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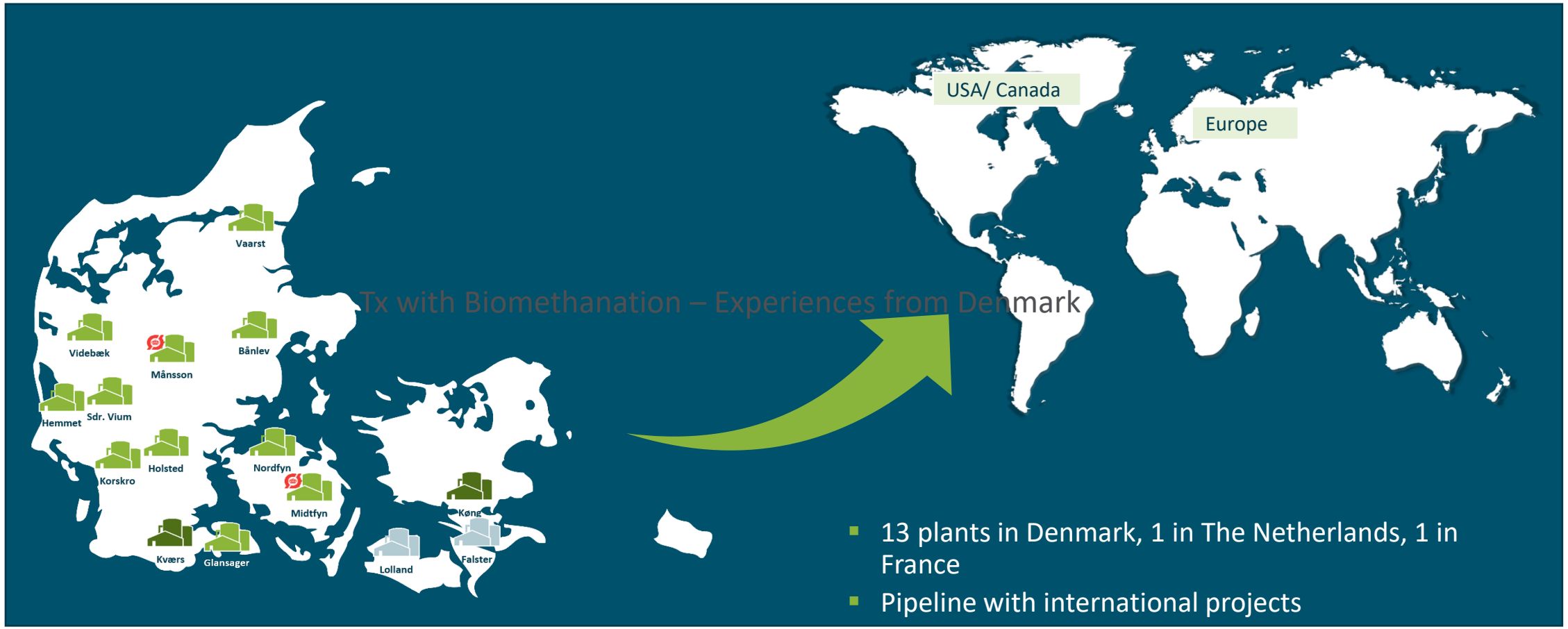
Power-to-x with Biomethanation – Experiences from Denmark

