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POHJANMAA
COUNCIL OF OULU REGION

BotH$_2$nia goes Oulu & Raahe 5.–6.5.2022

This is a presentation given at the event BothH_2nia Goes Oulu & Raahe on 5.–6.5.2022.

BotH_2nia is a network of operators interested in hydrogen. The objective of the network is to create a Nordic hydrogen cluster around the Baltic Sea, beginning with the Bothnian Bay. BotH_2nia strengthens the position of the north in the European hydrogen industry!

BotH_2nia invites all businesses, research institutes, investors, municipalities and cities to roll up their sleeves for a greener future.

Please notice that the presentation has been modified to comply with the Accessibility Directive. In case for need the original material, please contact Minna Näsman (minna.nasman@both2nia.com).

QPOWER

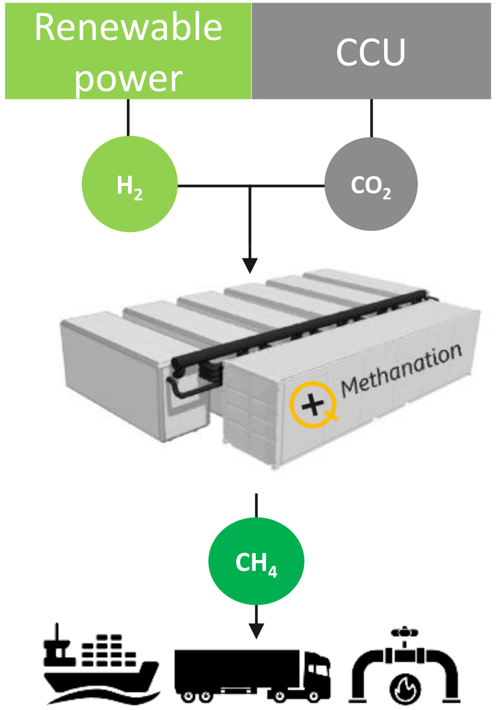
Power to X – towards a resilient and self sufficient energy system

5.5.2022

Concrete solutions for fighting climate change

Concrete solutions for the fight against climate change

Providing renewable energy solutions to substitute fossil fuels



Q Power enables our customers to work towards sustainable future. We turn emissions to valuable fuels and reduce fossil fuel consumption.

Full life cycle turnkey solutions from expert services to plant design, implementation and operation creates a next-generation energy system based on synthetic fuels.

Key segments are:

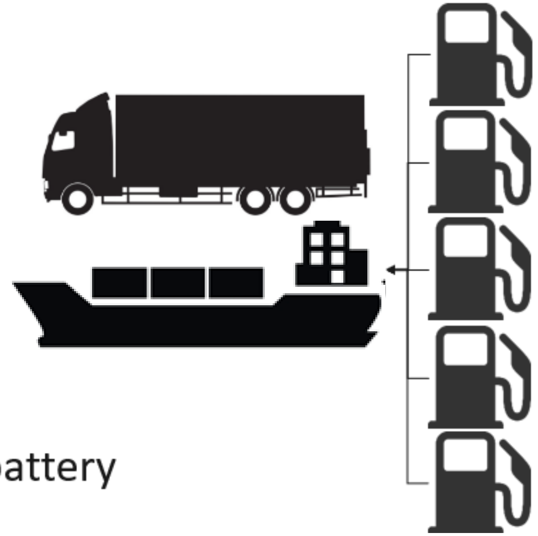
- ✓ Industrial and power plants – CO_2 capture + green hydrogen to renewable methane
- ✓ Biogas and landfill gas – upgrading even lower quality gas streams to high quality fuels

The challenge

There is no silver bullet for emissions – multiple solutions are needed in tandem

- Industry and transportation account for almost 50 % of all global emissions.
- In these sectors, direct electrification is often unfeasible.
    - In the transport sector, only 40 % of emissions are feasible to electrify
    - Carbon neutral renewable methane can directly replace LNG / CNG
    - Distribution and storage infrastructure available already
    - Local energy production and self-sufficiency

- Biomethane
- Synthetic methane
- Methanol
- Hydrogen
- Ammonium
- Biodiesel
- Solar / wind / battery

