Electrochaea
Renewable Natural Gas

Power-to-Gas via Biological Methanation

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About Electrochaea

Founded September 2010 as a University of Chicago spin-off, subsidiary in Denmark since 2011

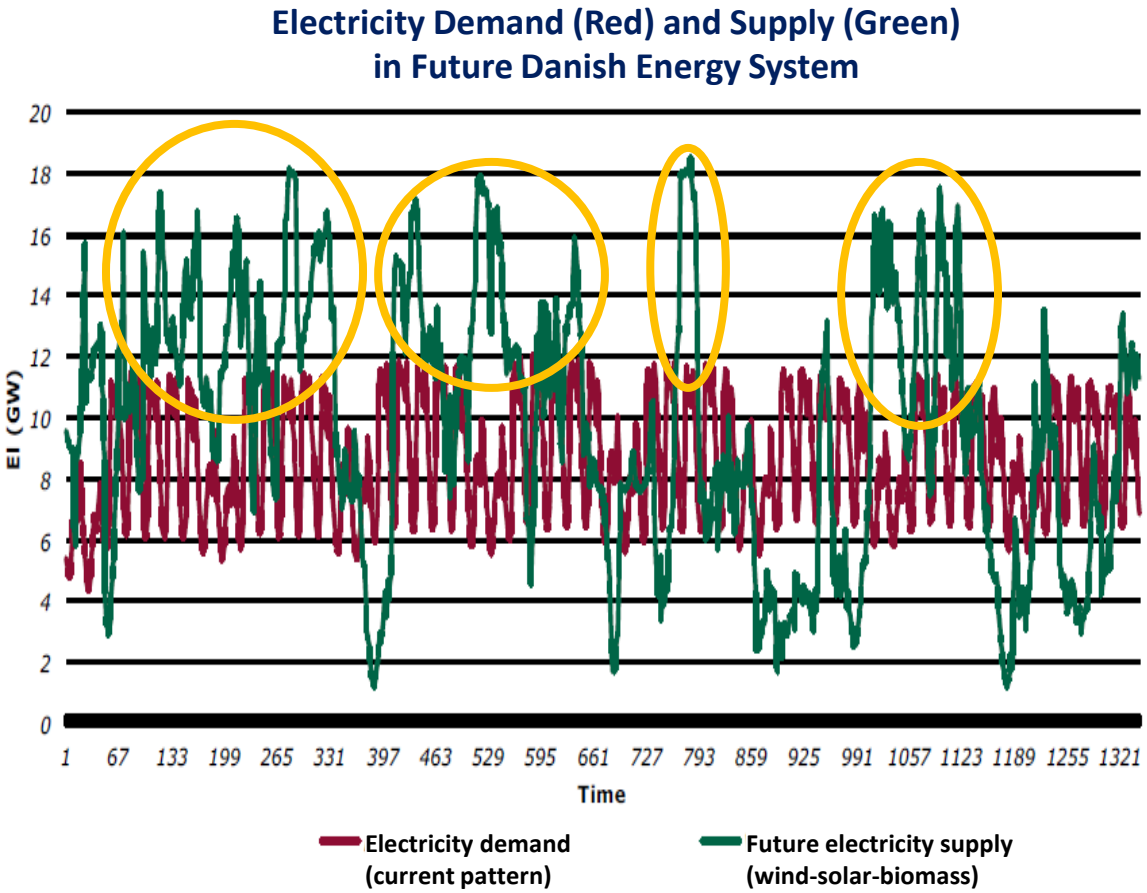
Mission Develop biological methanation process for power-to-gas energy storage

Partners Universities, public agencies, grid operators, utilities, gas distributors, technology developers, energy traders, engineering firms