UK Green Gas Day

5th of September 2024, Birmingham

Nature Energy focuses on large scale biomethane production



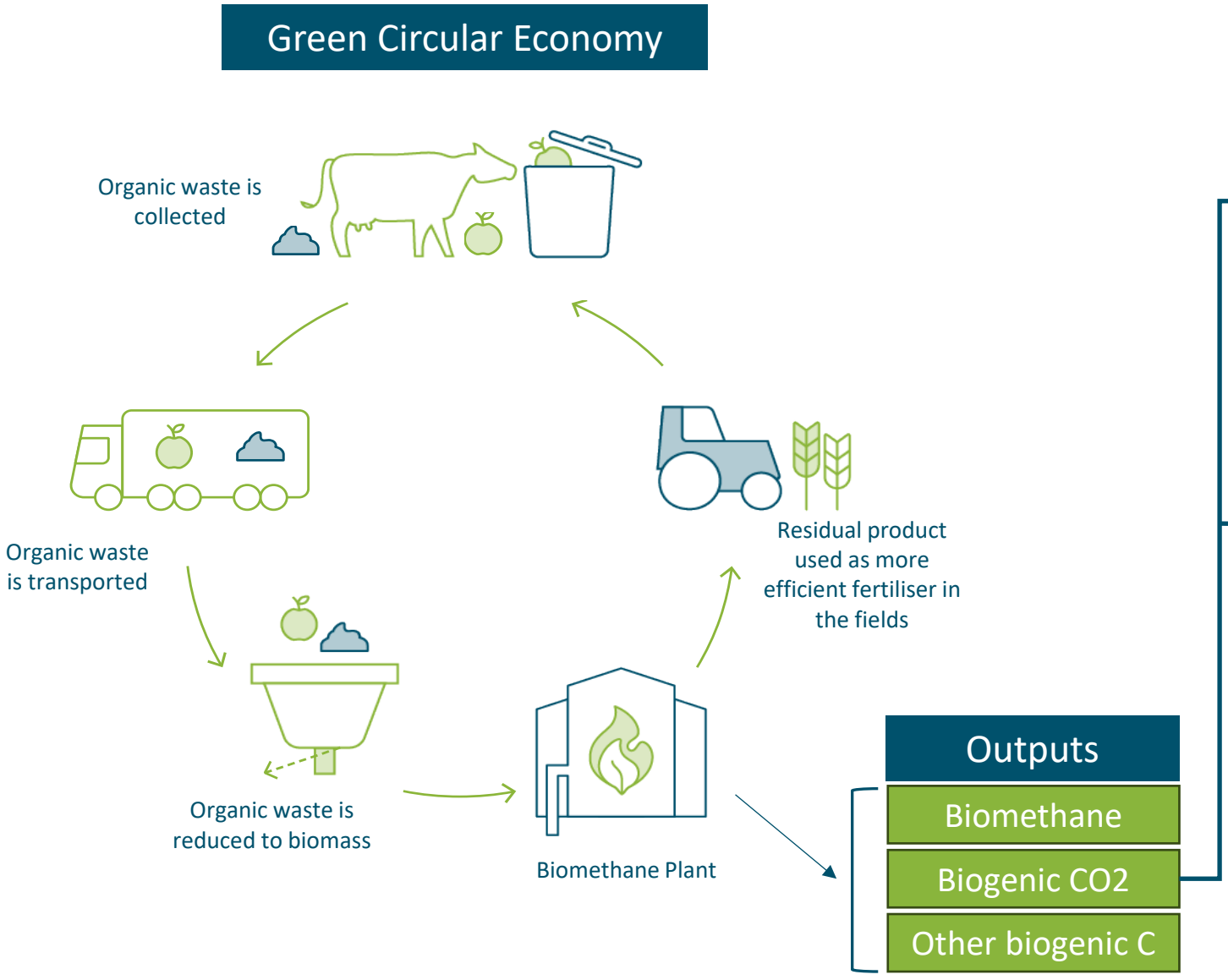
Nature Energy is the largest Biomethane producer in Europe and designs, builds, operates and owns large scale plants running on sustainable feedstock. Since Q1 2023, Nature Energy is fully owned by Shell

