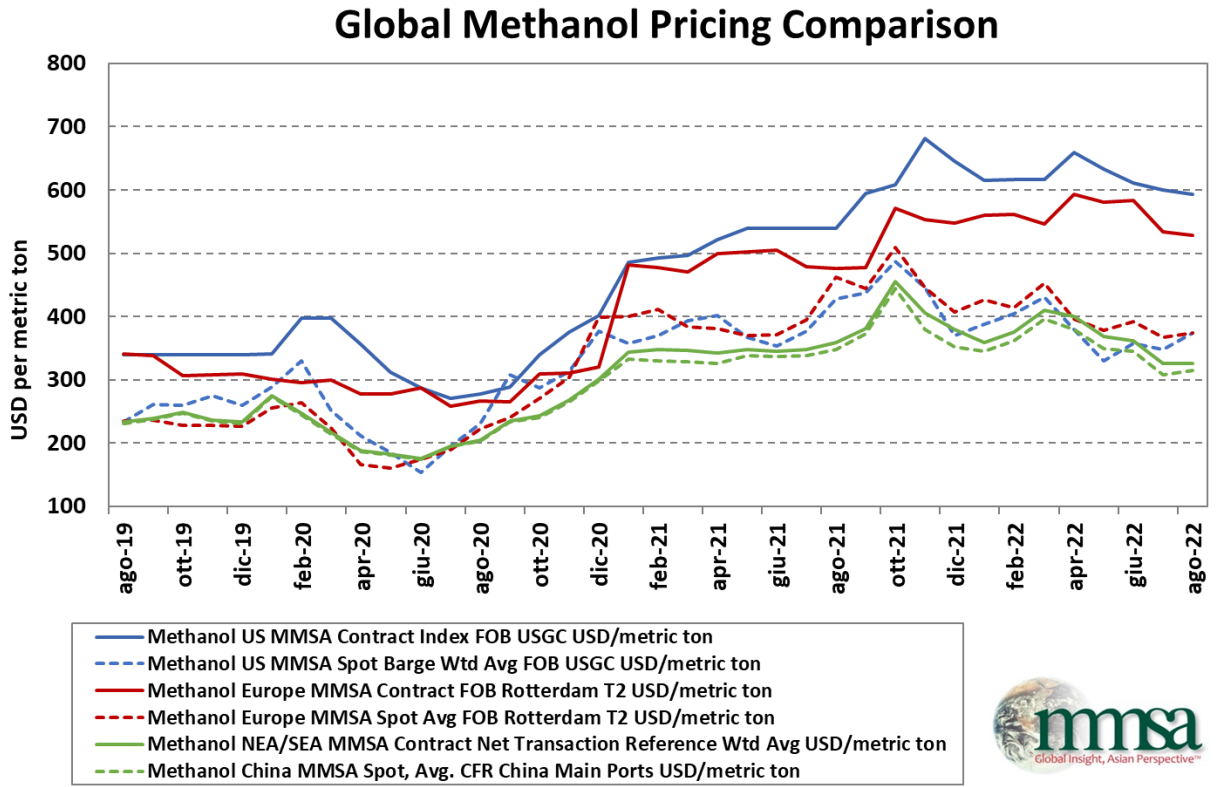


Daten: E-Bridge Consulting GmbH. Eigene Darstellung: ASUE Stand: 31.12.2021



Daten: E-Bridge Consulting GmbH. Eigene Darstellung: ASUE Stand: 07.10.2022

Fuel flexibility: Methanol



Source: Methanol Market Services Asia (MMSA)

