Synergies of Bio-CHP and Bio-CCU for combined heat and fuel production

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EPPSA

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Introduction to EPPSA

The European Power Plant Suppliers Association (EPPSA):

- Is the voice, at European level, of companies supplying the most advanced power plants, their components and related services for energy providers.
- Promotes state-of-the art, flexible and efficient thermal power generation technologies as part of the solution to enable the transition to a low-carbon, secure and affordable energy supply.
- Believes that increased investment in Research, Development and Demonstration is a key factor for driving EU competitiveness.

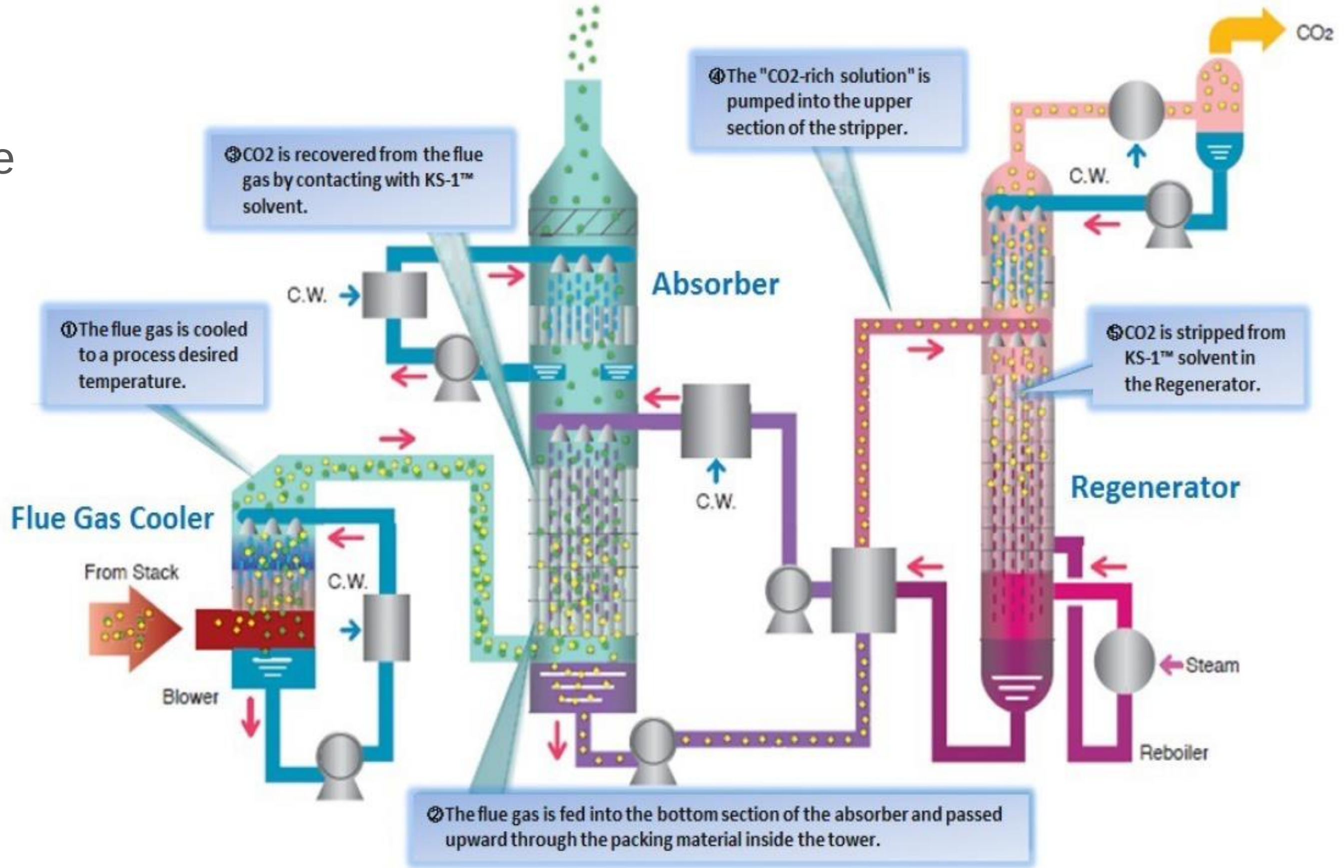
Members

Content

- State-of-the-art in Carbon Capture Technology
- Carbon Utilisation
  - Energy markets and cross-sectoral energy storage
- Process principle, example of Bio-CCU in CHP plants
  - Technology
  - New business case for CHP operators
- Comparison with traditional biofuels
- Conclusions

