



Meet Electrochaea: Providing Grid Scale Renewable Methane

Platform for Coal Regions in Transition - Advanced Fuels and Circular Carbon Economy
April 8th, 2019

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Electrochaea Snapshot



- Growth stage company enabling grid-scale renewable methane production
- Scalable and flexible biocatalytic process stores renewable energy and reuses CO₂ to make renewable methane
- Addressing existential risk to the natural gas industry and providing a revenue opportunity from curtailed and underutilized renewable power
- Technology validated in 3 industrial pilot plants in Europe and US
- Exclusive patents cover our proprietary process in international markets
- Series C financing and Storengy commercial partnership 1Q 2019



Partnership with Storengy

- Major global energy storage and energy services company – lead investor
- Multi-year commercial project development commitment
- Technology development collaboration

Our Vision

Become the Leading Provider of Power-to-Methane Technology for Carbon and Energy Storage



Our Mission

To decarbonize the gas grid with renewable electrons via P2G methanation technology

Our Strategy

License our technology to partners and developers to enable, commercially viable power to gas plants in regions where the market prices for methane, electricity and CO₂ enable a profitable business. Our revenues will be derived from licensing technology, providing engineering and expert services and royalties on sales of renewable gas and related products.

Current market drivers for a power to gas solution



- **Renewable energy curtailment**

- In 2018 CA curtailed 461 GWh wind and solar, Allianz suffered 5 TWh curtailment in their renewable portfolio; project developers are declining projects due to curtailment risks

- **Existential risk to gas industry**

- Fossil natural gas consumption is projected to decline as carbon tax and regulatory limits increase cost of NG use; decarbonizing the heating sector is an emerging strategic objective; major investors in gas distribution and infrastructure are sounding the alarm