Fuel flexibility: Methanol

Synthetic Methanol	Biologic Methanol	Fossil Methanol $C0_2$ Compensated SWISS CLIMATE Sustainable Business
Production: Renewable Energy H_20 + $C0_2$ Methanol Synthesis Plant ***Availability:*** Commercially ready by Q1 / 2024 Production Plants in Northern Europe ***$C0_2$ – Neutrality:*** 100% of Exhaust due to $C0_2$ Capturing 100% of Energy used for Production C02 Footprint Plant Material &Transport	***Production:*** Gasification Biomass (Agricultural and Household) and Catalisation ***Availability:*** Available, Varios Sources Production Plants in EU and US ***$C0_2$ – Neutrality:*** 100 % of Exhaust due to Biomass $C0_2$ Footprint Plant, Production, Transport	***Production:*** Gasification of Coal, Reforming of Natural Gas ***Availability:*** 2nd most traded chemical liquid > 95'000 Billion Litres / year production ***$C0_2$ – Neutrality:*** 100% of Exhaust compensated with C02-Certificates $C0_2$ Footprint Plant, Production, Transport
Methanol-Price Tank filled at site (07.10.2022)		
0.90 € per Liter	**1.12 € per Liter**	**0.50 € per Liter**

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silent POWER

Fuel flexibility: Methanol

Technical Data

Electrical Output:
- 400 V, 100 kW

Thermal Output:
- 170 - 200 kW

Exhaust Gas Temperature:
- 250°C

Optional cooling capability with absorption chiller:
- About 250 KW up to 300 kW

Electrical / Thermal / Total Efficiency:
- 30 % / 60 % / 90 %

Noise Level:
- Less than 72 dB(A)

Fuel Consumption:
- 74 litres per hour

Emissions (vs. Diesel gensets):
- CO2: 85 % less
- Nox 88 % less
- UHC (unburned hydrocarbons): 99 % less
- Soot / Particulate Matter: 100 % less

Dimensions

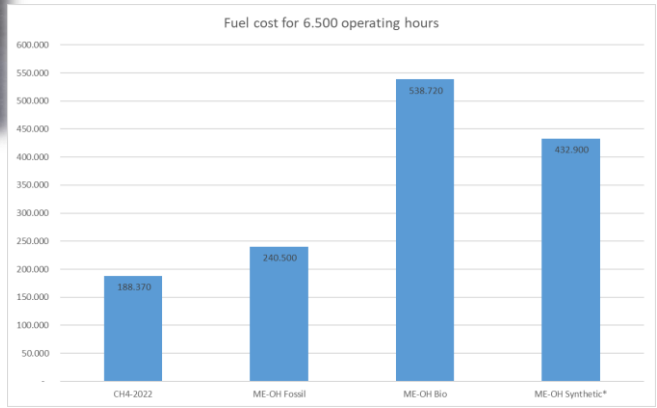
- Width x Height x Length:
  - 900 x 1900 x 2700 mm
- Footprint:
  - 2.43 m2
- Gross Weight Outdoor Installation:
  - 2770 KG