State-of-the-art in Carbon Capture Technology: KM CDR Process®

- Advanced amine based post-combustion-capture
- ~ 1kg steam per kg CO_2 capture needed
- <8 %-points efficiency reduction in optimised PP systems
- Worldwide proven system



Courtesy: Mitsubishi Heavy Industry, MHPSE 2016

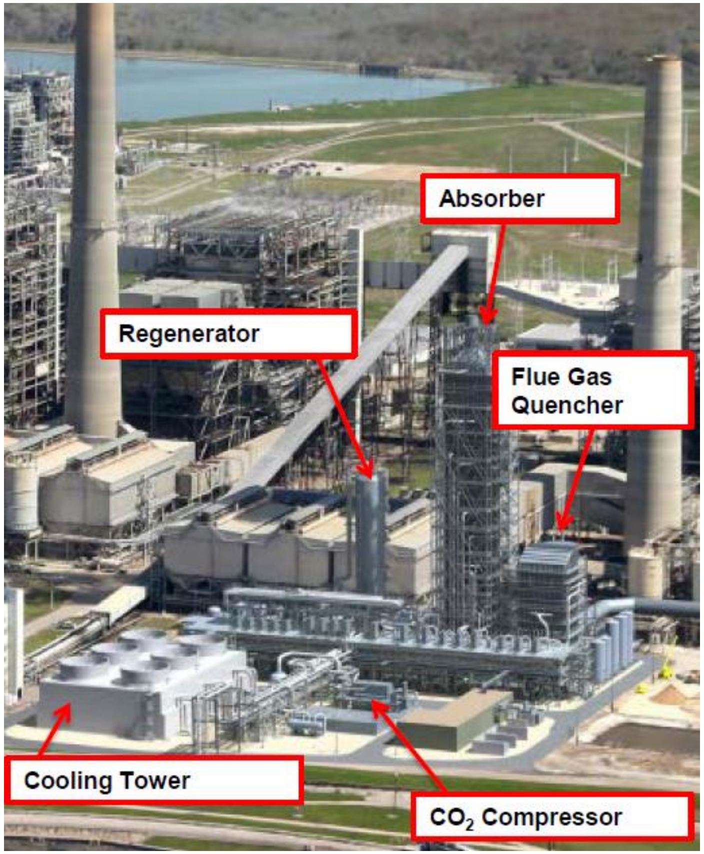
State-of-the-art in Post Combustion Capture (1)

- Commercial Experience of MHI, Ammonia Plant Flue Gas CO_2 Capture

Courtesy: Mitsubishi Heavy Industry, MHPSE 2016

State-of-the-art in Post Combustion Capture (2)

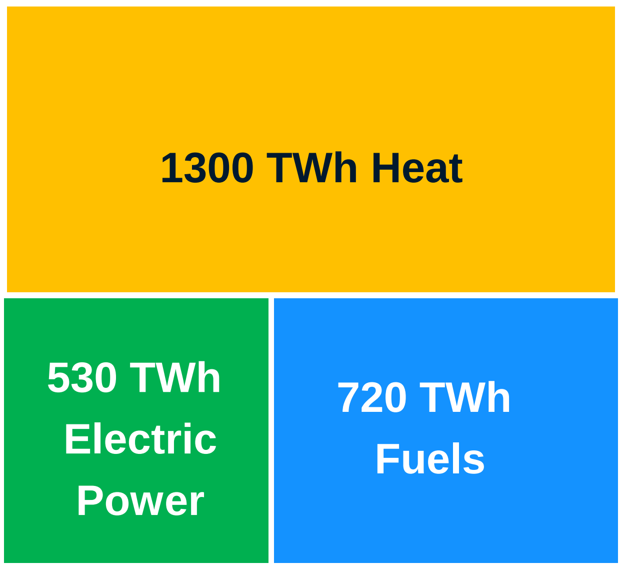
- The world's largest CO_2 capture and compression plant
  - Project owner: Petra Nova, a partnership between NRG Energy, Inc. and JX Nippon Oil & Gas Exploration Corporation
  - Location: NRG WA Parish Power Plant in Thompsons, TX.
  - Flue gas source: 650MW coal-fired boiler
  - CO_2 concentration: 11.5%
  - CO_2 capture capacity: **4776 t/d** (240MW equivalent)
  - CO_2 capture ratio: 90%
  - CO_2 Use: EOR
  - Pipeline: 12inch diameter, approx. 81miles
  - Injection Site: West Ranch oil field in Jackson County, TX
  - Operation Start: 4th quarter 2016

