

# Power2Met webinar

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# The Power2Met project – eFuel project (Phase 1)

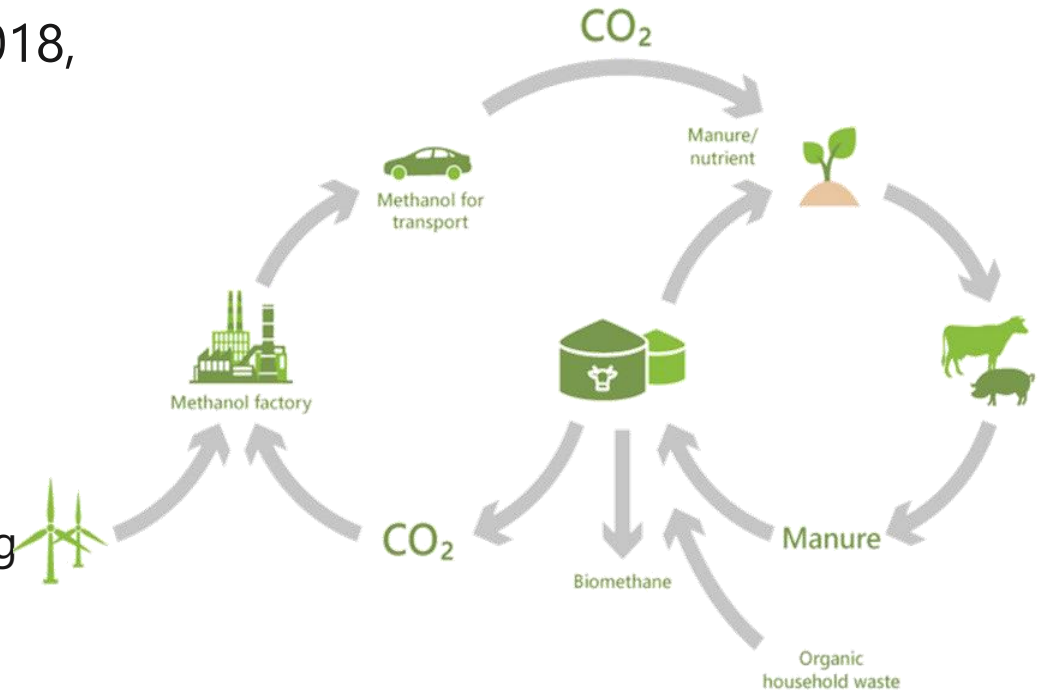
- Biogas CO<sub>2</sub>+ green hydrogen in catalytical process = green methanol
- Project objective: To Develop and demonstrate a complete, down scaled Power2Methanol pilot plant to validate
  - A combination of two proven technologies (methanol synthesis and water electrolysis) integrated and managed as “one” process
  - The business case in green methanol production from biogas CO<sub>2</sub>
- Project participants represent entire value chain:
  - CO<sub>2</sub> from biogas, **Nature Energy** and **E.ON**
  - Electrolysis, **Green Hydrogen Systems – Project Lead**
  - Methanol synthesis plant, **REintegrate**
  - Process calculations and validation of design, **Process Engineering**
  - Host and test, **Aalborg University**
  - Roadmap for green methanol use in transport, **Drivkraft Danmark**
  - Project management and public relations, **Hydrogen Valley**
- Total project budget of **3,5 mio. €** supported by the Danish EUDP program

# Project background

- Denmark is a leader within wind power as well as biogas, which gives a unique opportunity to develop and demonstrate Power2Met technology in Denmark and establish the basis for future export of the technology
- Biogas is an important element in the renewable energy system utilizing agricultural and other organic waste materials
  - Today, only the produced biomethane is used – the CO<sub>2</sub> is a waste product
  - Instead CO<sub>2</sub> could be a basis for a new revenue stream in a catalytic process with hydrogen to produce methanol
- Phase 2 of the project (2022) - to build a scalable, turnkey Power2Met system with a capacity of 10 MW based on matching methanol reactor modules and electrolyzer modules
  - Standard system modules matching each other, standard installation, standard price, full control over process flow in entire value chain (from power to methanol)