Plants at Industrial Scale – Example Nature Energy Korskro

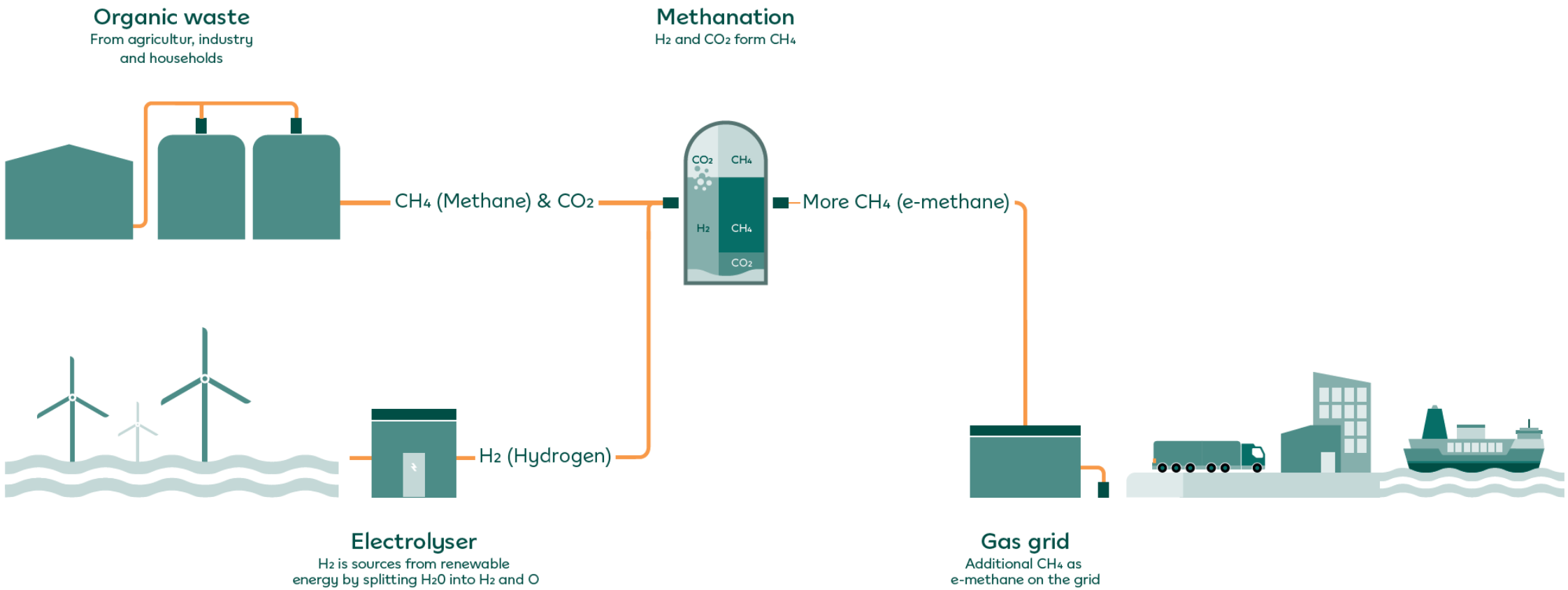
Biogas production: 36 mill. m^3 gas / year
Biomass capacity: 1 mill. tons / year
CO2 volume: 25.000 tons / year

Sites with industrial scale plants offer opportunities for value-adding assets for other decarbonization solutions

Production focused on Biomethane, but other outputs got into scope



Power-to-eCH_4 at Nature Energy in Glansager: Hydrogen from an electrolyzer and CO2 from digestion are converted into eMethane