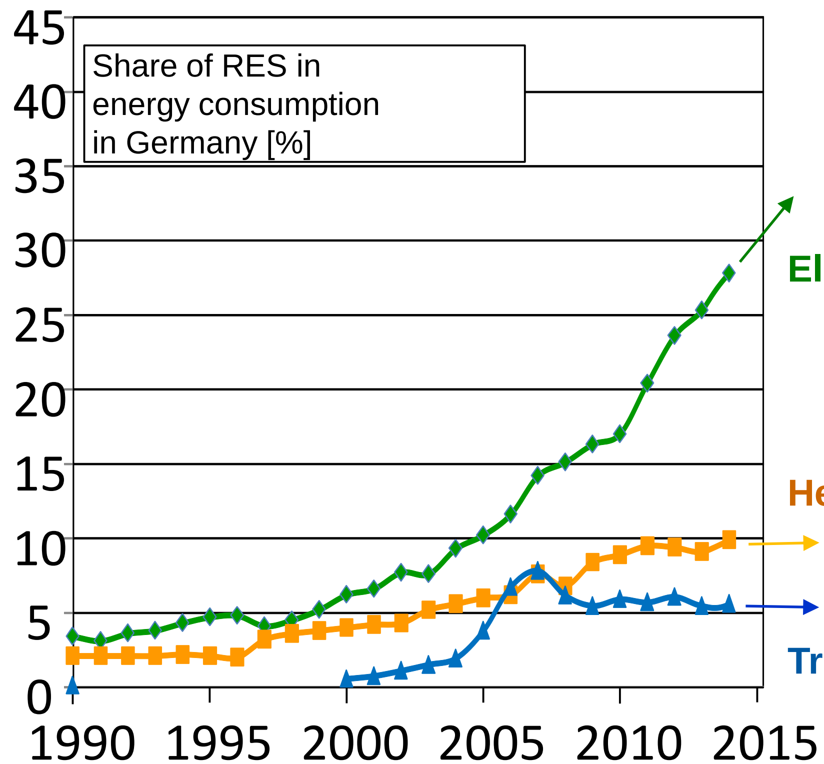


Courtesy: Mitsubishi Heavy Industry, MHPSE 2016

Energy consumption in Germany 2014

How to decarbonise the energy system without CO_2 storage?

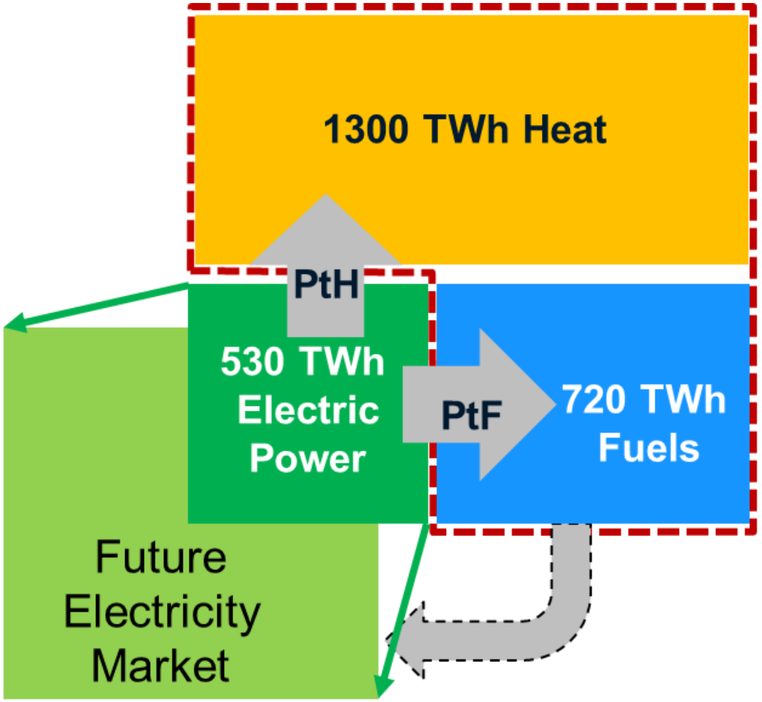




Arbeitskreis Energiebilanzen, BDEW, UBA

- RES in the electricity market increase faster than planned
- Heating, electricity and fuels compete for biomass sources