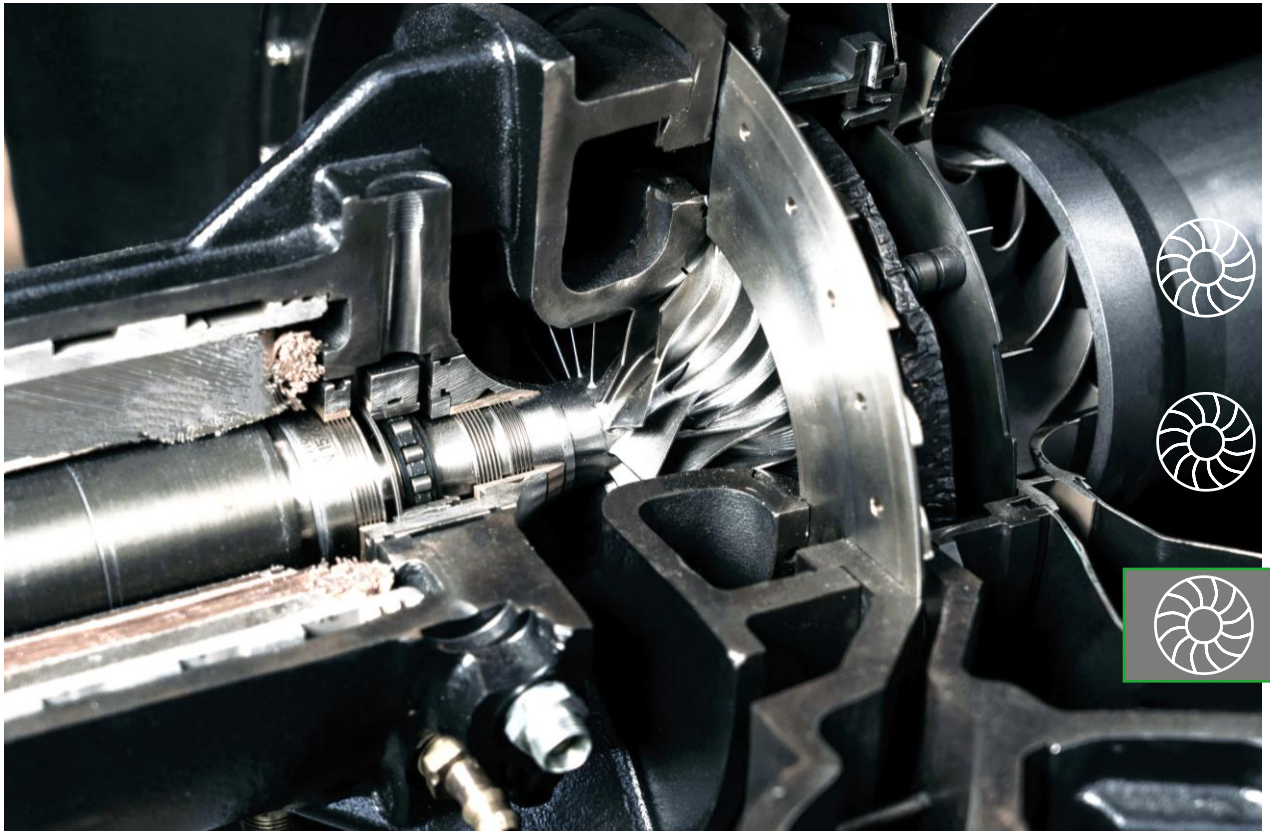
Application Area

Housing
- Heating and Electricity for Residential Buildings
- Regional District Heating for housings
- Heating or Cooling for commercial building

Hotels
- Heating, Cooling and Electricity for Resorts
- Heating for Pools, Amusement Parks
- Backup - Power

Island Operation
- Electrical Power Production,
- Fixed or mobile installations (on trucks or ships)