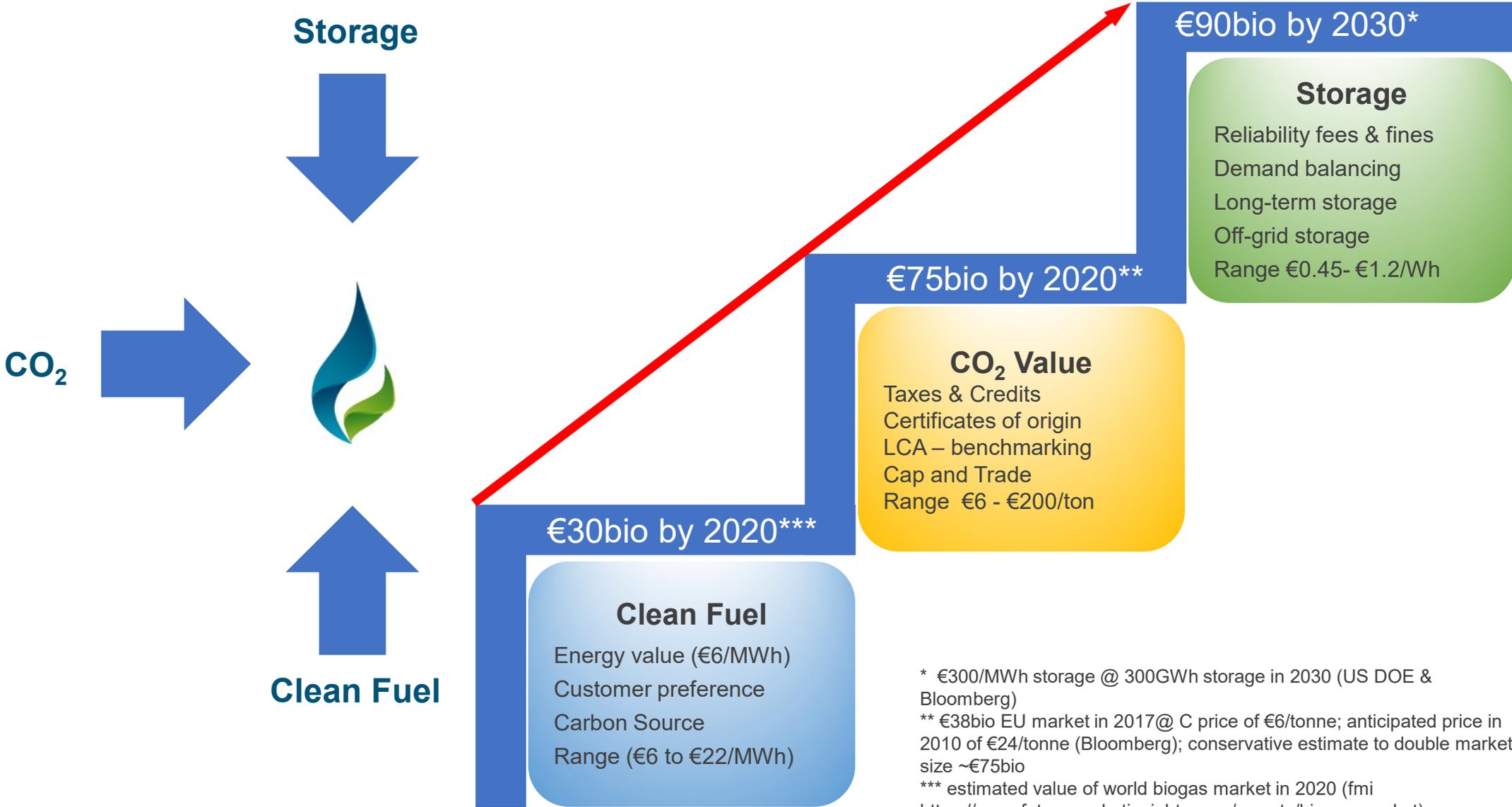
- **Seasonal energy storage**

- There is growing demand for seasonal storage, batteries have limited capacity (1-4h) to manage power surpluses; FR moving to decarbonize entire gas grid; the power grid is NOT a battery - the natural gas grid is our largest available battery

- **Decarbonizing transportation**

- First profitable markets in CA and SE are rapidly decarbonizing their fleet transportation sectors with renewable natural gas, driving investment in renewable gas infrastructure via tax incentives and C credit mechanisms (e.g. CA LCFS and US EPA RIN system)

Total addressable markets: up to 195 bio € by 2030



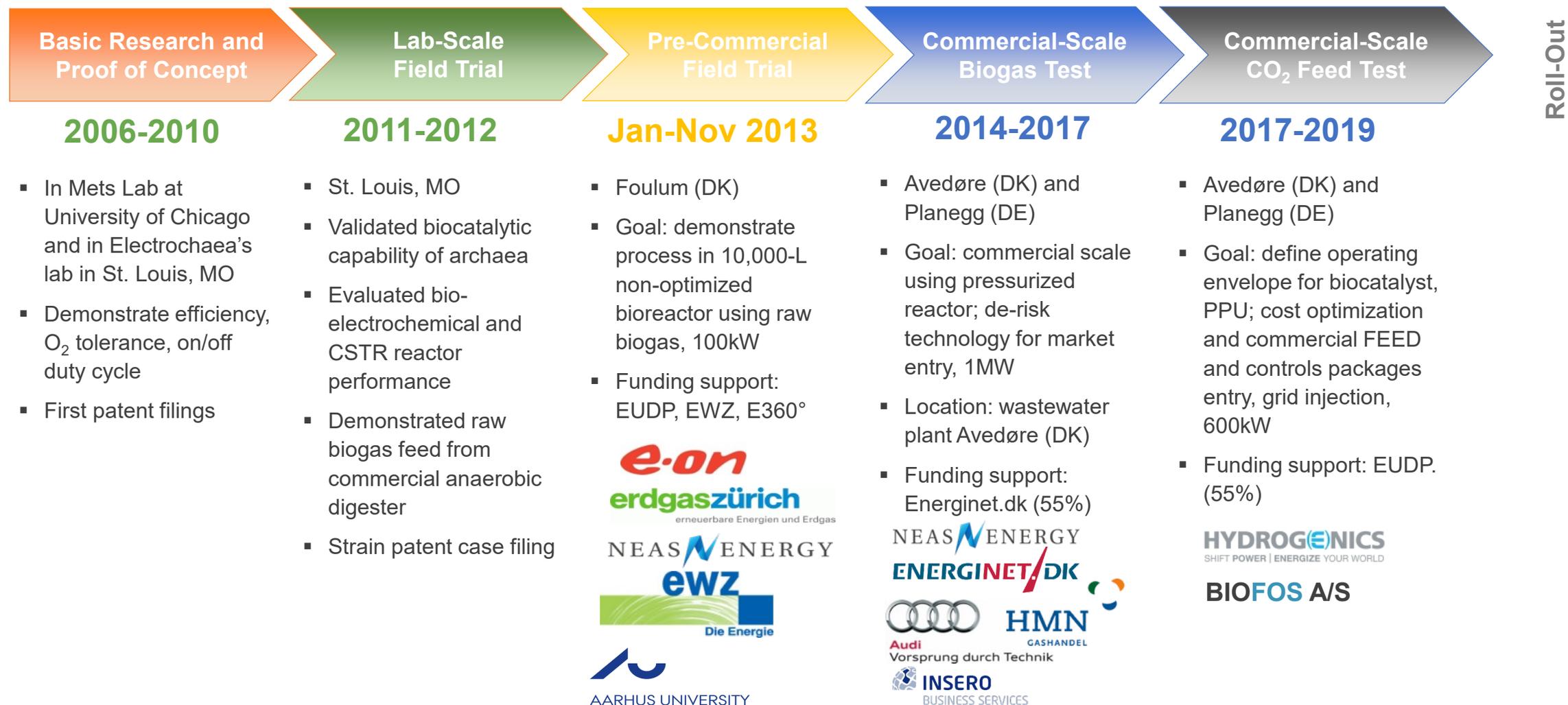
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* €300/MWh storage @ 300GWh storage in 2030 (US DOE & Bloomberg)
 ** €38bio EU market in 2017@ C price of €6/tonne; anticipated price in 2010 of €24/tonne (Bloomberg); conservative estimate to double market size ~€75bio
 *** estimated value of world biogas market in 2020 (fmi <https://www.futuremarketinsights.com/reports/biogas-market>)