Energy production / consumption in future



Power to Heat (PtH) & Power to Fuel (PtF)

- allow sectoral integration and GHG savings in all sectors through the use of low carbon electricity
- allow storage of excess energy

CCU

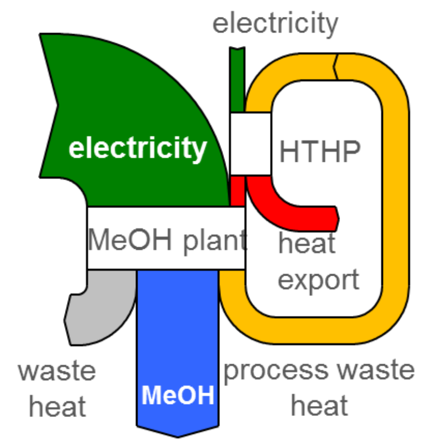
- goes hand in hand with cross sectoral energy storage
- needs low carbon electricity for PtF
- legal basis exists

New fuels introduced in FQD and RED

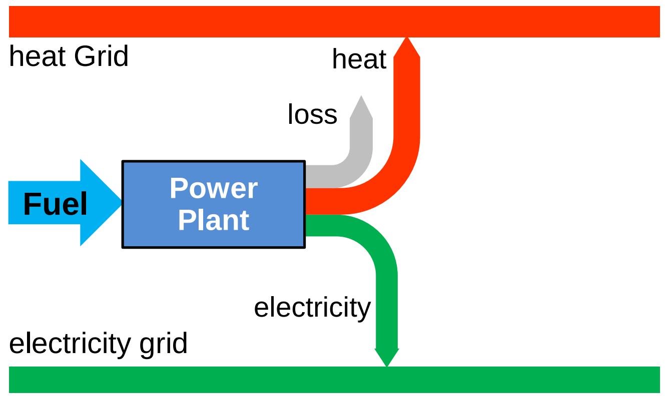
- Renewable fuels of non-biological origin
- Fuels from CCU for transport purposes

Power to Methanol integrated in Bio- CHP Plants

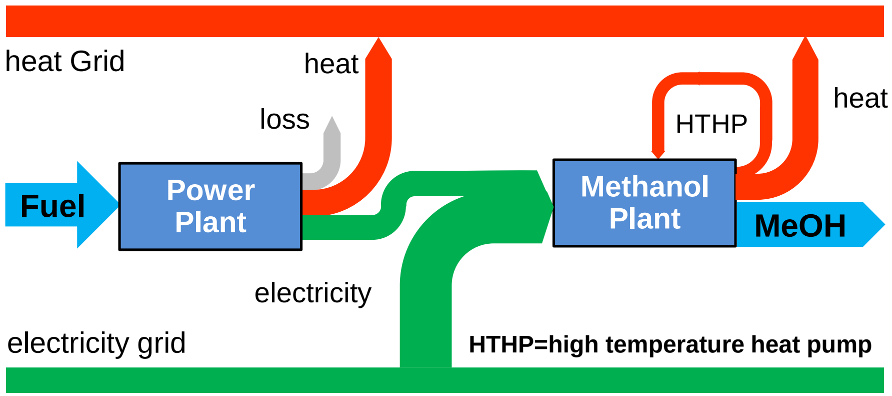
- Plants that produced electricity and heat in the past can deliver fuel and heat in the future
- Conversion efficiencies of more than 70% are reached (fuel + electricity towards heat + fuel)
- Applications exist e.g. in chemical industry, bio-refineries, wood industry, etc.



