



Creating Renewable Natural Gas: what could Power-to-Gas provide to the EU energy future?

RESEARCH | TECHNOLOGY | CATALYSTS

[John Bøgild Hansen](#), Haldor Topsøe

Annual GIE Conference, Krakow, May 24, 2012

Haldor Topsøe group – Key figures 2011



Headquarter in Lyngby, DK

- Turnover: DKK 4.4 billion (Euro 594 MM)
- Result: DKK 397 MM (Euro 53 MM)
- 2200 employees

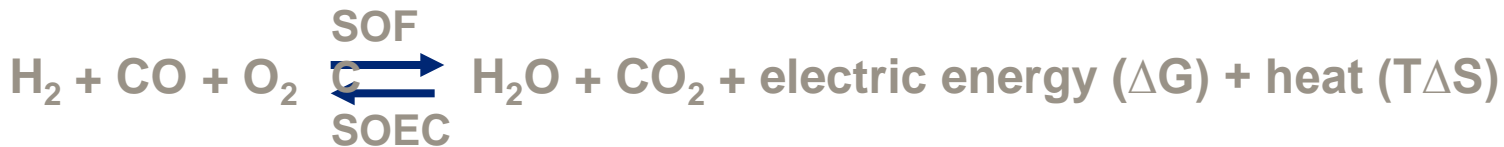
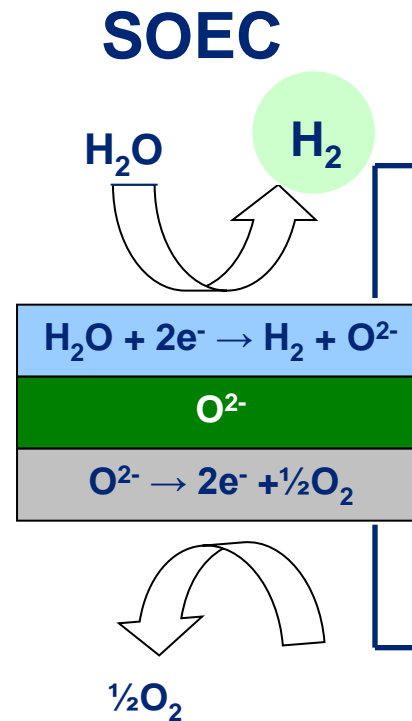
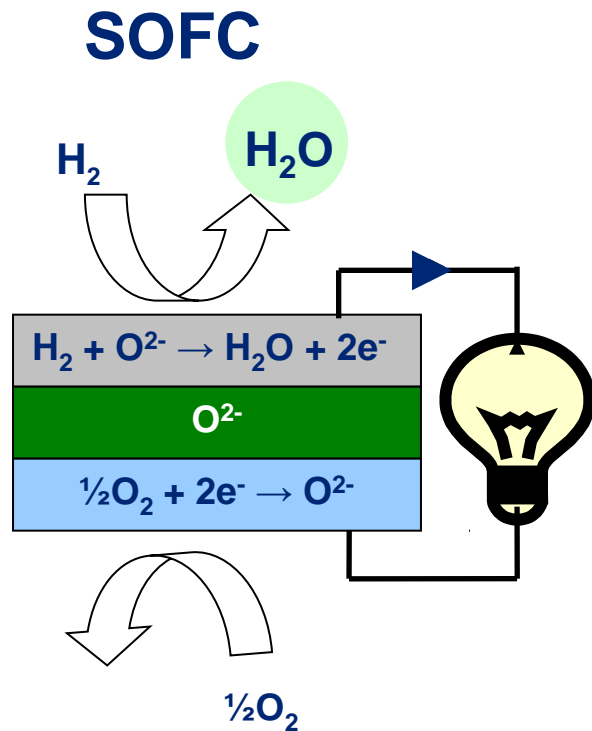