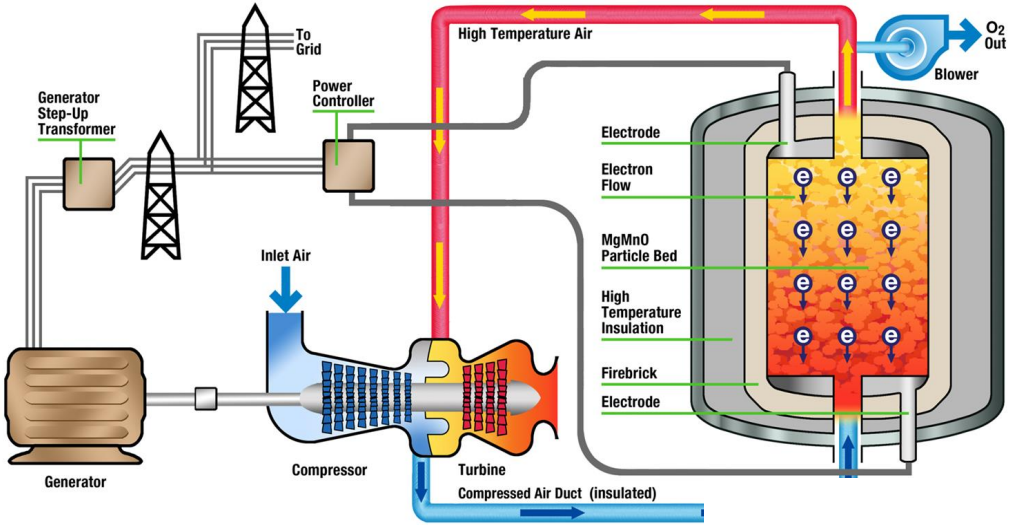
Conventional CHP

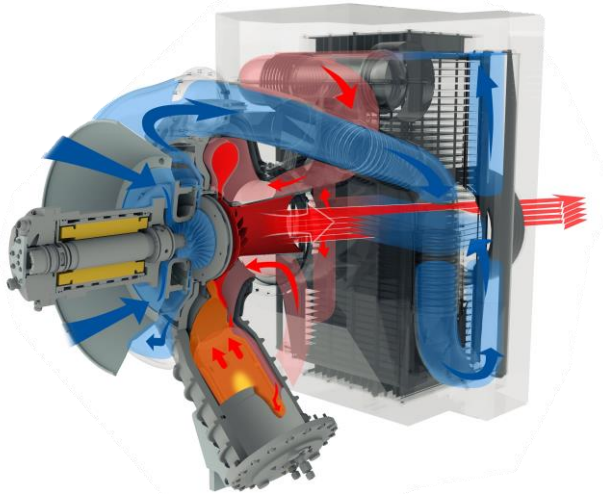
Fuel Flexibility