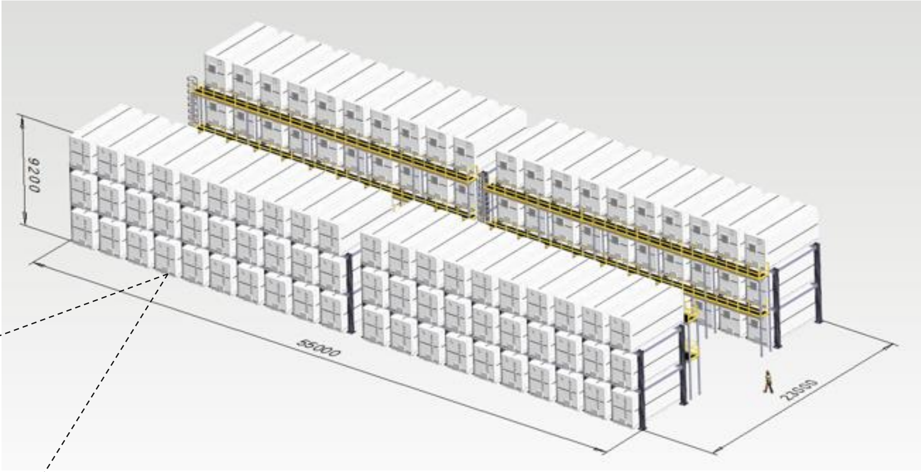


The solution

Modularly scalable and highly efficient

Large scale microbiological methanation

- Modular scalability by stacking the methanation units to industrial scale
  - Indoor and outdoor installations
  - **Capacity from 5 MW to 100 MW and beyond**
- Centralized control building to operate whole system, aligned with customer control room



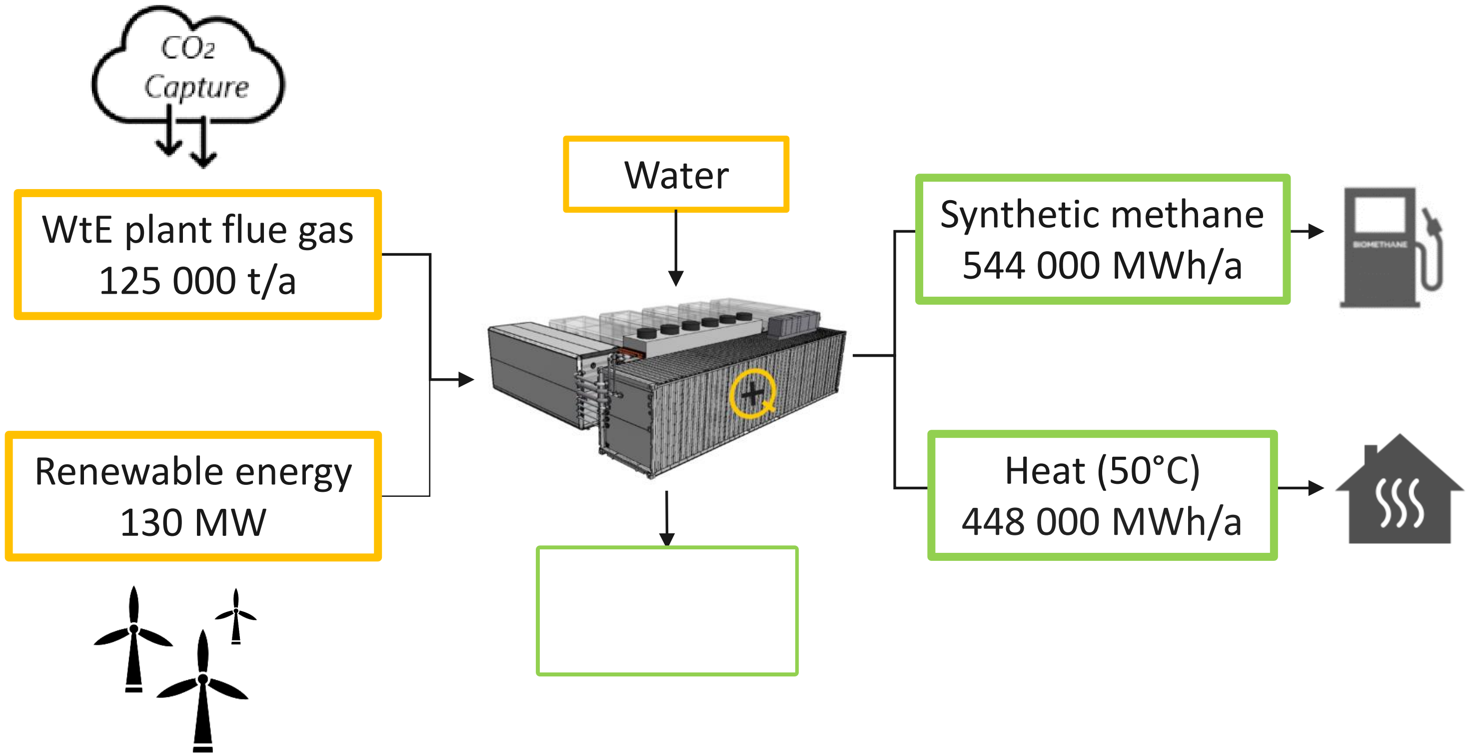
Methanation unit
- Parallel scalable unlimited
- Each module containing 29 bioreactors, which are the heart of the process