THE CASE FOR P2G IN DENMARK

Problem (1): Excess Power Supply

Intermittent Renewables Create System Management Challenges



Implication #1 → Periods of low or negative power prices

Implication #2 → Wind power curtailment

Implication #3 → Grid balancing challenges

Source: Energinet.dk, *Energi 2050 – Vindsporet,* January 2011

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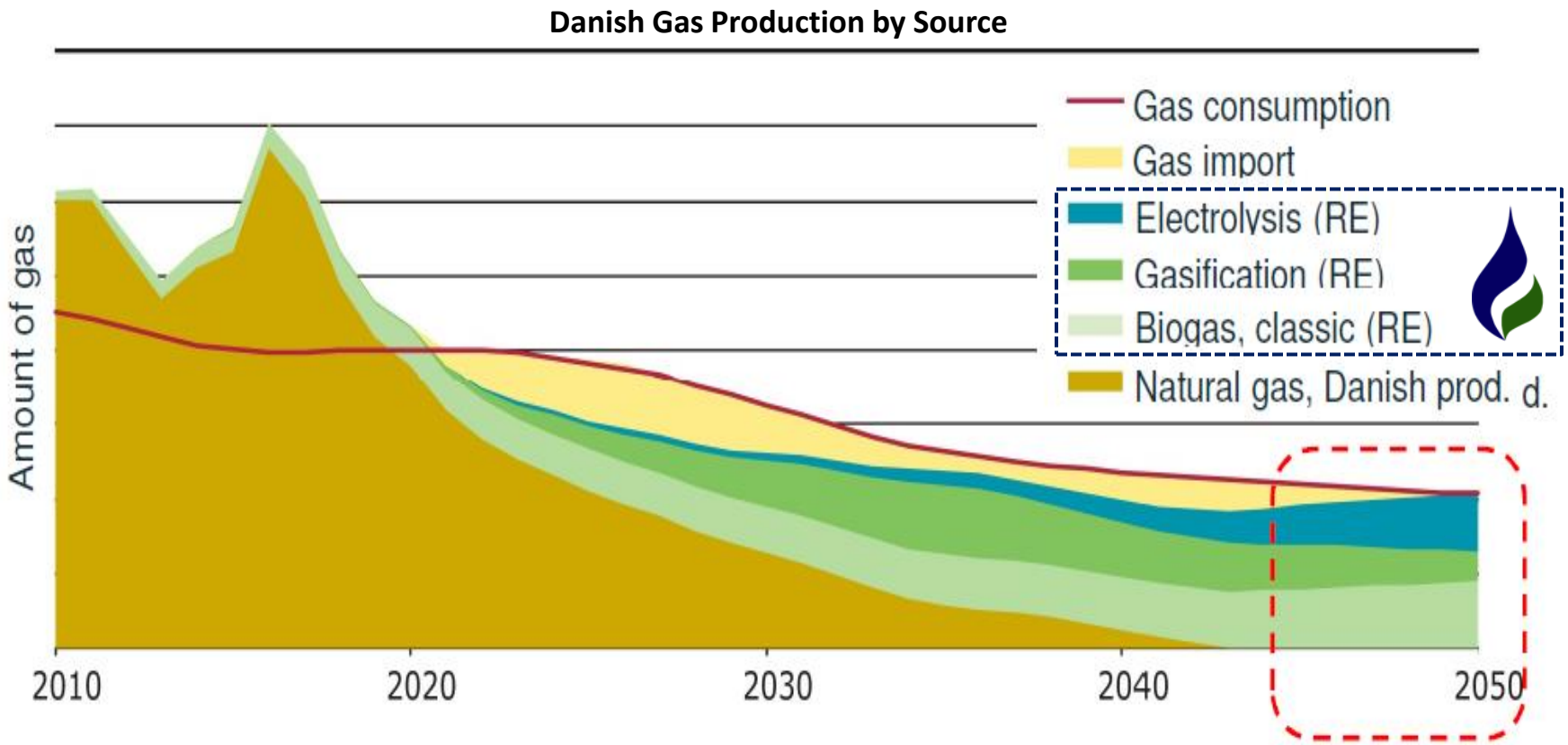
Problem (2): Declining Fossil Gas Reserves