Today: Stand-alone Bio-CHP PP

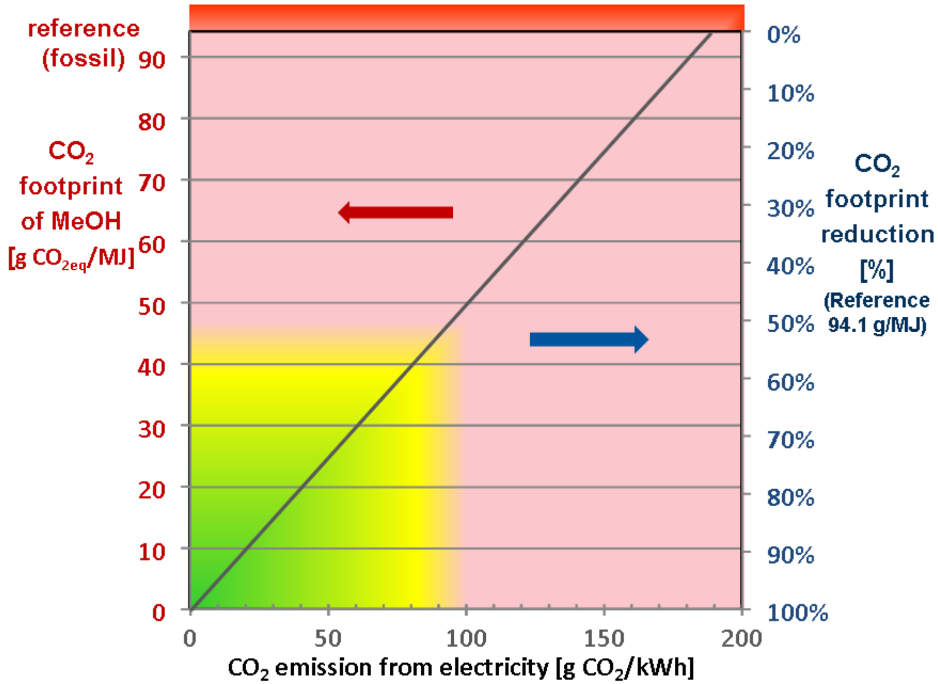


Future: Bio-CHP PP combined with MeOH plant, exporting additional heat



CO_2-intensity of the produced methanol fuel – calculated from grid carbon footprint

- 9.89 MWh_{el}/t
- Reference value for reduction: 94.1g CO_2eq/MJ (FQD, fossil fuel, 2010)



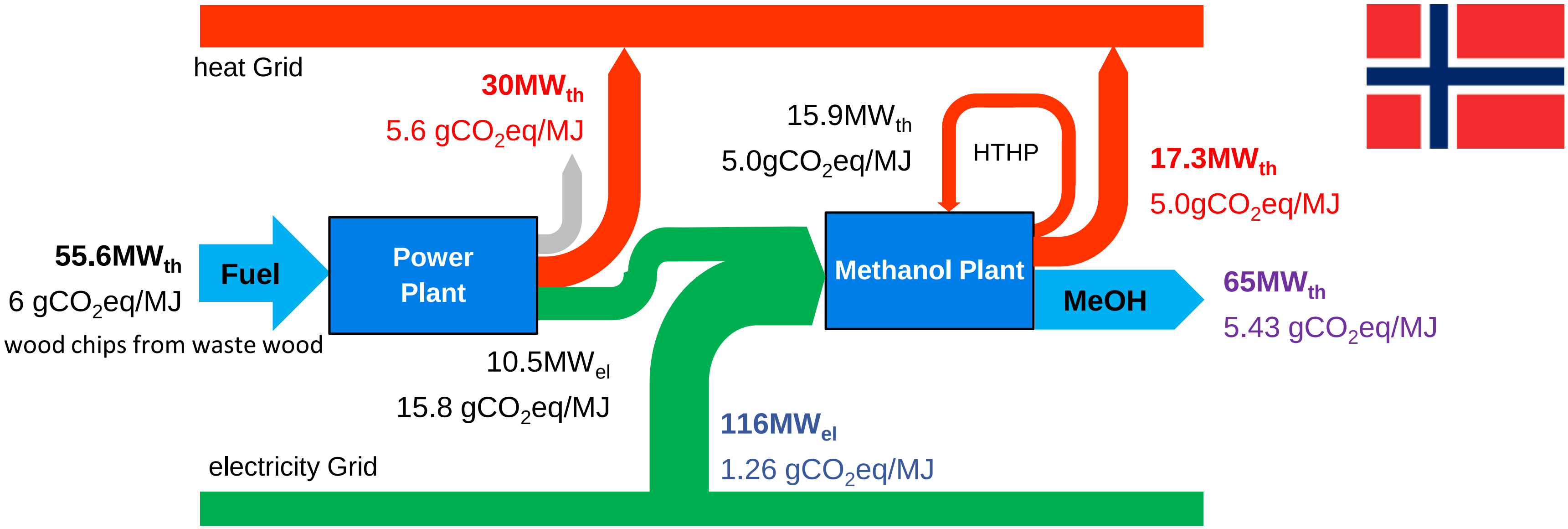
- Few countries offer suitable low carbon electricity directly from the grid
- Other ways for certification to be established!