Control unit
- A central control building is used to operate full methanation stack.

Schematic of a 120 methanation unit plant, with methane output of ca. 14 MW utilizing 25 000 t/a CO_2.

Example Laanila: CO_2 capture and methanation

Preliminary mass balance calculation



Key drivers of project profitability:

1. Securing reasonably priced renewable power supply
2. Efficient hydrogen production
3. Sufficient methane end-use value
4. Value-adding utilization of heat
5. Avoided emission fees in the future
6. Meaningful CO_2 utilization (PR)

Future plans – several Power-to-X projects under preparation

KERAVAN energia

- Biopower plant flue gas CO_2:n capture (10 kton/a), hydrogen production and methanation
- Methanation capacity approx. 11 MW
- Renewable fuel for traffic and industrial use
- Target start at 2024

LOUNAIS-SUOMEN JÄTEHUOLTO — Lounavoima

- WtE plant flue gas and landfill gas CO_2 capture (5 - 20 kton/a), hydrogen production and methanation
- Methanation capacity approx. 5 - 20 MW
- Renewable fuel for traffic use

REN GAS

- Power plant Power-to-X projects at Lahti, Mikkeli, Tampere and Kotka
- Methanation capacity over 160 MW
- Renewable fuel for traffic use

P2X solutions

- CO_2 from biogas plant (40 kton/a)
- Hydrogen production capacity 20 MW
- Renewable fuels and chemicals to local industrial use
- Target start at 2024

Vantaan Energia — ENERGIAA ELÄMÄÄN — WÄRTSILÄ

- WtE plant flue gas CO_2 capture (10 kton/a), hydrogen production and methanation
- Methanation capacity approx. 10 MW
- Renewable fuel for traffic and VE own industrial use
- Target start at 2025