Technology Development Timeline

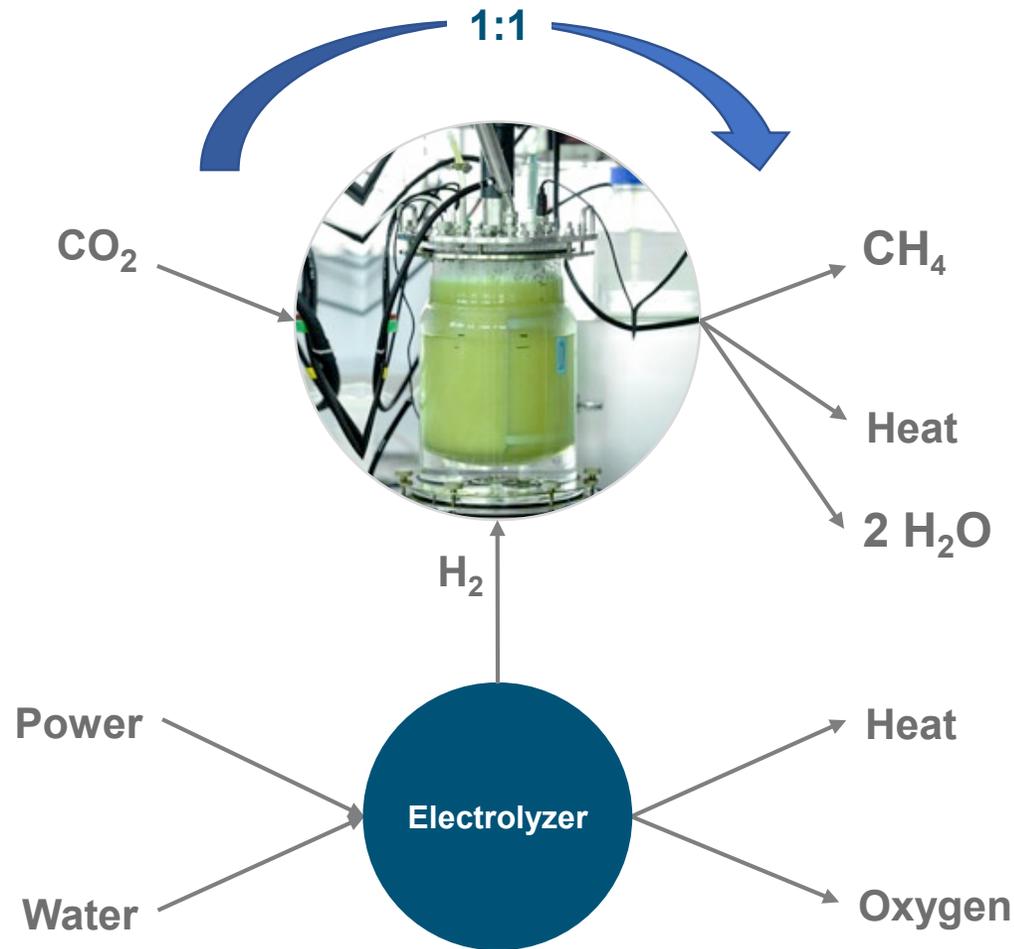


Path to Commercial Scale



Roll-Out

What we are doing to lower the world's carbon footprint



Proprietary Biocatalyst

4 issued patents, active patent applications worldwide

Operating Conditions

temperature 65°C, pressure 1 to 10 bar(a)

