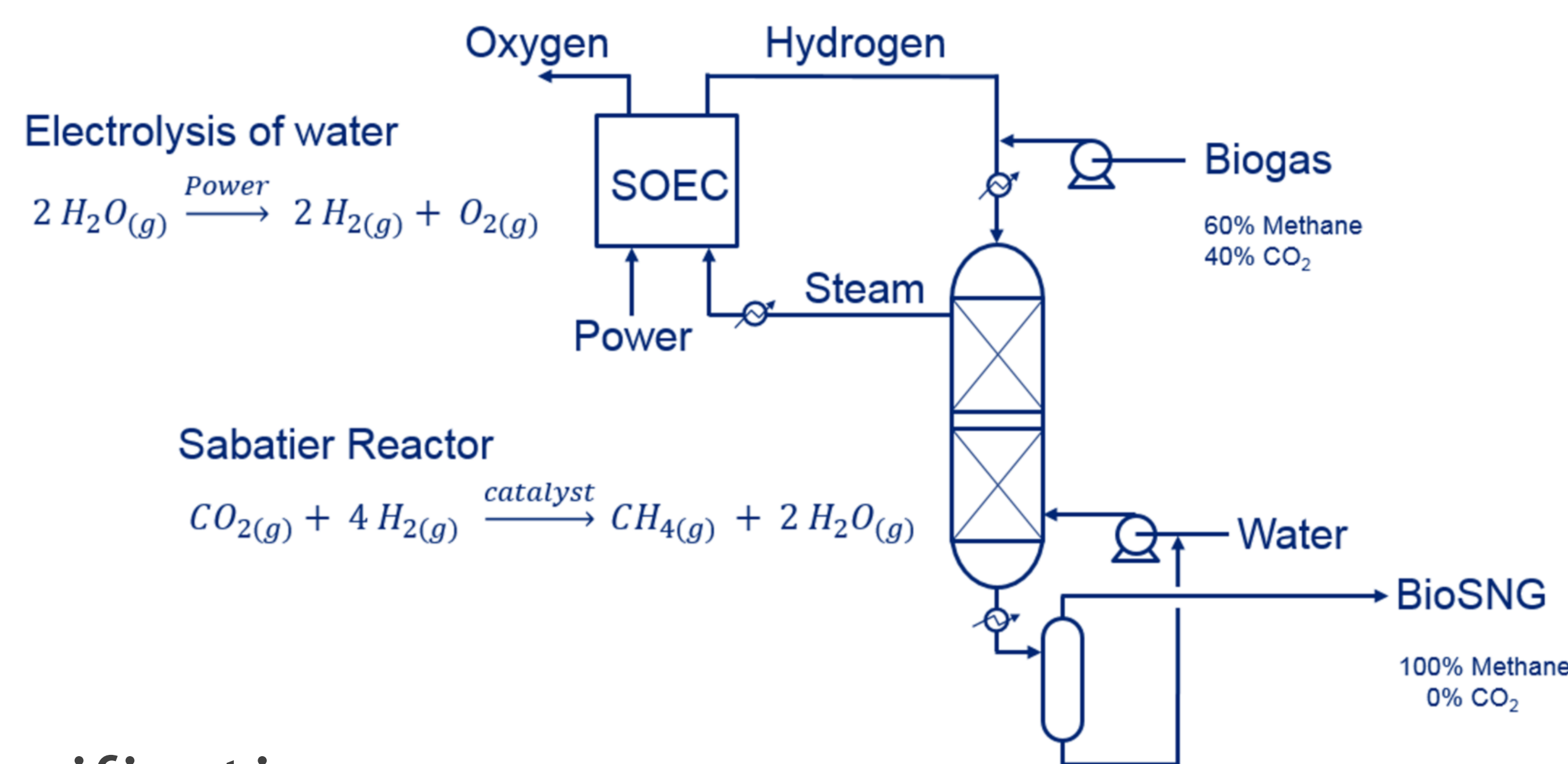


Synergies between SOEC and Catalytic Methanation

Upgrading of CO₂ from biogas to produce synthetic natural gas

Biogas → **BioSNG**
60% Methane → 100% Methane