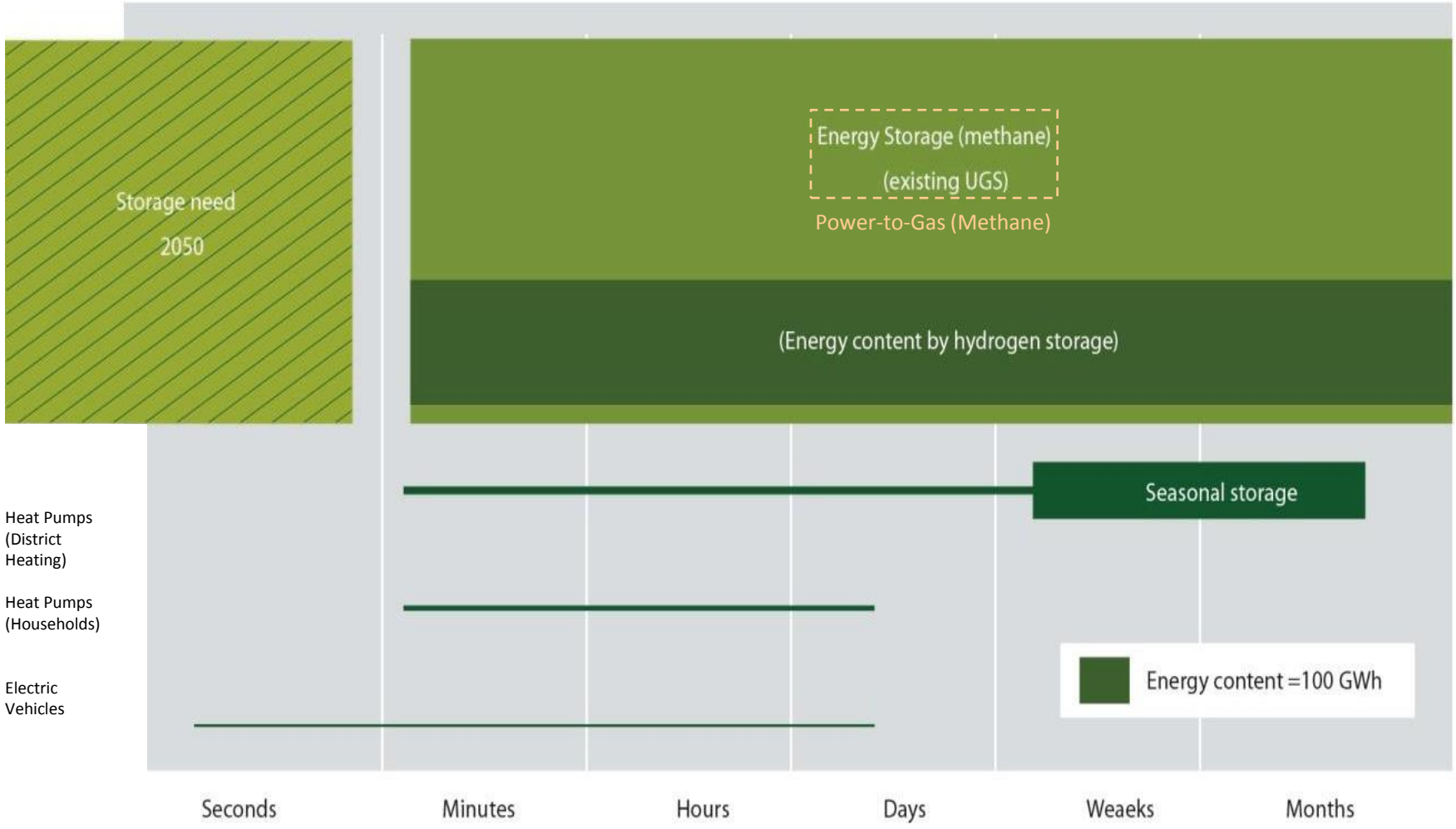
Domestic Fossil Gas Supply will Cease after 2040



Source: Energinet.dk

Solution: Power-to-Gas (Recognized as Necessity)

2050 Storage Need in Denmark and Storage Capacity of Different Technologies



Source: Energinet.dk, *Wind and Gas System Integration – A Necessity in Denmark,* June 2013