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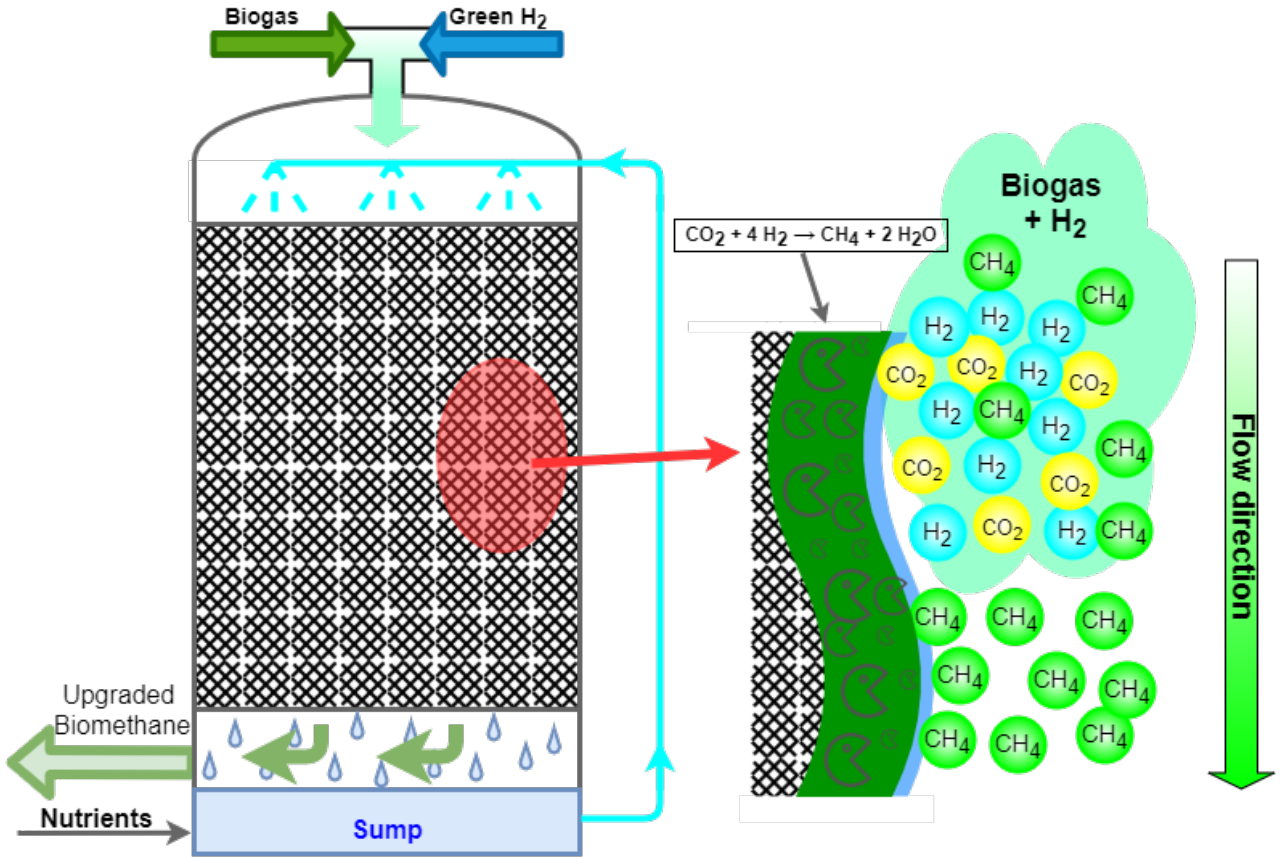
6 MW Power-to-eMethane plant in Glansager/DK in ramp-up

Pictures

NE's expertise in biological processes allows to benefit from advantages of Biomethanation over Catalytic Processes