40% CO₂



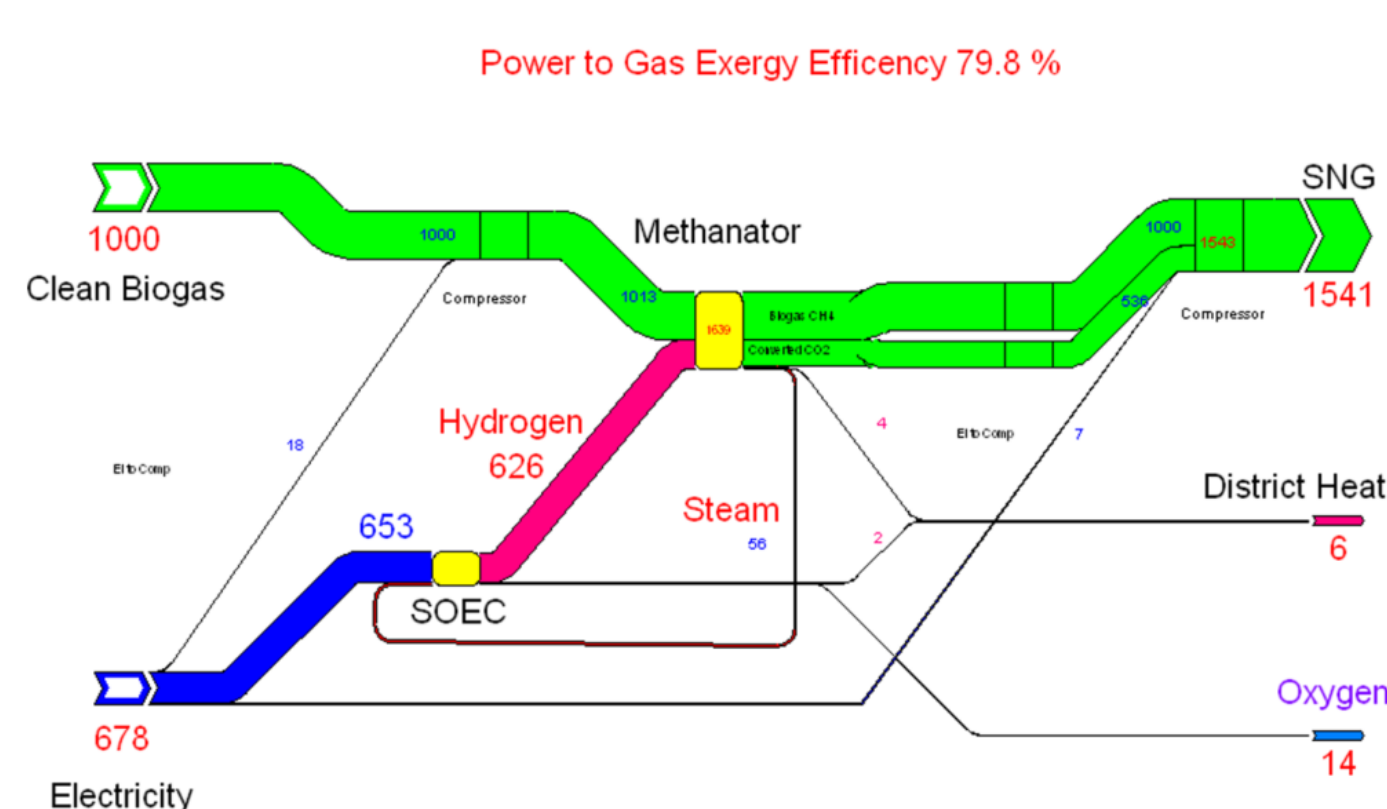
Specifications:

50 kW SOEC unit, producing 16 Nm³/h hydrogen
Upgrading of 10 Nm³/h biogas to pure methane
Producing 10 Nm³/h methane on spec as natural gas