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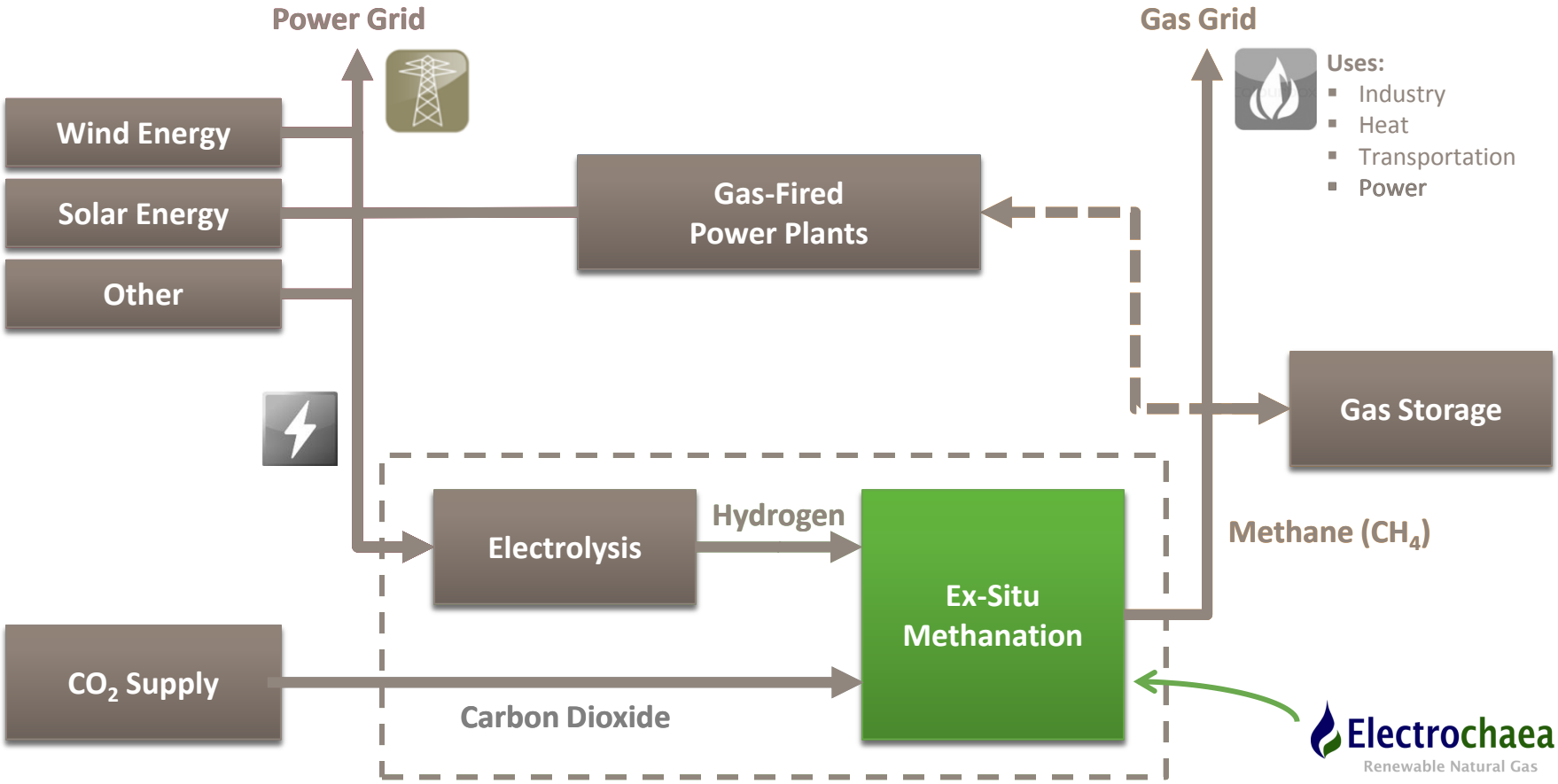
ELECTROCHAEA'S BIOMETHANATION AT A GLANCE