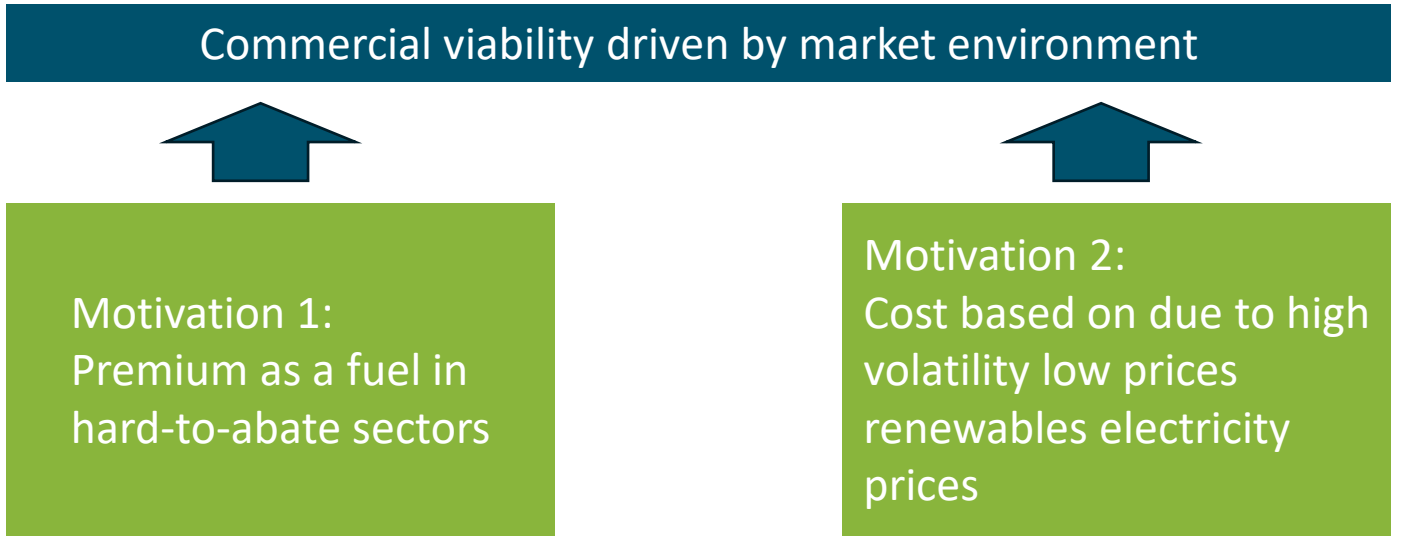
Biological methanation

$4\ H_2 + CO_2 \rightarrow CH_4 + 2\ H_2O$



- Advantages
  - Robust microbial culture as microorganisms from the biogas plant's own reactors are used
  - Can use raw biogas, no purification needed
  - High efficiency
  - Uses technology familiar from sulphur removal
  - Cheap technology vs catalytic Methanisation
- Challenge
  - Monitoring the condition of the microbial culture inside the reactors

Commercial motivation for eMethane production

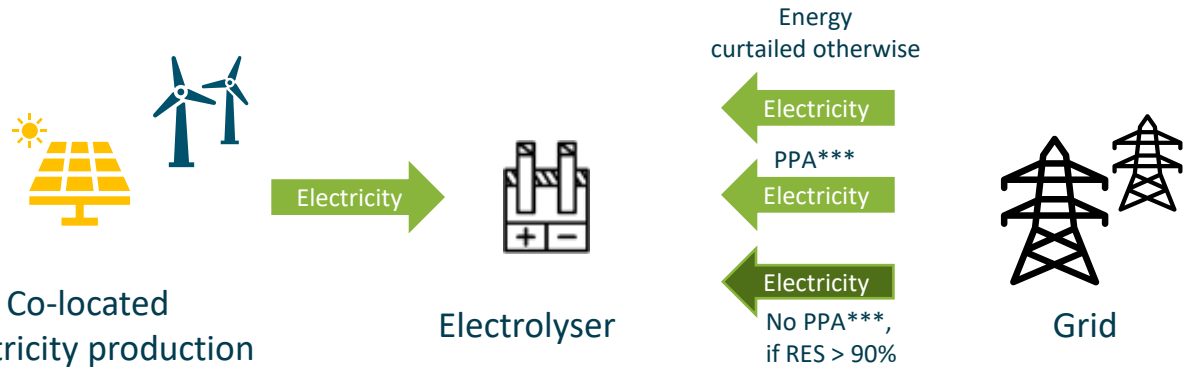


Motivation 1: Production of eFuels as RFNBOs is an interesting strategic option for the decarbonization of hard-to-abate segments

Price for RFNBOs - based on a RED target – will set an incentive to invest in eMethane as an eFuel:

- Target market is the eFuels market in the Transport segment as defined in REDIII*, including a consumption target from 2025 onwards.
- Target is set for so-called “RFNBOs” (Renewable Fuels of Non Biological Origin). The energy content of such fuels has to be based on non-biobased renewable energy, i.e. electricity.
- Similar Regulation in UK

The EU Delegated Act describes different sourcing options for the electricity – selection depends on detailed analysis of the location