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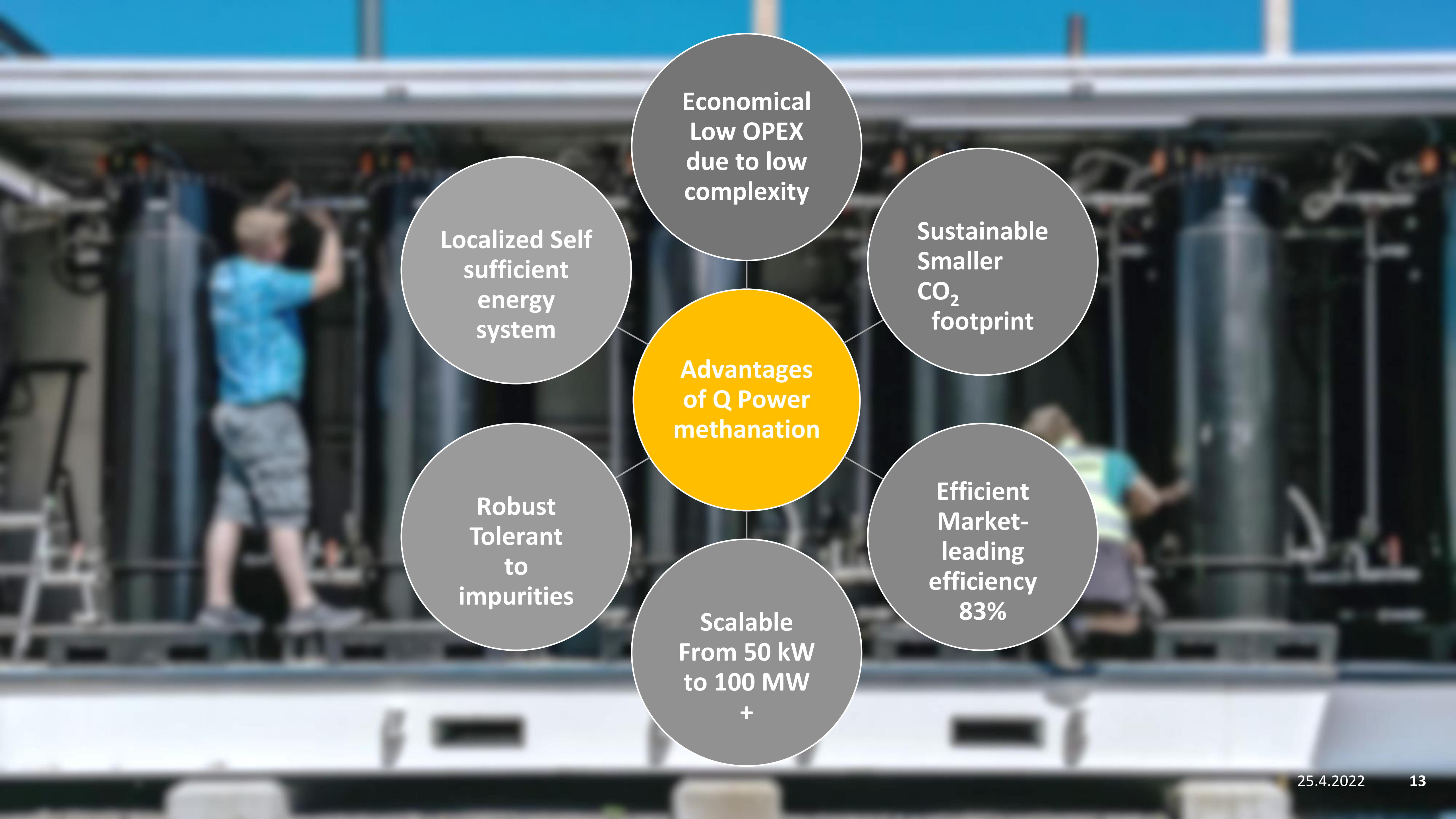
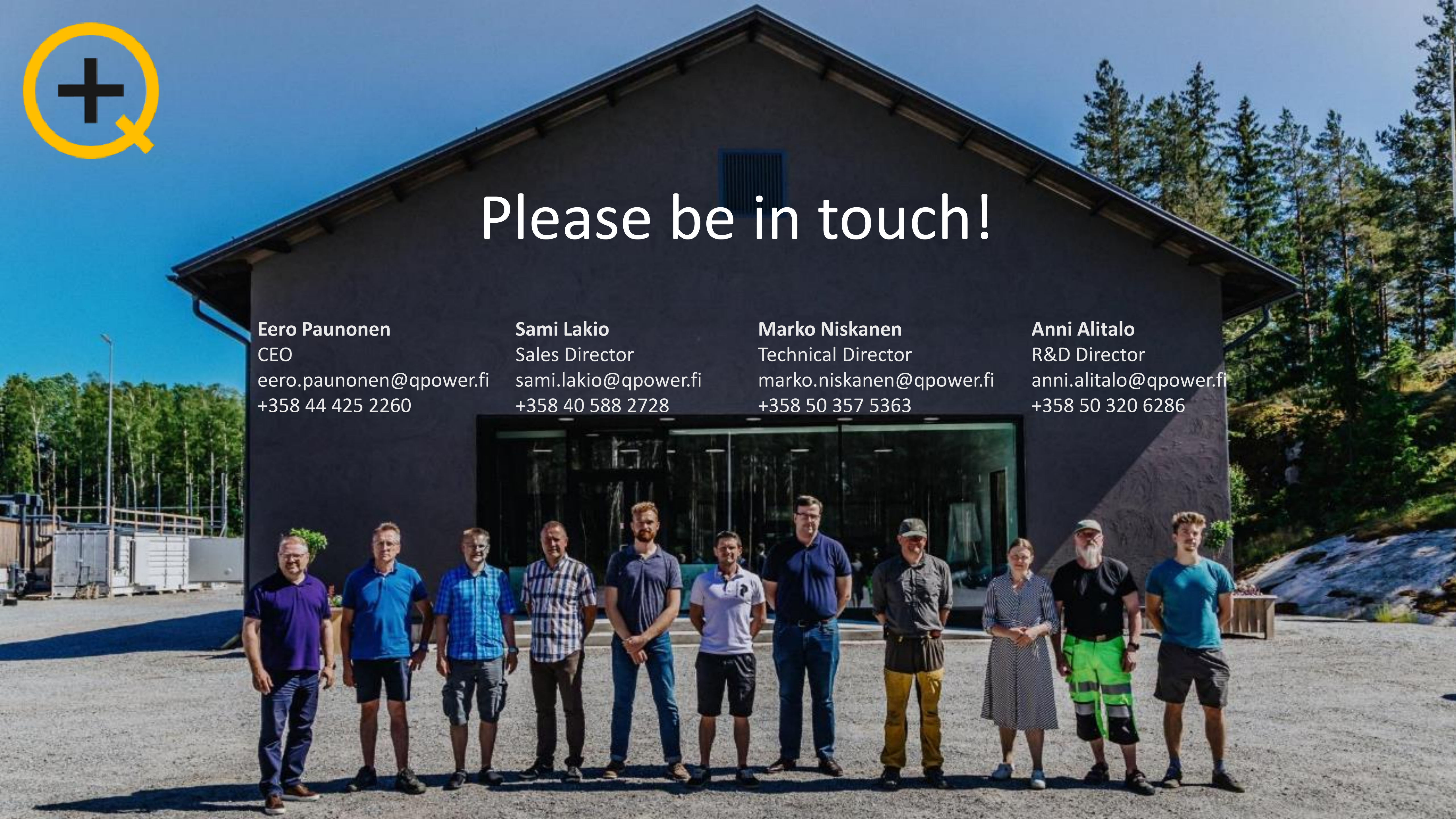
Involved several projects as technology provider and/or consultant