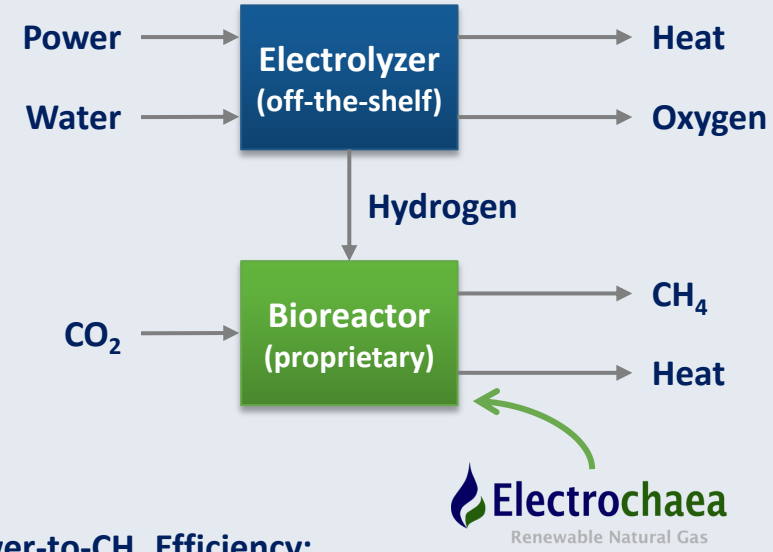
Biological Methanation



Raw biogas (40% vol. CO_2)
Fermentation off-gas (e.g. ethanol plants)
Oxy-combustion flue-gas
Industrial processes (ammonia, NG processing, etc)
Other captured CO_2 (flue gas, cement, iron & steel, atmosphere)

System Design & Microorganism

System Design



Power-to-CH_4 Efficiency:

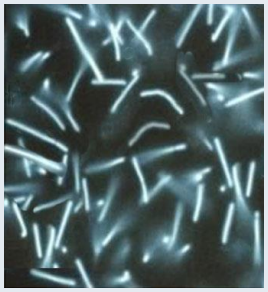
- 78% (incl. heat recovery)
- 58% (excl. heat recovery)

Development Status

- Pre-commercial demonstration plant (10,000 L)

Microorganism

- Methanogenic archaea
- Selectively evolved, not genetically modified
- Thermophile (60-65°C)
- Properties:
  - Robust (tolerant to contamination)
  - Long-lived (self-replicating)
  - Efficient (long doubling time)
  - Dynamic (short ramp rate)
  - Selective (100% methane)



Comparison with Sabatier Process

	Thermochemical Methanation	Biological Methanation	Advantage of Biological Methanation
Temperature Range	300-400°C	60-65°C	**Lower engineering complexity, better ramping capability**
Contamination Tolerance (H_2S, O_2, KOH)	Low	High	**Ability to use raw biogas and low-purity H_2**
Fuel Produced	CH_4 + Intermediates (esp. CO)	CH_4 only	**No post-reaction product separation required**
Engineering Complexity	High	Low	**Lower CapEx, greater system modularity/mobility**
Scalability	Low	High	**Economic viability even at small scales**

Simplicity, responsiveness, robustness → lower CapEx and OpEx, higher operating flexibility