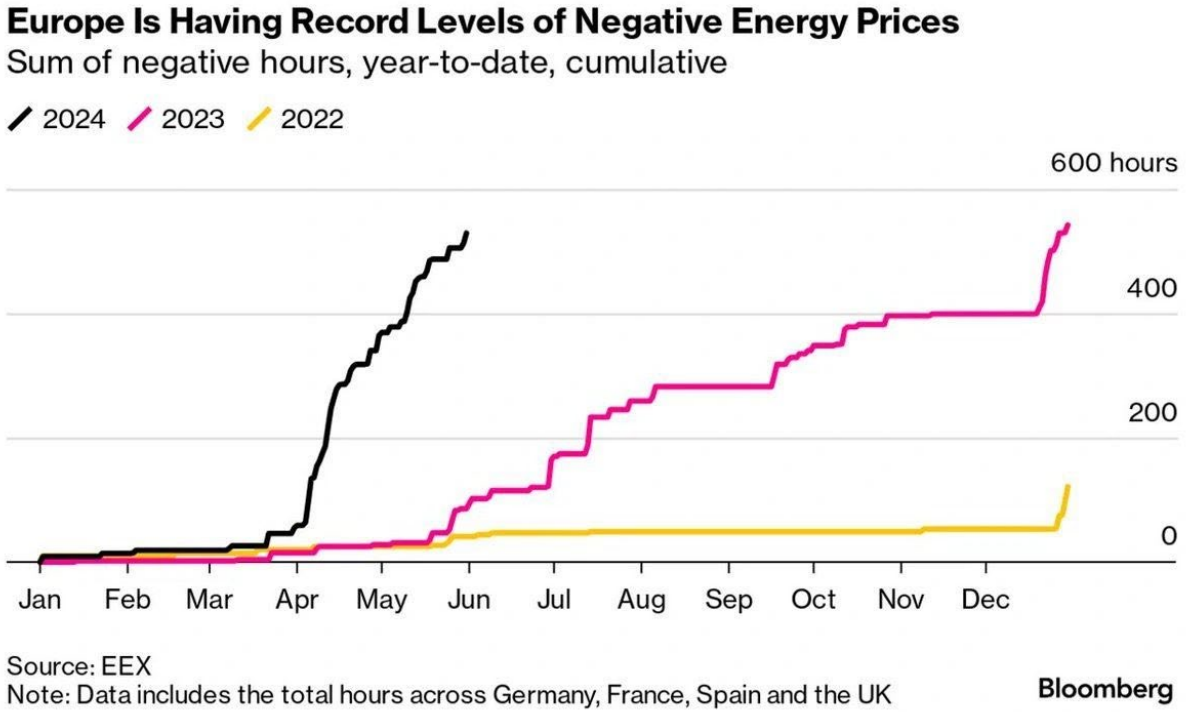
Requirements for the electricitiy to produce RFNBOs are a hurdle

- “PPA obligation” includes hinderances, e.g.:
  - Risks from fixed price
  - Time wise matching
  - Additionality
- “90%” rule provides the highest flexibility in electricity utilization
  - Denmark already close to the share

*DIRECTIVE (EU) 2023/2413 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 October 2023 **COMMISSION DELEGATED REGULATION (EU) 2023/1184 of 10 February 2023 ***Power Purchase Agreement with RE plant

Motivation 2: eFuels can benefit from low electricity cost - increasingly volatile prices due to more fluctuating renewable generation to be observed

Challenges for the supply-demand-balance with low electricity prices are indicated by negative electricity prices



The value of the PTx has to be analyzed from a trading perspective (”extrincic value”) since the exposure to the short-term electricity market is a profitability driver!

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eFuel production creates significantly higher value if optimized in the short term market – especially in case of low premium

Optimization Strategy	Volume Maximation	Day-ahead hourly Optimization	Optimization real option, targeting full extrinsic value: Day-Ahead + Intraday hourly Optimization	Optimization real option, targeting full extrinsic value: Day-Ahead + Intraday 15min Optimization

Main take aways

- Maximizing output is not a commercially viable strategy
- Optimization in the electricity market creates high value
- High contribution especially at low premium, working like a hedge

Technical flexibility is key driver for profitability

Calculation basis: avg. results for market DE/LU in the years 2018/2019/2020/2021, overall efficiency 50%. Numbers are indicating potentials from historic data.

Summary

- Nature Energy is the biggest Biomethane producer in Europe. The decarbonization brings all output of the Biomethane production into the business scope.
- To develop the CCU pathway, Nature Energy build a plant to produce eMethane from green Hydrogen and biogenic CO2.
- The plant in Glansager/Denmark is a demo scale with 6 MW electrolyzer, using biomethanation for eFuel production
- Commercial success will mainly depend on
  - Achievable premium in the RFNBO market
  - Optimization of production cost in the volatile electricity market by optimizing the asset as a real option
- Profit optimization is not consistent with volume maximation – flexibility of the process is the key

Our project is performing well to benefit from an early start into the eFuels business

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