Advantages of Q Power methanation
Economical Low OPEX due to low complexity
Sustainable Smaller CO_2 footprint
Efficient Market-leading efficiency 83%
Scalable From 50 kW to 100 MW +
Robust Tolerant to impurities
Localized Self sufficient energy system



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Appendices

Comparison to competing technologies

Variable	Cathalytic reactor	Biological liquid reactor	Q Power: biological solid state reactor	Q Powerin benefit
Plant efficiency	~50%	~58%	**~82%**	✓ Lower OPEX
Product gas	CH_4 + side products	CH_4	**CH_4**	✓ No need for upgrading
Product gas purity	~92%	98-99%	**98-99%**	✓ Better product purity
Operation temperature	300-500°C	60-65°C	**60-85°C**	✓ Optimal temperature
Other operation conditions	High pressure	Pressurization and mixing	**Normal pressure, no mixing**	✓ Lower OPEX, better efficiency
Tolerance to impurities	Low	Medium	**High**	✓ Raw biogas can be used as feedstock
System complexity	High	Medium	**Low**	✓ Lower OPEX ja CAPEX
Conversion method	Chemical	Biological, pure culture	**Biological, mixed culture**	✓ Better stability

Q Power technology is **more efficient** and creates a **better end product** in **simpler and more stable conditions**.