Chemical Reactions

Methanation $\text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O} + \text{Heat}$
Electrolysis $4\text{H}_2\text{O} \rightarrow 4\text{H}_2 + 2\text{O}_2 + \text{Heat}$

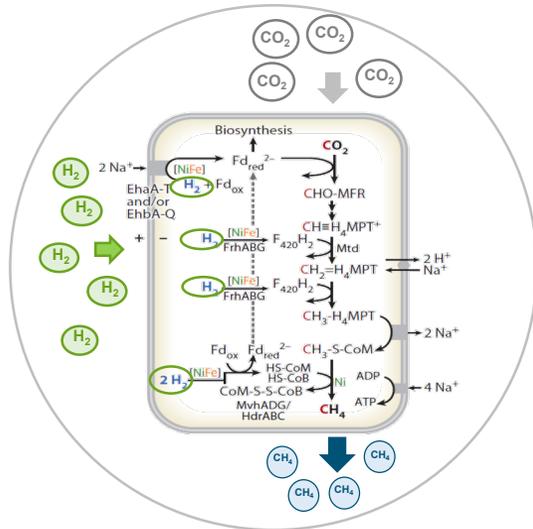
Net Reaction

$\text{CO}_2 + 2\text{H}_2\text{O} \rightarrow \text{CH}_4 + 2\text{O}_2 + \text{Heat}$

Our archaea transform virtually every molecule of CO₂ into a molecule of CH₄ without using fossil fuels

A Scalable Biocatalytic System

1 enzyme complex



1 single cell



1.5L bioreactor



3500L bioreactor



Peak measured productivity*:
Current productivity:

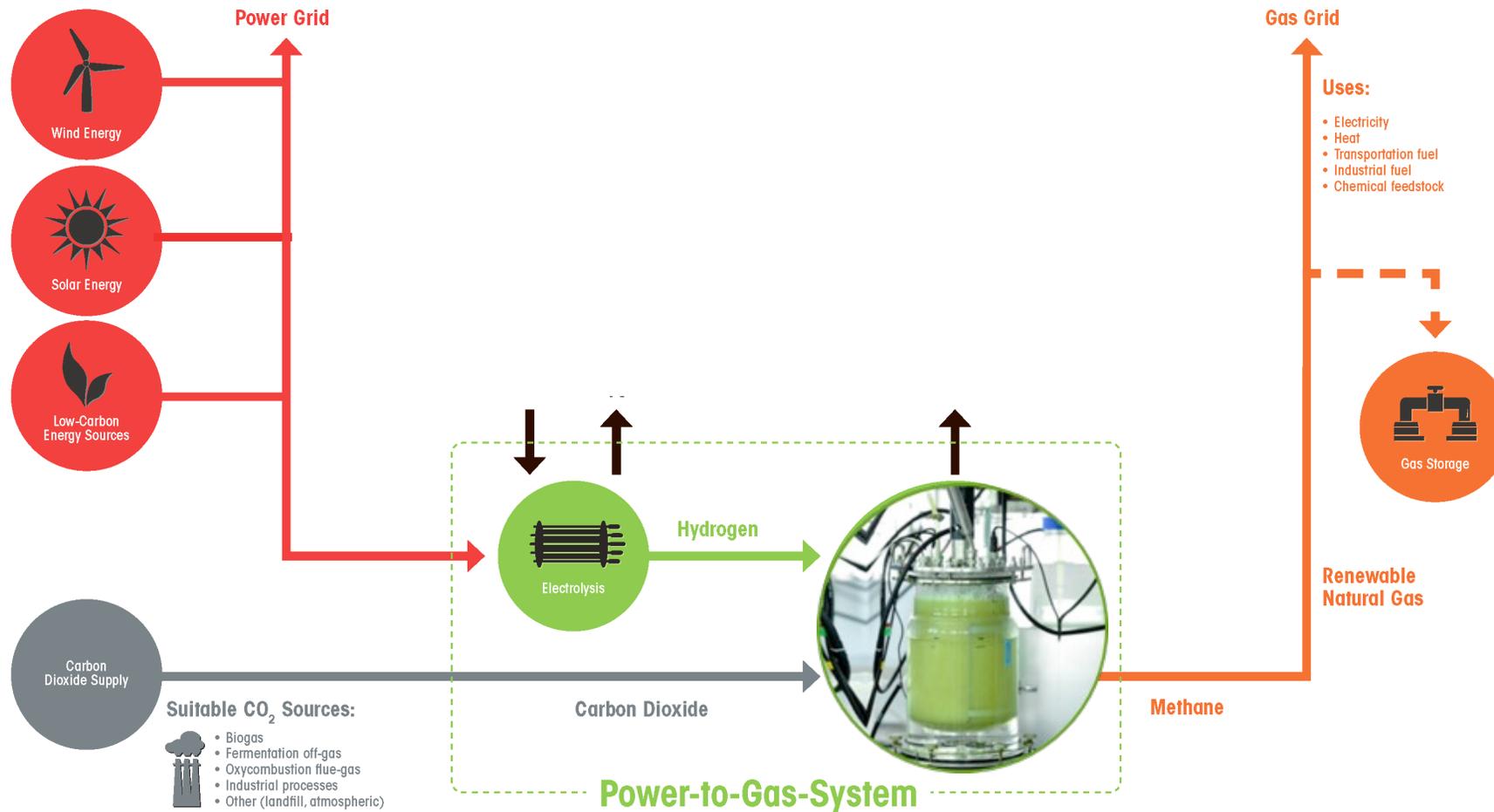
8.3×10^{-14} Nm³/hour
nd

0.045 Nm³/hour
0.007 Nm³/hour

152 Nm³/hour
31 Nm³/hour

* assuming that vvd=800VolCH₄/VolBioreactor/Day at a dry weight of 10g/L can be reached

Electrochaea's "neomethane" is produced using archaea as biocatalyst and CO₂ and electricity as energy sources



Suitable CO₂ is available from many sources

- **“pure“ CO₂ sources**
 - Ethanol mills (maize, sugar beet, sugar cane)
 - C carbon capture and natural gas clean up
 - Breweries and fermenters
 - Biogas upgrading
- **“impure“ CO₂ sources**
 - Biogas from anaerobic digestion
 - Landfill gas
 - Geothermal gases
 - Industrial gases low in oxygen
 - Oxycombustion flue gases

Methanation of raw biogas stream

1 MW BioCat Plant in Avedøre (DK)



2019 - Our technology is derisked in three commercial-scale pilot plants

0.25 MWe



Golden, Colorado, US
(April 2019)

- Commissioning ongoing
- 1st US biological methanation
- High pressure (18bar)
- Project support from SoCal Gas, NREL (US DOE)

0.7 MWe



Solothurn, Switzerland
(February 2019)

- Commissioning ongoing
- Automated operation
- Commercial design
- Project support from EC (H2020), RES

1 MWe



Avedøre, Denmark (April 2016)

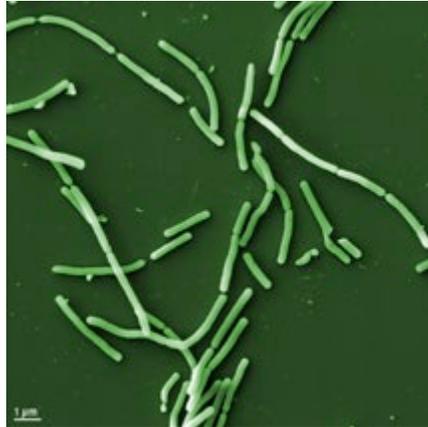
- Demonstration of grid gas quality
- Flexible operation, load following
- 1st grid scale demonstration
- Project support from EUDP, Energinet, HMN, AUDI, Insero, Hydrogenics, BioFos