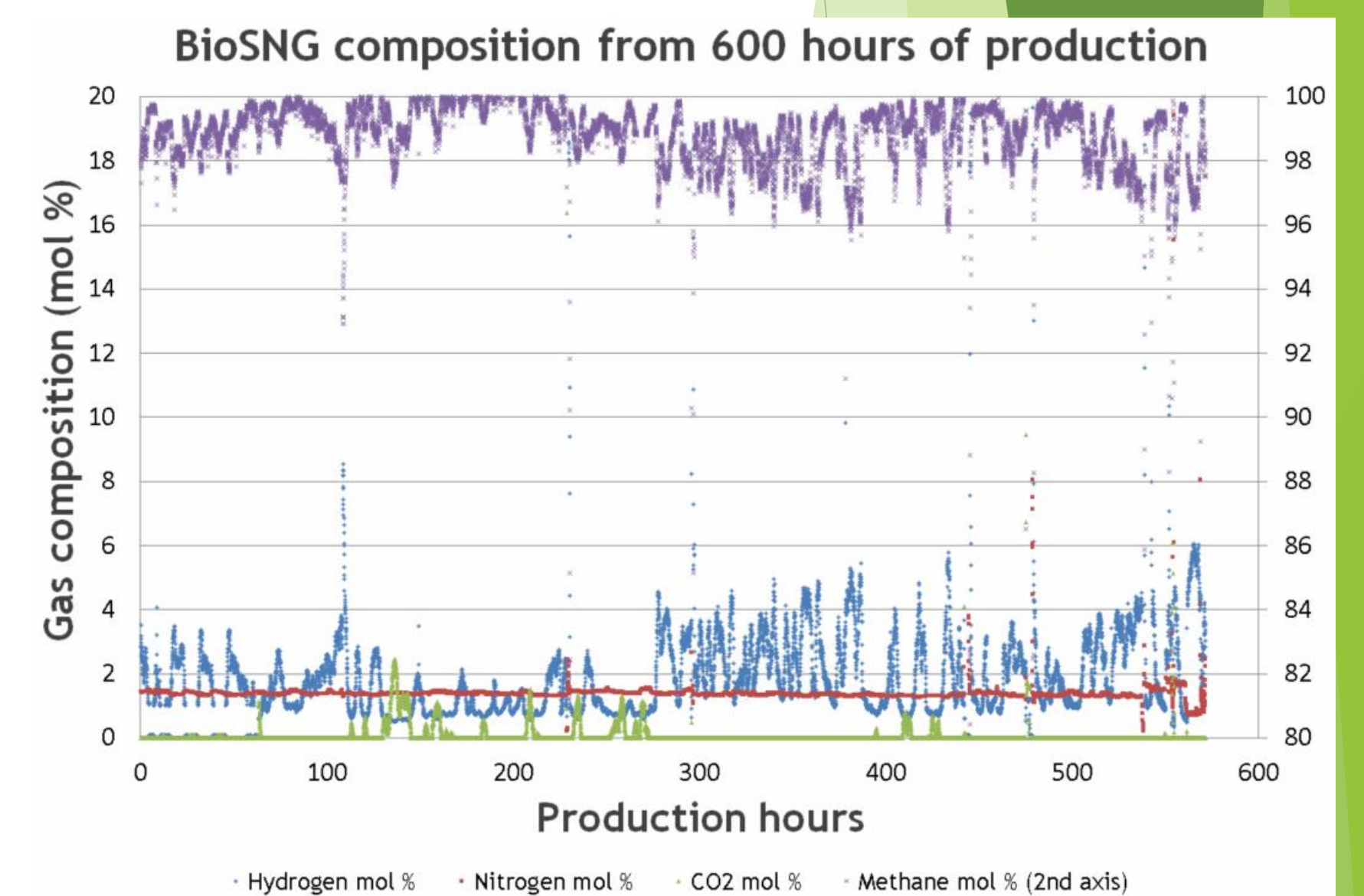
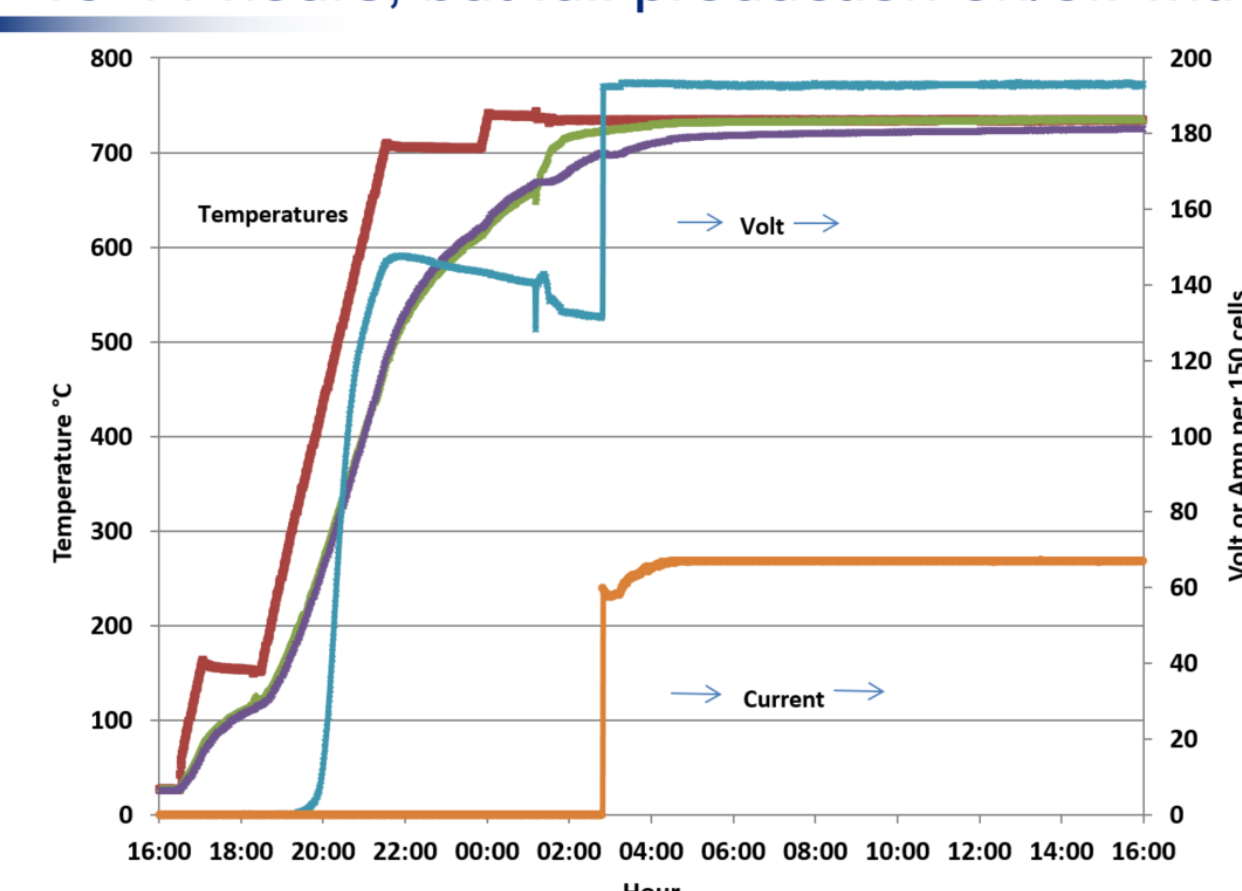
Synergies between SOEC and catalytic methanation of biogas

- The catalytic methanation produces high temperature steam in two ways:
 - Steam is formed as a product of the Sabatier reaction, this covers half the SOEC water requirement.
 - The catalytic methanation boiling water reactor produces most of the high pressure steam needed for hydrogen production in the SOEC.
- Both hydrogen and oxygen from the SOEC unit is required in upgrading of biogas
 - Hydrogen needed for the Sabatier reaction.
 - Oxygen required in biogas pretreatment (H₂S removal).
- Using biogas as CO₂ source simplifies methanation reactor design
 - The methane content already in the biogas results in a lower adiabatic temperature.
 - Fewer separate reactors compared to methanation downstream wood or coal gasifiers.

Exergy Flows in CO₂ case



Heat up of SOEC unit from cold 10-11 hours, but full production on/off within seconds



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

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

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Duration:
Jun. 2013 - Sep. 2017
Project sum:
5.3 mio €
Location:
AU Foulum