	$\frac{gCO_{2eq}}{kWh}$
Iceland	0.207
Mozambique	0.493
Norway	2.458
Nepal	3.376
Switzerland	3.421
Zambia	3.549
Democratic Republic of Congo	4.609
Albania	10.133
Sweden	24.733
Tajikistan	25.737
Angola	42.117
Costa Rica	70.762
France	75.927
Georgia	99.045
Kyrgyzstan	101.392
Brazil	110.151
Ethiopia	132.020
Lithuania	135.098
New Zealand	214.553
Japan	467.380
United States	589.156
Germany	717.712
People's Republic of China and Hong Kong China	1081.061

M. Brander, A. Sood, C. Wylie, A. Haughton, J. Lovell: Technical Paper| Electricity-specific emission factors for grid electricity, Ecometrica, Emissionfactors. com, 2011

"Low carbon" fuel from "low carbon" electricity

Production of "low carbon" methanol in Norway

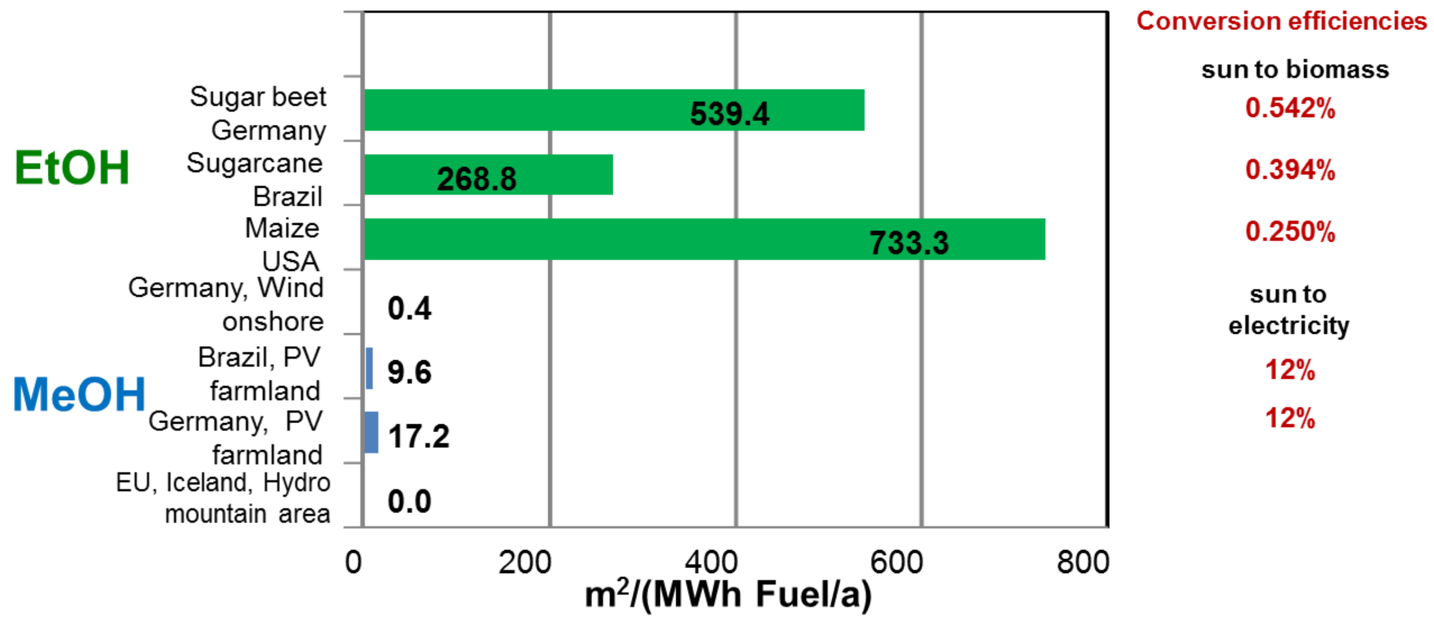


Summary data:

- Grid Carbon Footprint: 1.26 g CO_2eq / MJ
- Carbon footprint heat from HTHP heat: 5.0 g CO_2eq / MJ (as clean as biomass CHP)
- Methanol fuel CO_2 footprint: 5.43 g CO_2eq / MJ (94.2%) reduction compared to gasoline)
- Conversion efficiency (fuel + electricity towards heat and fuel): **65.3%**

Land demand, conversion efficiency

Biofuels and their land footprint vs. low carbon methanol



- **Synthetic fuels from electricity virtually have no land demand**: land demand is 15-50 times lower than for biofuels
- **Biomass CHP + CCU + RES electricity** can drastically reduce overall land demand for heat and transport sector

Based on publicly available literature and MHPSE calculations.

Conclusions

- CCS is commercially available today.
  However, public opposition and lack of infrastructure hinders deployment.
- Compared to CCS, the value of the product created by CCU pays for the CO_2 avoidance
- Power to Methanol is a cross sectoral energy storage which
  - avoids curtailment of RES & allows an increased RES installation
  - avoids cost of extensive grid refurbishment & electricity storage
  - reduces agricultural land use for biofuels, and
  - reduces emissions in industry, energy and transport sectors
- Power to Methanol can be economically built today at industrial scale (50+kt/year)
- CO_2 capture and PtMeOH are commercially available today
- The reduction of total carbon emissions has to be investigated
  - for the whole system
  - case by case
  - according to local boundary conditions

Thank you!