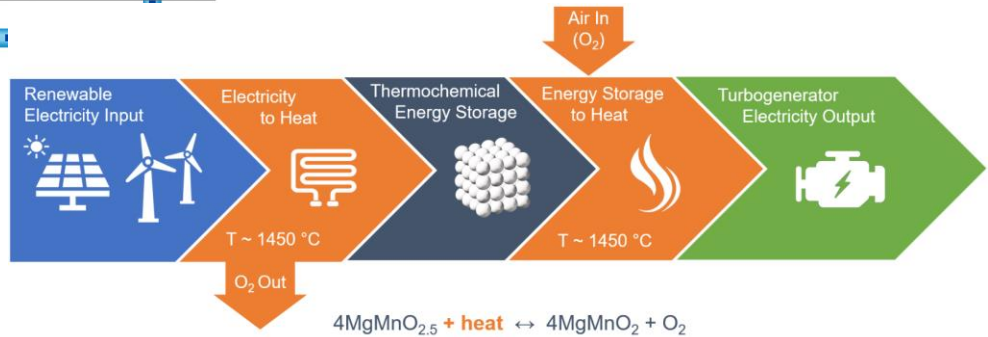
Energy storage

redoxblox

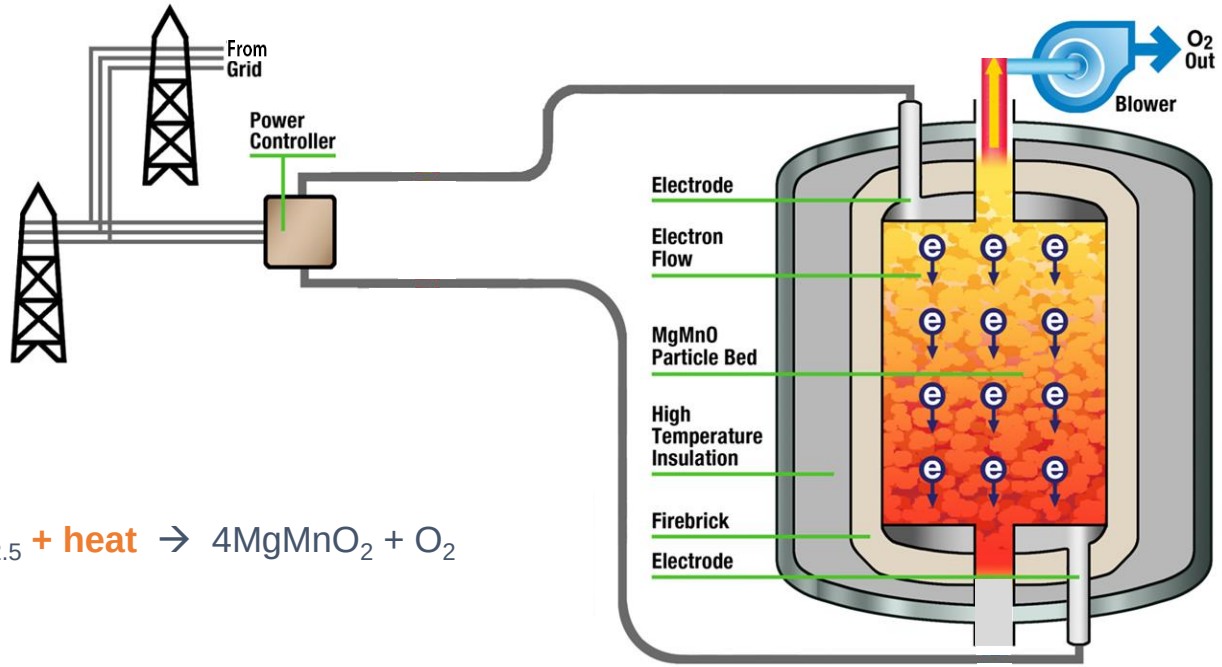
Energy storage: Thermochemical batteries