Catalyst plant in Frederikssund, DK



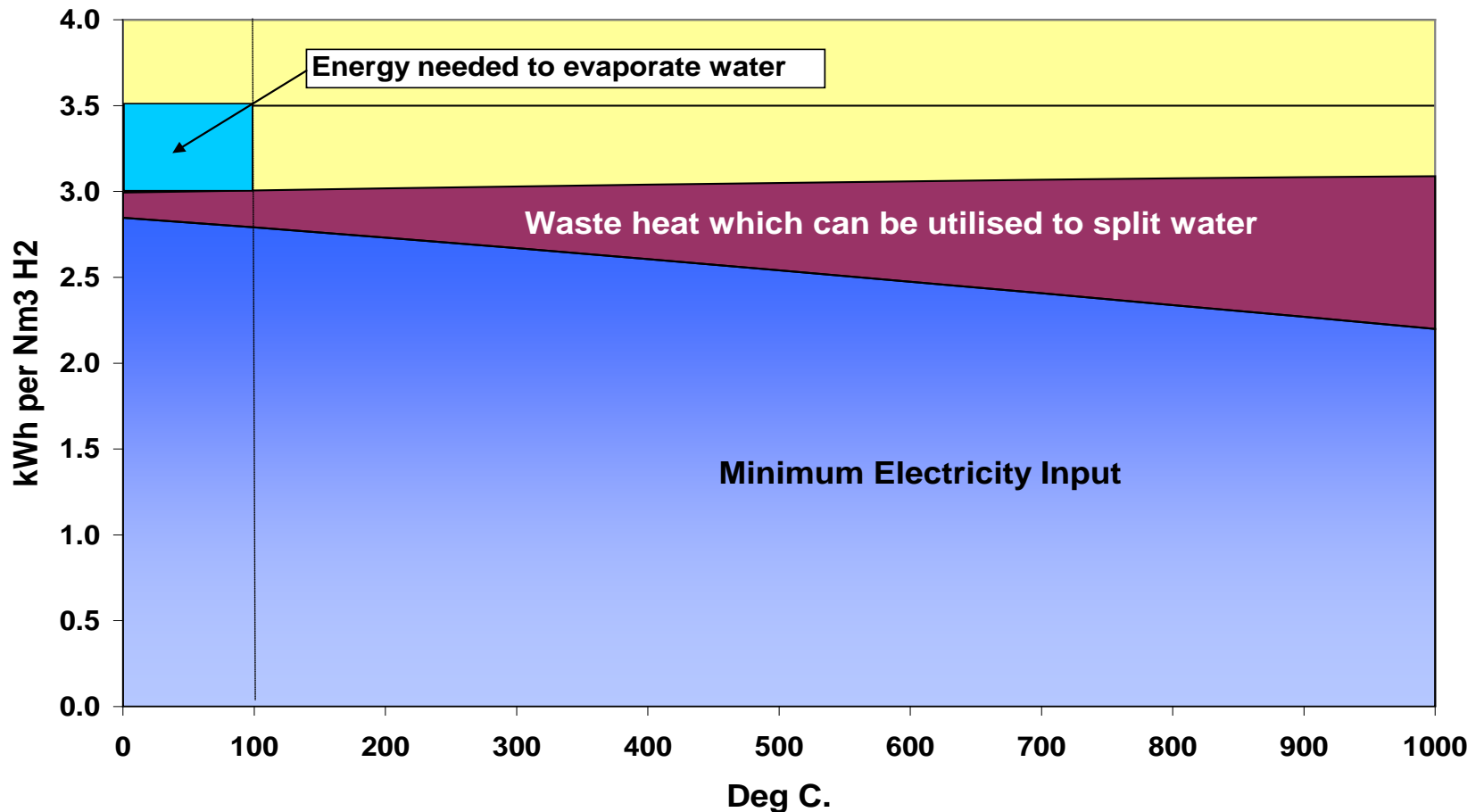
Catalyst plant in Houston, Texas

Fuel Cell and Electrolyser

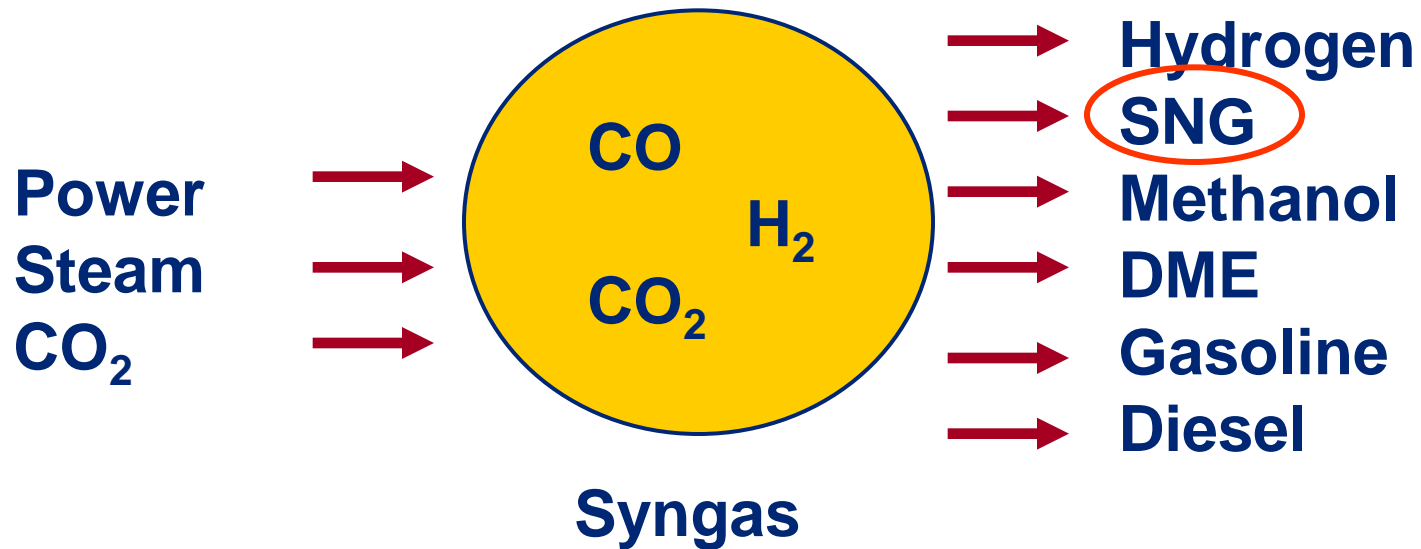