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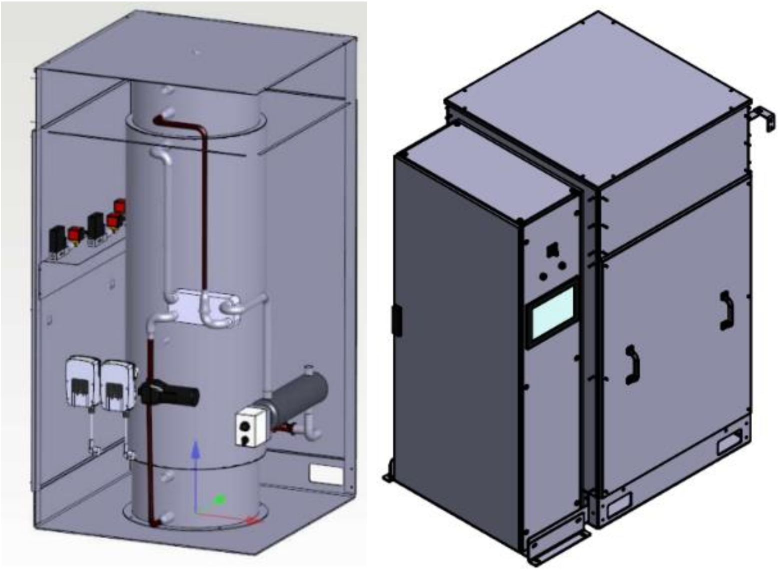
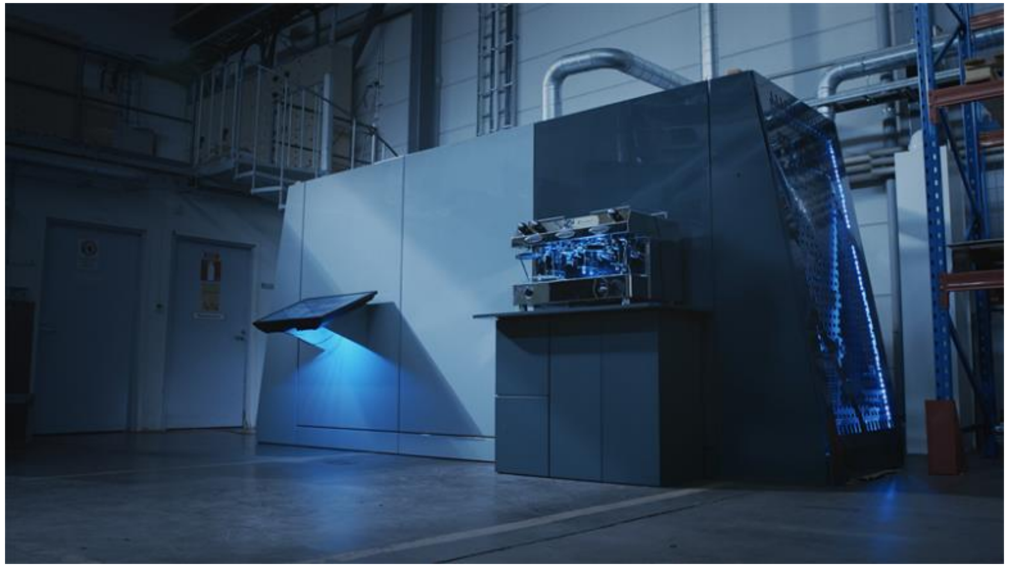
References - Wärtsilä Dubai EXPO unit





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Wärtsilä Dubai Convention Demonstration unit. Methanation by Q Power

- DAC by SoletAir Power Oy, CO_2 from air
- Electrolyzer, hydrogen from electricity and water
- Q Power Methanation unit to produce methane from H_2 and CO_2

References - 1

Bioethanol CO2 sidestream methanation pilot, Vantaa, Finland
In 2019, Q Power and Nordic energy company ST1 conducted a successful pilot methanating the CO_2 side stream from a bioethanol production process. Findings:

- Methanation process is operational and efficient in an industrial environment.
- High-concentration CO_2 side streams can be utilized as such.
- Residual concentrations of ethanol in the gas stream are not a problem.