Unique features of Electrochaea Technology



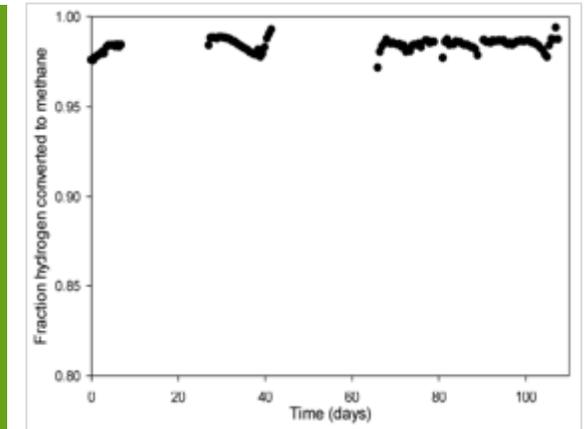
Unique Biocatalyst

- Patented strain
- Optimized methane productivity (20 x increase)
- Outstanding robustness
- Fast start/stop cycles
- Self-sustained



Scalable Bioreactor

- Mild operating conditions
- Optimized and proprietary design
- Broad range of applications



Efficient



98.6% of carbon goes into **methane**

Productive



VVD* of 800, H₂ mass-transfer limited

Responsive



Quick return to methane production – ideal for intermittent duty cycles and load following

Selective



100% methane, no intermediates

Robust



Tolerant to **oxygen, H₂S, CO, Sulfate, Ammonia, particulates**

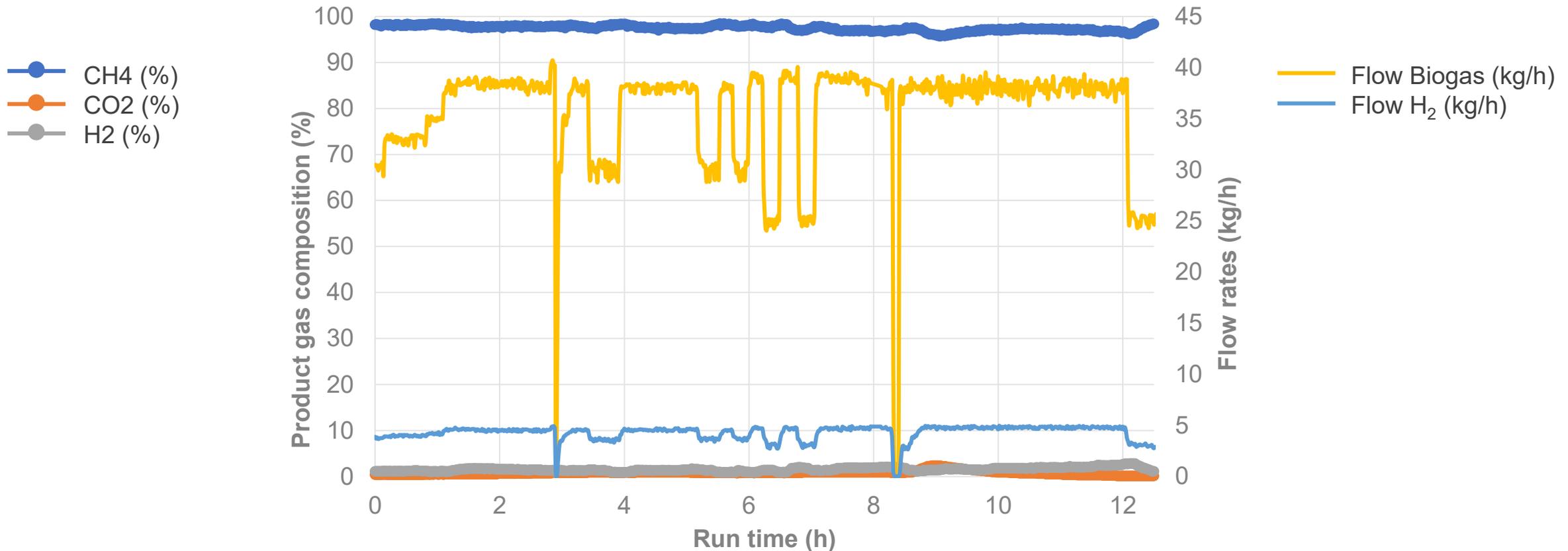
Simple



Moderate temperature range (60-65°C)

*VVD = volumes of gas per volume of reactor per day (24-hr)