THE BIOCAT PROJECT

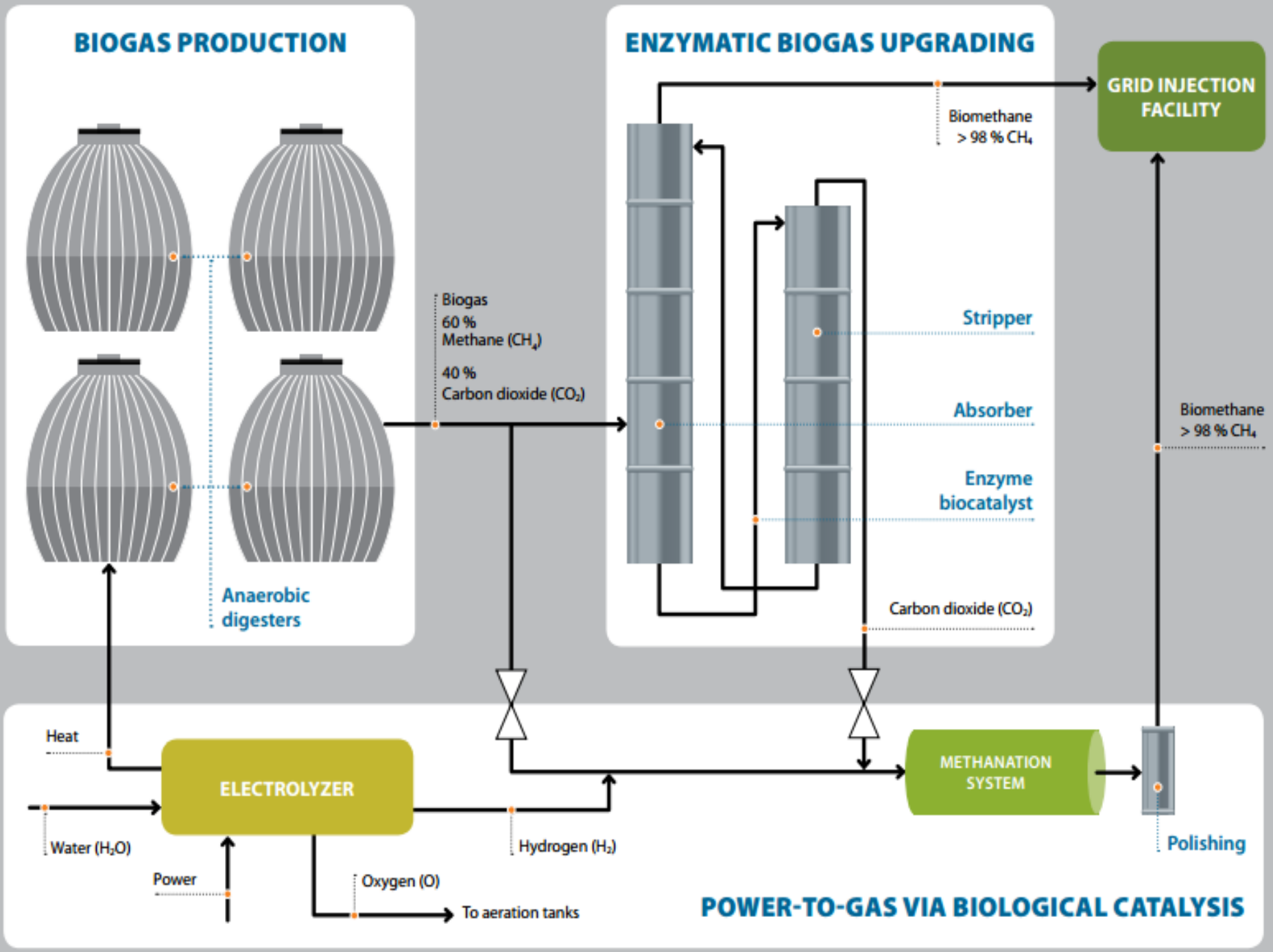
BioCat Project

Scale-Up to Commercial Size

- 1 MW electrical input
- Alkaline electrolysis and biological methanation
- CO_2 from biogas
- Injection into 3.6 bar distribution grid
- Heat recycling in buildings
- Oxygen recycling in activated sludge treatment
- Frequency regulation provision

- Location: Avedøre WWTP, Copenhagen
- Timeline: Feb 2014 – Dec 2015

www.biocat-project.com


BIOGAS PRODUCTION
Anaerobic digesters
Biogas
60 % Methane (CH_4)
40 % Carbon dioxide (CO_2)
ENZYMATIC BIOGAS UPGRADING
Biomethane > 98 % CH_4
Stripper
Absorber
Enzyme biocatalyst
Carbon dioxide (CO_2)
GRID INJECTION FACILITY
Biomethane > 98 % CH_4
Heat
ELECTROLYZER
Water (H_2O)
Power
Oxygen (O)
To aeration tanks
Hydrogen (H_2)
METHANATION SYSTEM
Polishing
POWER-TO-GAS VIA BIOLOGICAL CATALYSIS

Contact

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