# CO<sub>2</sub> from biogas

- Large amounts of CO<sub>2</sub> is available. By December 2018, 32 Danish biogas plants upgraded raw biogas to biomethane<sup>1</sup>.
  - Biomethane production ~340 mio. Nm<sup>3</sup>/year => ~ 225 mio. Nm<sup>3</sup> CO<sub>2</sub>/year (40%)
  - E-fuel from CO<sub>2</sub> improves carbon utilization
  - Energy output from biogas plant increases significantly
  - Biogas as a key enabling technology for sector coupling
  - Danish potential exceeds 400 mio. L green methanol requiring 400 MW electrolysis (energy storage)



1: Biogas på nettet – status, GasEnergi nr. 1, 2019, Energinet

# The need to balance the grid

- Wind energy fluctuates – the grid requires stability
- During periods we produce more electricity from wind turbines than we are able to use
- We can store excess electricity as liquid fuels/eFuels
- We can limit production or stop the Power2Met plant without interrupting the biogasplant - It will continue to deliver biomethane to the gas grid
- There is no required baseload on Power2Met and the plant is not a liability to the grid – but offers flexibility
- How and when the power is used is a question of pricing → power price is absolute key to competitive pricing for green methanol

# Electrolysis technology – pressurised alkaline

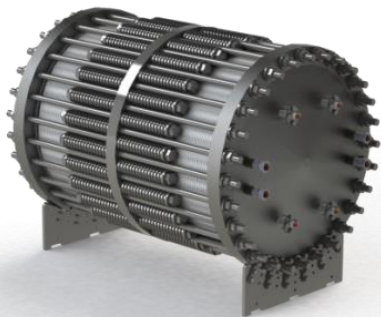


## Stand alone unit

- Footprint 20 ft. L xWxH (6050 x 2438 x 2896)
- Grid 400V 50/60 Hz
- Outlet pressure H<sub>2</sub>: 35 bar
- Response time: <5s
- Dynamic load range: 16-100%
- Hydrogen production: 90 Nm<sup>3</sup>/H<sub>2</sub>/h or 8,1 kg

## Nominal data stack

- Electrical power: 375 kW
- Number of cells: 125
- Electrode size: 3000 cm<sup>2</sup>
- Current density: 600 mA/cm<sup>2</sup>
- Operating pressure: max 40 bar
- Operating temperature: 100°C
- Electrolyte: KOH solution (liquid), 30wt%





# Methanol production technology



# Pilot plant (PoC) - live under final testing

- Proof of technology (pilot plant) live in October 2020:
  - Powered from the grid
  - H<sub>2</sub> from elektrolyser
  - CO<sub>2</sub> delivered from industry gas supplier
  - Daily methanol production capacity: 1.000 L
  - Objectives are reached: green methanol production can be down scaled to match the CO<sub>2</sub> output from biogas plants – with a positive business case
  - Testing continues on pilot plant after official project end to gather important experience and collect data on performance



# Required for green methanol to be competitive

- The cost of producing hydrogen has to be reduced with at least 30%
- Confirmation of certification to secure high value methanol in RED II and IMPCA
- Mapping the market for green methanol
  - Today there is a market for “black” methanol priced at 350 €/ton (2018 price)
  - The end-product from Power2Met will compete against 2nd generation bio-ethanol also made from waste stream. Price for bio-ethanol is 1,000 € - 1,200 €
  - There is no market (yet) for E-fuel – but the price for green methanol should at least be competitive against bio-ethanol
  - Long term market certainty is key (RED II)

# Electrolysis technology – price/kg H<sub>2</sub> is key..



- Low price/kg H<sub>2</sub> = low price on electricity + low opex (high efficiency) and low capex
- Electricity price 0,04 €/KWh or less
- 2022 objectives for electrolyser:
  - 83% efficiency (HHV)
  - 30% capex reduction
  - Cost price of H<sub>2</sub> produced
    - 2.50 - 2.75 €/kg H<sub>2</sub>

# Next step – scale Power2MET to 10 MW (+...)

- In GreenLab Skive REIntegrate and Green Hydrogen Systems will deliver a complete 10 MW methanol plant in 2022 (project supported by funding from Danish Energy Agency)
  - Modular electrolyser system of 12MW capacity delivered by Green Hydrogen Systems
    - 10 MW for methanol production
    - 2 MW for mobility applications
  - Methanol reactor and distillation system from Re::integrate
  - CO<sub>2</sub> delivered from E.On's biogas plant
  - Power delivered by EuroWind based on windturbines and PV
  - Off-take contract secured for full methanol capacity

# Thank you



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