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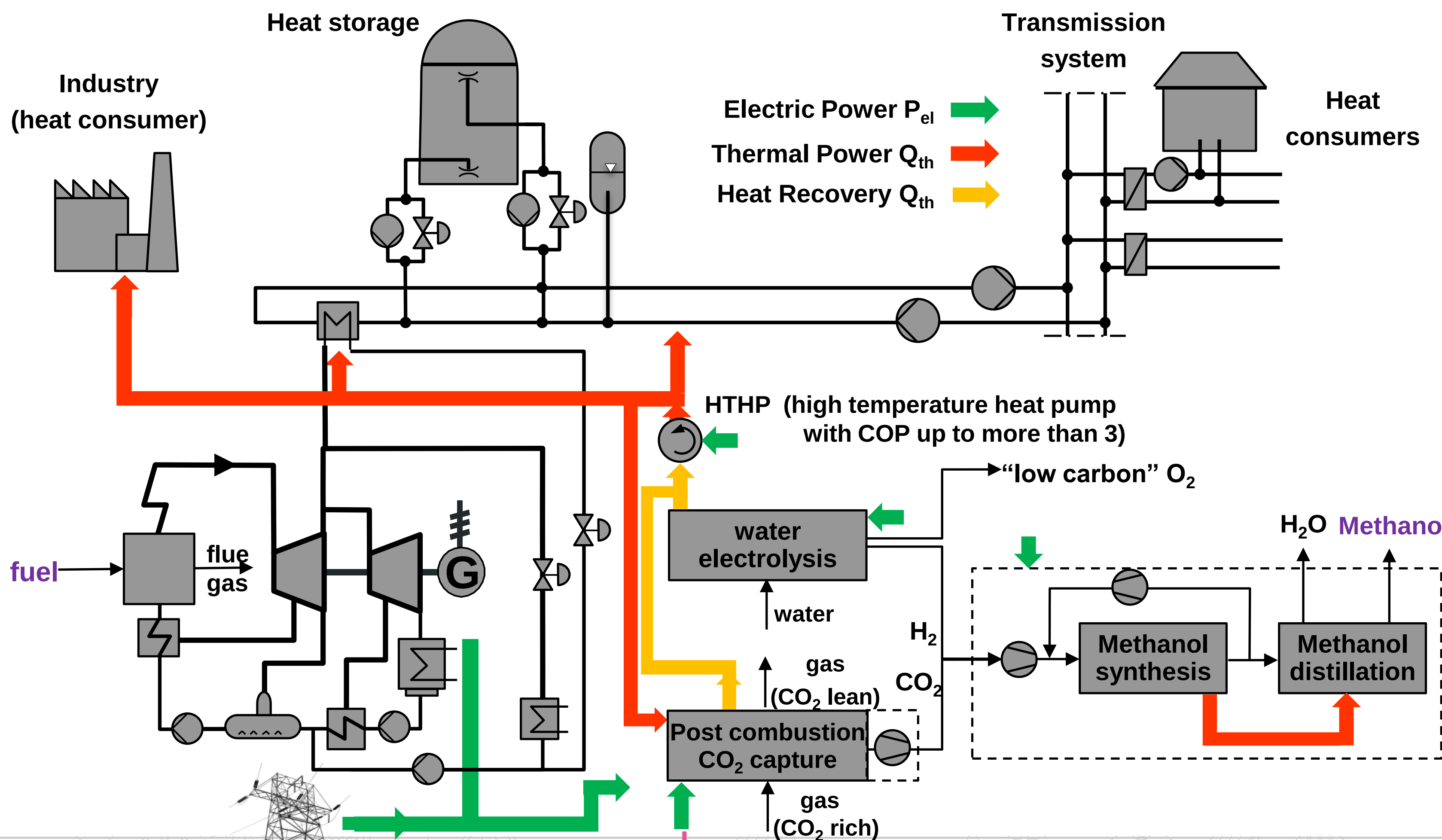
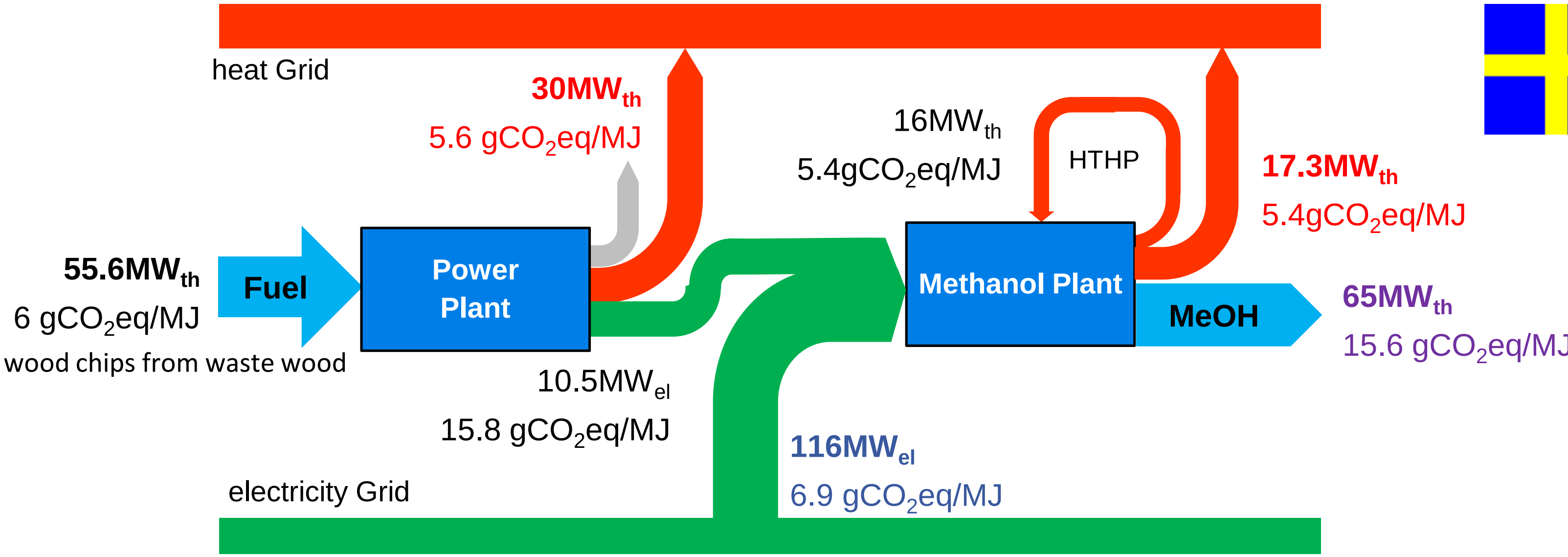
CCU in Bio-CHP plants – how does it work?



“Low carbon” fuel from “low carbon” electricity
Production of “low carbon” methanol in Sweden



Summary data:

- Grid Carbon Footprint: 6.9 g CO_2eq / MJ
- Carbon footprint heat from HTHP heat: 5.4 g CO_2eq / MJ (as clean as biomass CHP)
- Methanol fuel CO_2 footprint: 15.6 g CO_2eq / MJ (83.4% reduction compared to gasoline)
- Conversion efficiency (fuel + electricity towards heat and fuel) **65.3%**