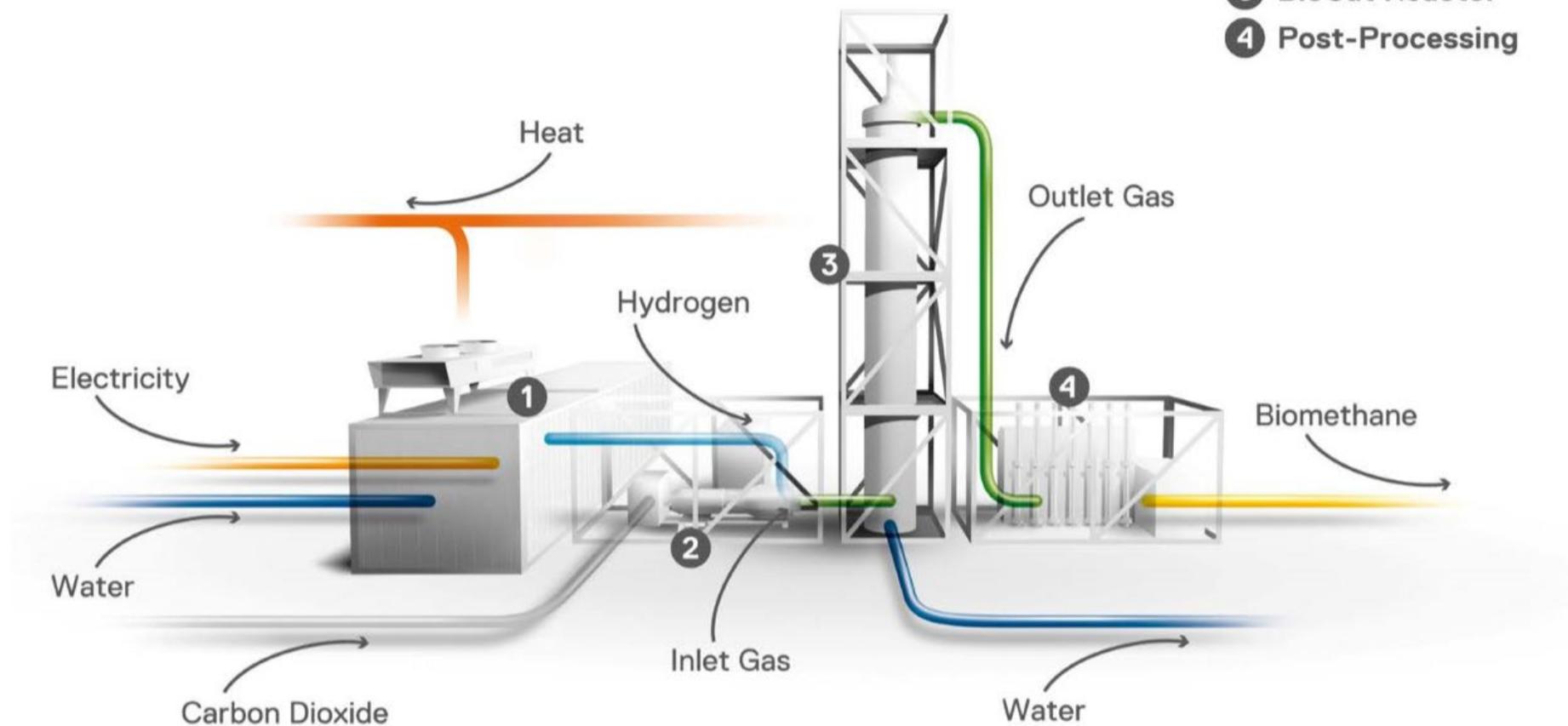
Flexible Load Operation at Grid Gas Quality



- Flexibility of the process between 0 - 50 - 100% of the total capacity
- Quick adaptation of the biocatalyst: no impact on the product gas composition at different loads