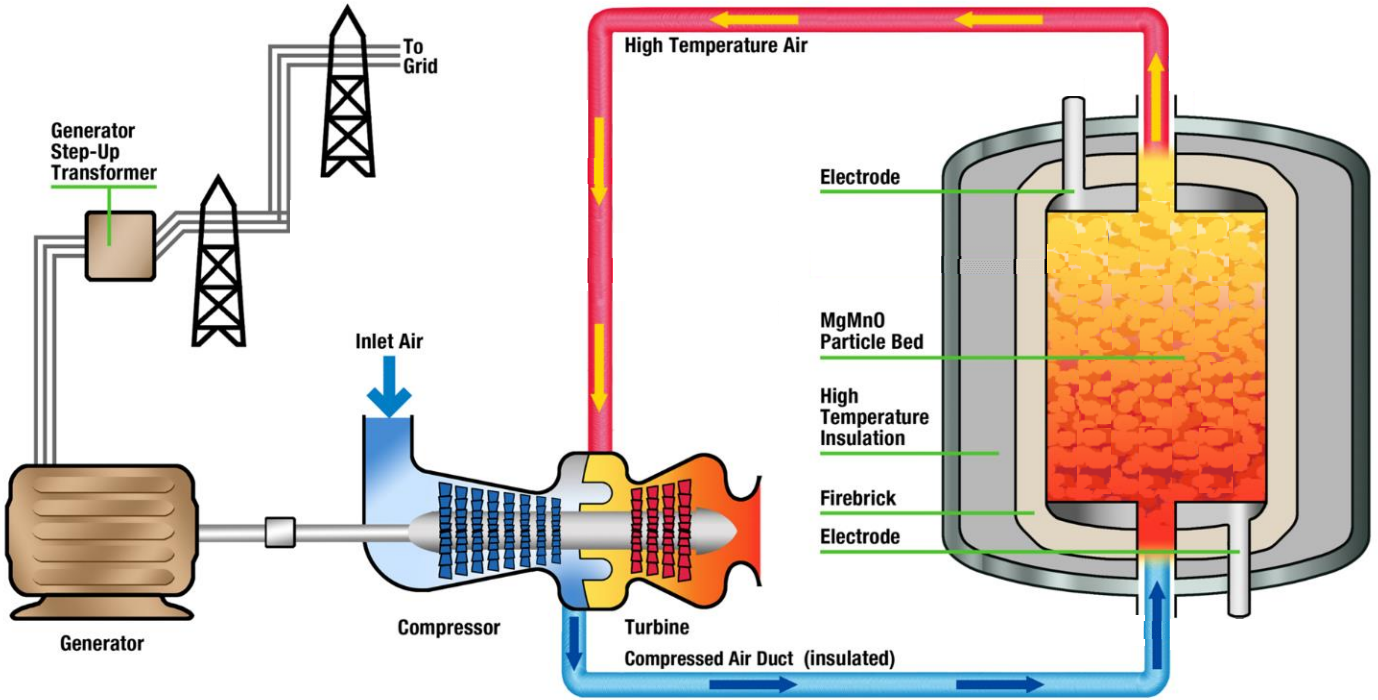


Energy storage: Charging phase



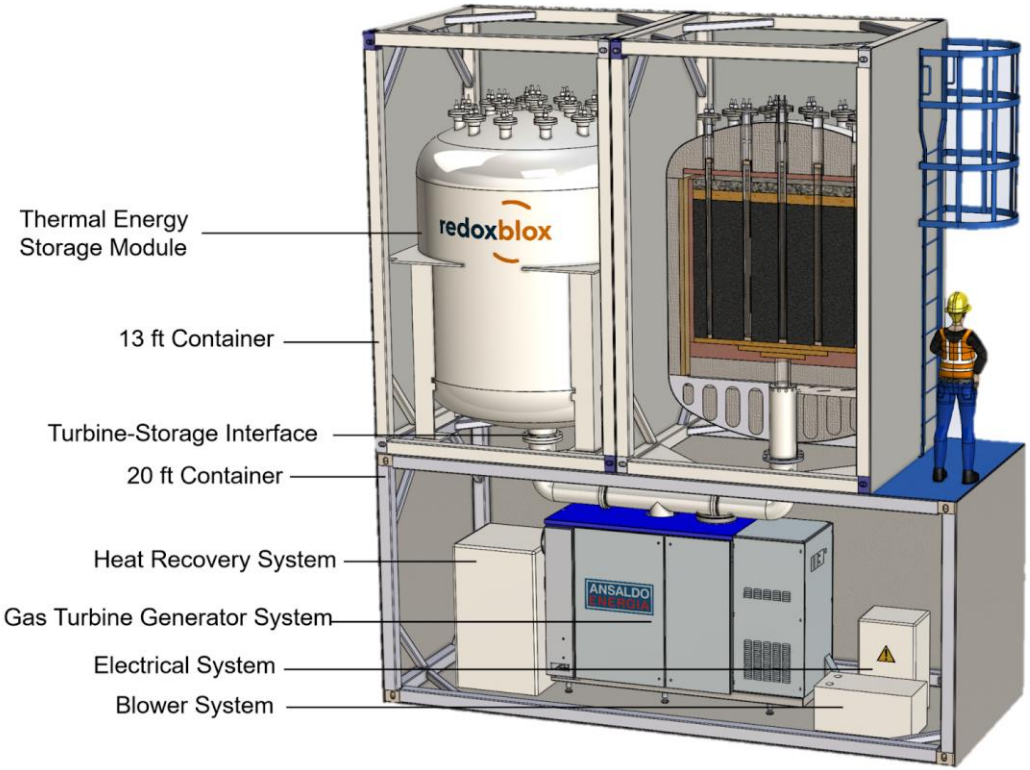
$4MgMnO_{2.5}$ **+ heat** → $4MgMnO_2 + O_2$

Energy storage: discharging phase



$4MgMnO_2 + O_2 \rightarrow 4MgMnO_{2.5}$ **+ heat**

5 MWh_{th} storage with 100 kWe micro-turbine



- Thermal storage capacity: **5 MWh**
- Electrical power output: **100 kW**
- Storage duration: **15 h**
- Storage material mass: **8 t**
- Max redox material temperature: **1500°C**
- Min redox material temperature: **1000°C**
- Enclosure dimensions:
  - H : 6.8 m
  - L : 6 m
  - W : 2.5 m

Disclaimer