SOEC more efficient than present Electrolysers

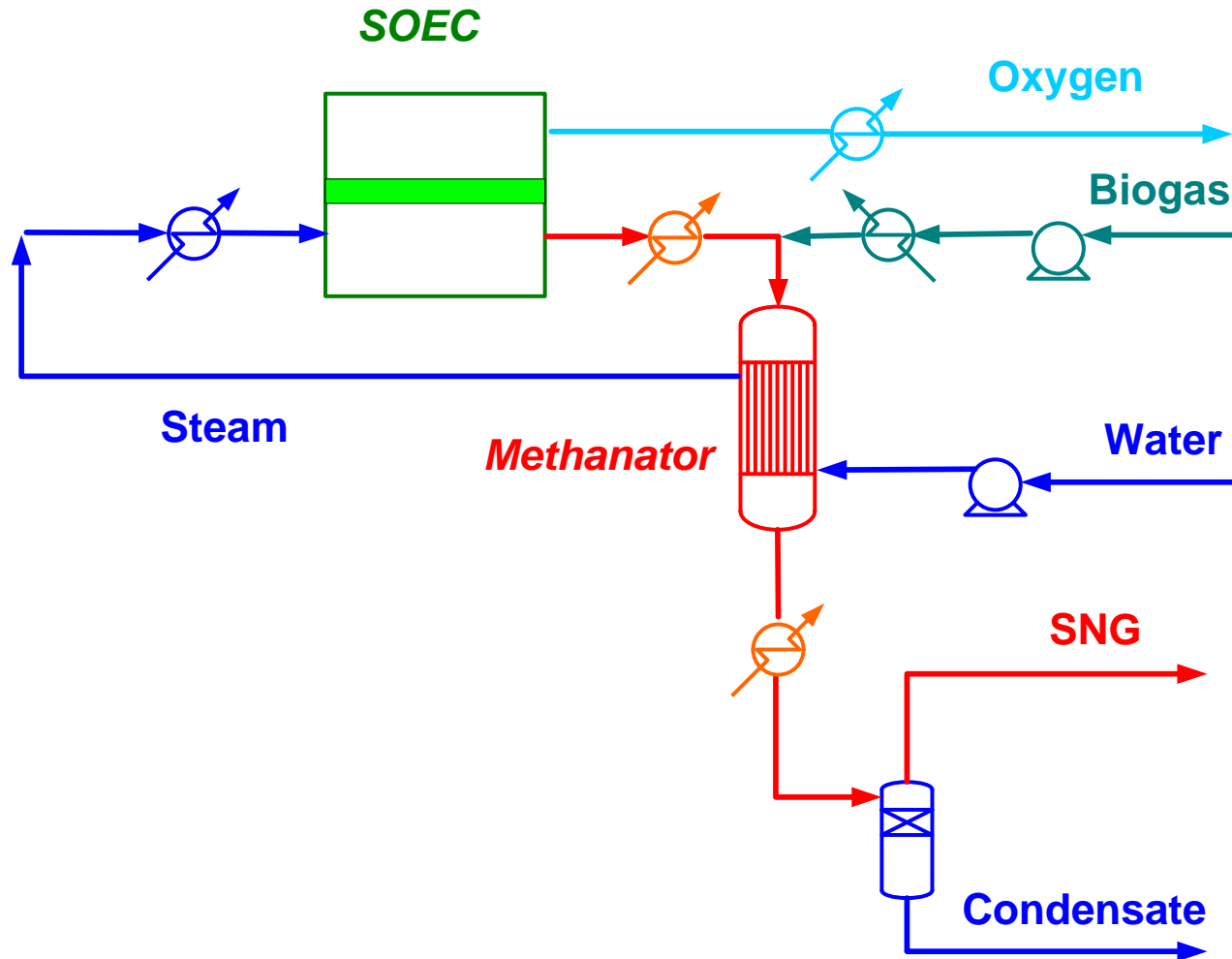
Internal waste heat used to split water



High Temperature Electrolysis



Biogas to SNG via SOEC and methanation of the CO₂ in the biogas:



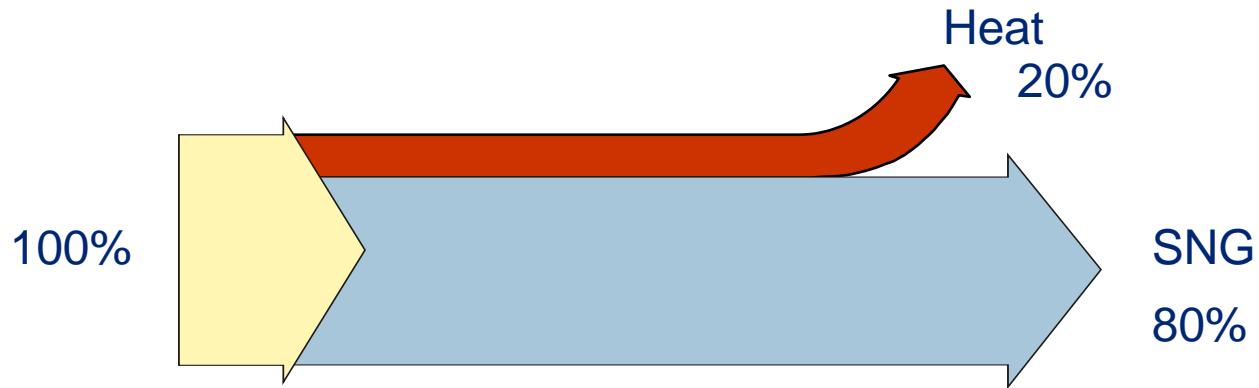
SNG Technology

Methanation generates a lot of heat

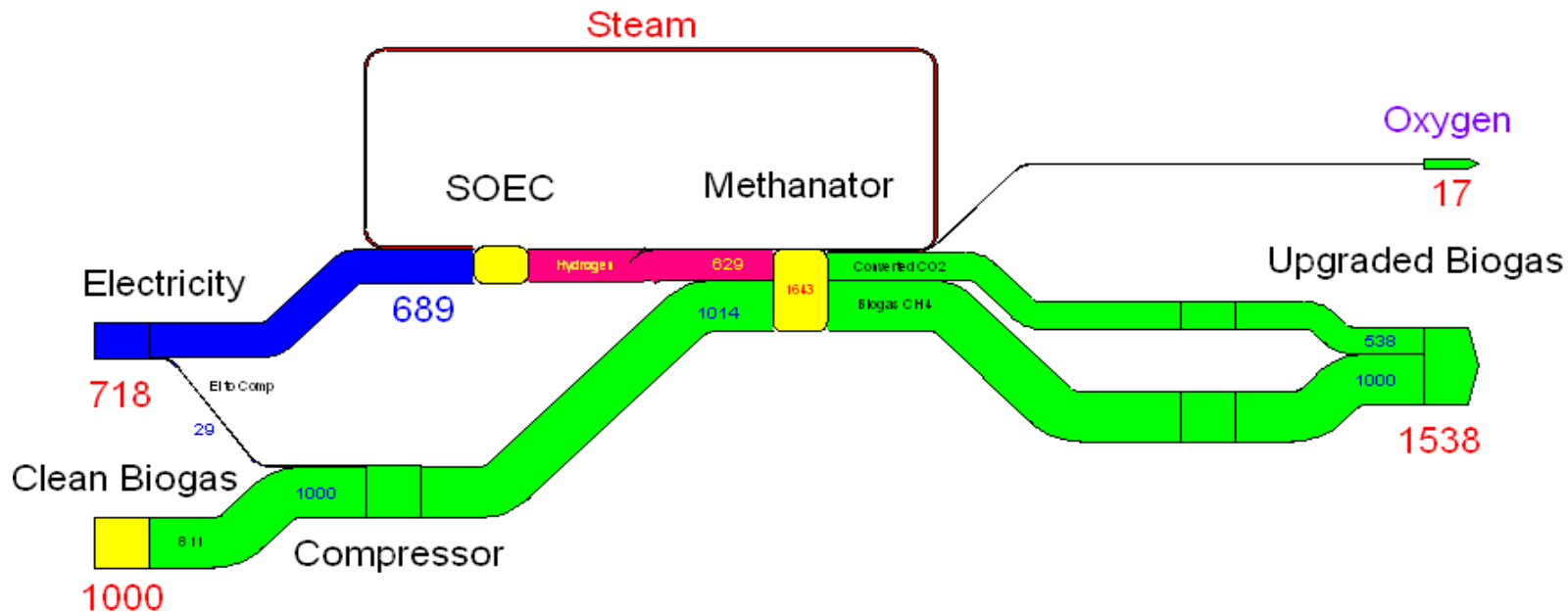