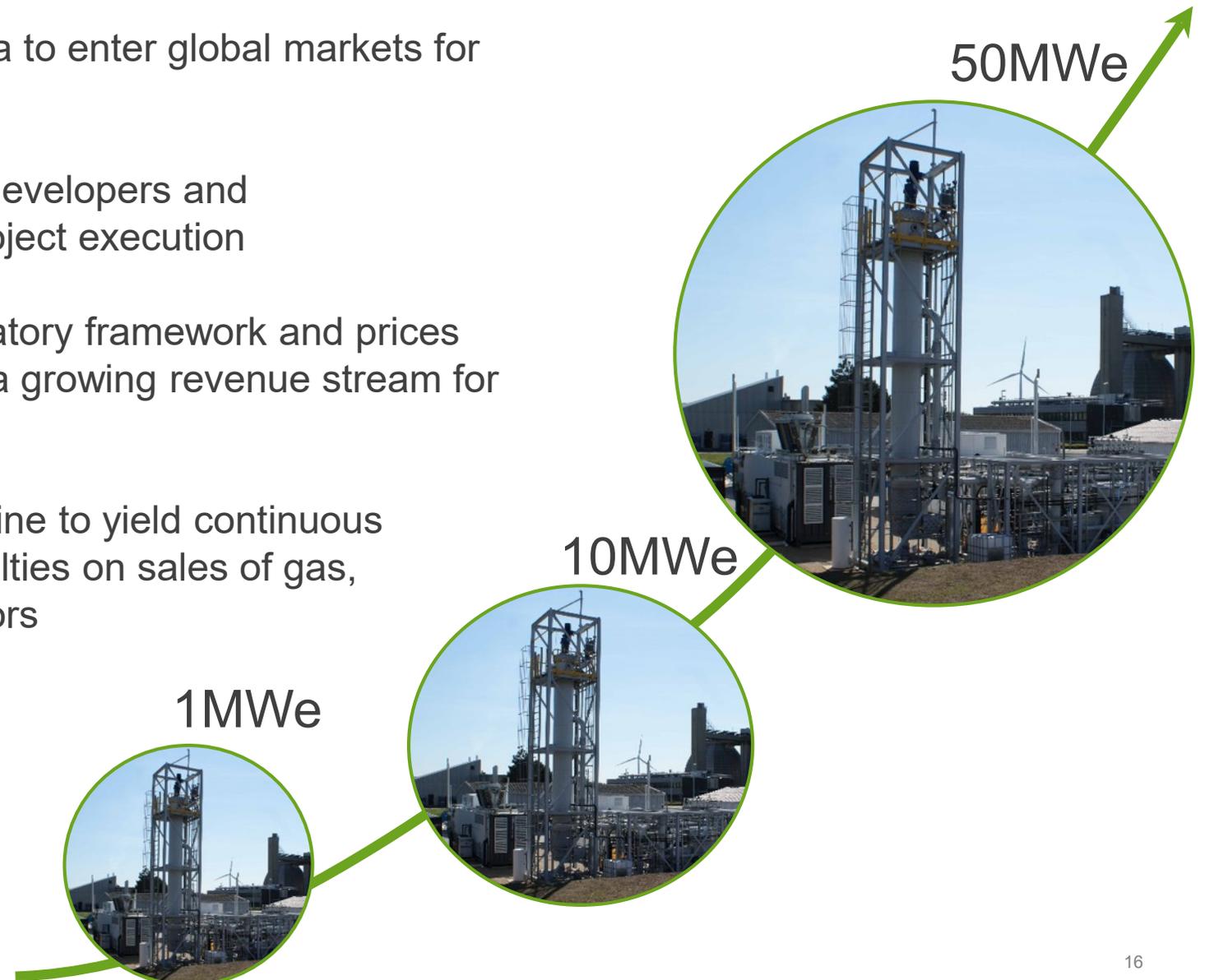
A Scalable and Simple System Design

- 1 Electrolyzer
- 2 Pre-Processing
- 3 BioCat Reactor
- 4 Post-Processing



Ambitions

- Attract equity investment in Electrochaea to enter global markets for power to gas
- Establish key partnerships with project developers and engineering/design/build partners for project execution
- License our technology where the regulatory framework and prices for methane, electricity and CO₂ create a growing revenue stream for Electrochaea and our partners
- Demonstrate an expanding project pipeline to yield continuous revenues from technology fees and royalties on sales of gas, enabling an attractive exit for our investors



Electrochaea – who we are!



We have a highly motivated and diverse team, led by seasoned management with international experience in commercialization and project execution



Mich Hein, PhD

Managing Director, CEO

Co-founder and managing partner at Nidus Partners
Passionate entrepreneur
Raised \$90 mn for start-ups



Doris Hafenbradl, PhD

Managing Director, CTO

20 years of experience in biotech, biofuels and pharmaceutical industries
Expert in hyperthermophilic archaea
Commercialized multiple technologies



Francesco di Bari

Director of Business Strategy, CFO

24 years of experience in finance, business development, M&A and change management
Expert in building up and establishing businesses



Gorm Teper

Director of Project Execution

Global experience in project management, construction, automation, water & wastewater, waste to Energy and Oil & Gas industries

Strong Network and Collaborations



Investors



Memberships



Partners



Sponsors and Funded Projects