Syngas = SNG + heat

Energy: 100% = 80% + 20%



Exergy analysis of Biogas SOEC: Total efficiency el to methane ~75 %



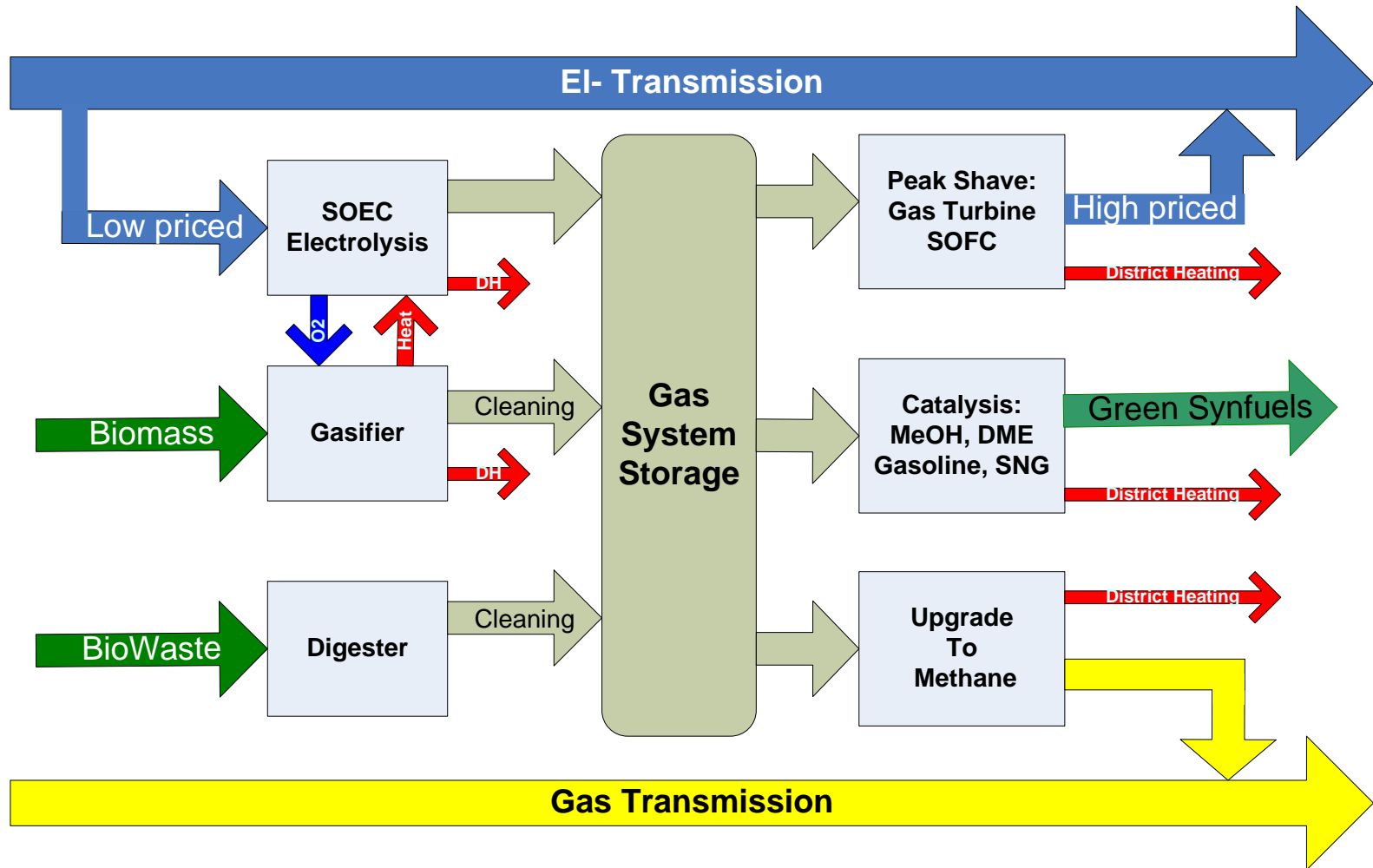
Efficiency ~ 75 %
El to methane

Key numbers

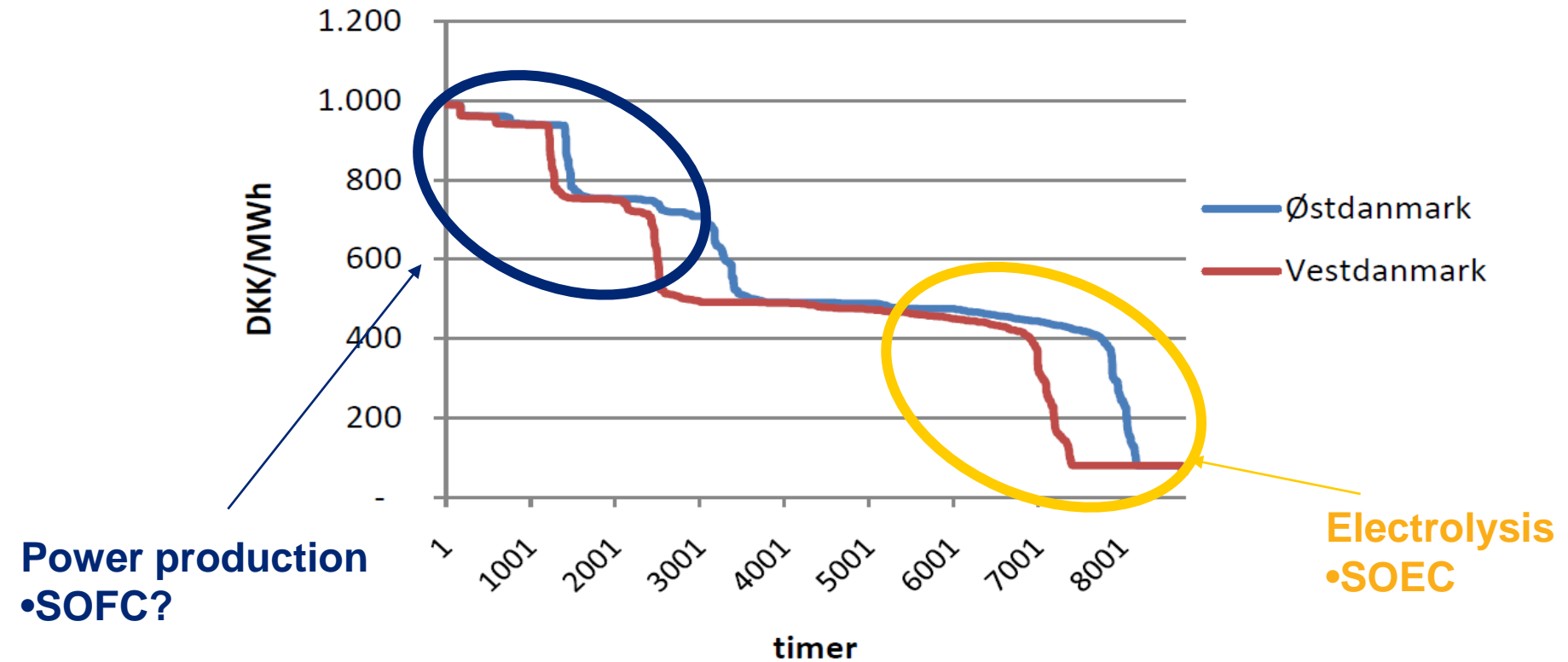
Denmark (2008)

- Final energy consumption: 673 PJ
- Biogas potential: 40 PJ
- If upgraded by SOEC: 67 PJ ~ 10 %
- NG used for power plants: 73 PJ
- NG used in household, industry and service: 76 PJ
- Saved CO₂ ~ 1 MT/capita

Energinet.dk's vision for fossil fuel free Denmark in 2050 – The Wind Scenario



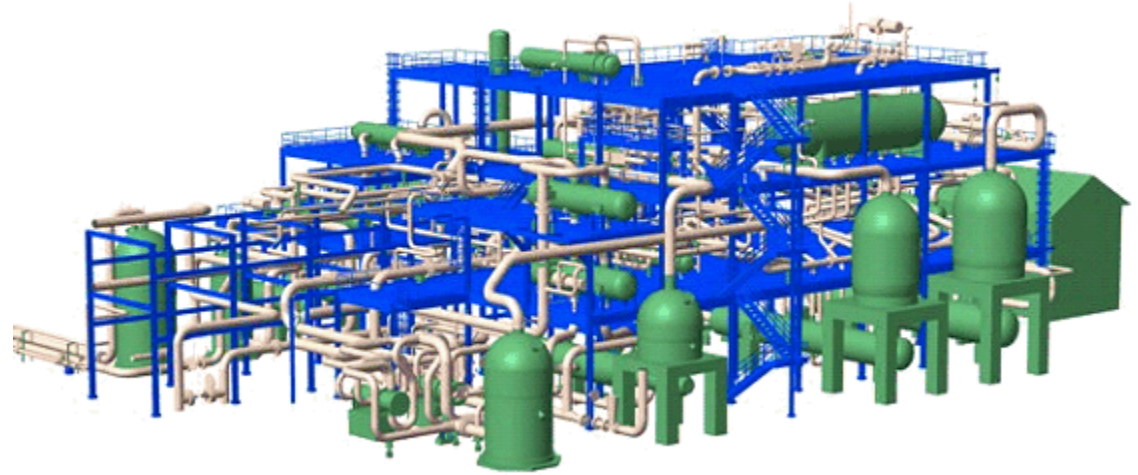
Challenge no 1: Fluctuating electricity prices



Figur 22: Varighedskurve for elpriser beregnet med Balmorel for det ambitiøse fremtidsbillede i 2050.

Challenges no 2: Biogas plants are small

- First modern SNG plant to start up is in China: Xinjiang Qinghua



- Largest single train SNG plant ever: 1,4 billion Nm³/year = 50 PJ/year
- One biomass gasification plant @ 200 MW wood = 4 PJ/year
- One biogas upgrading plant @ 5 million Nm³ biogas = 0,06 PJ/year

We need economy of numbers not scale !

Green Synthetic Natural Gas

- GoBiGas, Gothenburg

- A 20 MW (SNG – 2,200 Nm³/h) **commercial** plant in Gothenburg (Sweden) with Topsoe SNG technology



- If coupled with SOEC production of SNG could be increased by 180 % !

Key numbers

EU 27 all numbers in MTOE

■ Total energy consumption	1715
■ Natural gas consumption	440
■ Natural gas production	152
<i>Proved reserves</i>	<i>2115</i>
■ Biogas potential	29
■ Total biomass potential EU27	295
■ Eastern Europe bioSNG potential	83
(Potential in Russia, Ukraine, Belarus)	

Sources: BP, AEBIOM, European Env. Agency,
Deutsche Biomasseforschungszentrum

Conclusions

- Biogas can be upgraded electrochemically by SOEC to pipeline quality
- Consumption of electricity 13 – 14 kWh per Nm³ methane
- Complete sulphur clean up has been proven successfully
- Methanation is proven technology
- Economic analysis has shown that upgrading by SOEC can compete with traditional upgrade by CO₂ removal
- 10 % of Denmark's energy consumption could be achieved and 1 MT CO₂ per capita per year saved
- Production of SNG from wood gasification could be boosted by a factor of almost 3