Landfill gas methanation pilot, Salo, Finland
In 2020, Q Power, Lounais-Suomen Jätehuolto and Lounavoima conducted a successful pilot methanating the raw landfill gas from the Korvenmäki waste management site.

- Even low-quality landfill gas is suitable for methanation in the Q Power process
- The methanation process is highly resilient to feed gas impurities
- Impurities (hydrogen sulfides and siloxanes) can be microbiologically metabolized to purify bio and landfill gas for end use

References-2

Qvidja R&D center, Parainen, Finland
Q Power, together with our parent company Qvidja Kraft, has designed and implemented a versatile R&D environment at the Qvidja Manor in Parainen, Finland.

The site includes a methanation plant, gasification plant, biogas plant, gas storages, solar power plant, biogas filling station, and a syngas powered micro-CHP plant. Q Power can utilize the site in developing various novel solutions for customers.

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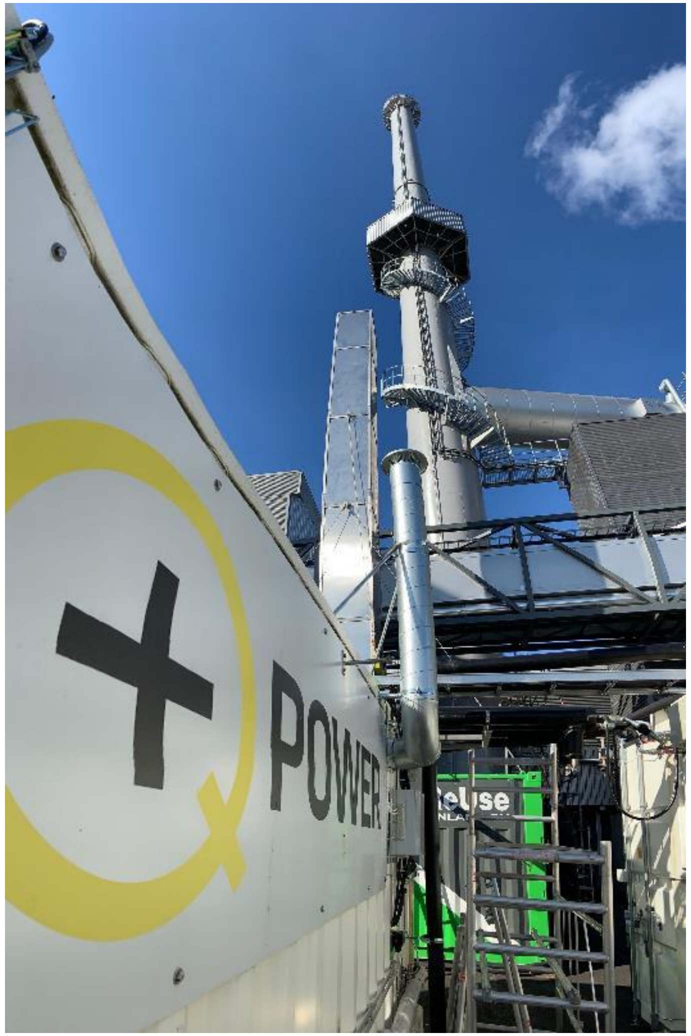
References – 3

Biopower plant flue gas methanation, Kerava, Finland
Keravan Energia Oy and Q Power Oy Power-to-Methane pilot and planning to implement full-scale methanation plant.

The pilot scale production of synthetic methane has been completed Dec 2021, designed to validate the methanation process with the specific flue gas composition. Q Power delivers, commissions and operates the whole technology chain from the flue gas CO_2 capture to synthetic methane utilizable as traffic fuel.



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References – 4

Waste to energy plant flue gas methanation, Riihimäki, Finland
Q Power microbiological methanation enables Fortum's groundbreaking pilot. The aim is to recycle waste to energy plant CO2 emissions into new materials.

Fortum has started with Q Power a pilot at Riihimäki waste to energy plant. It's aim is to capture carbon dioxide from flue gas and with added hydrogen, produced with renewable energy, the microbiological process will produce renewable synthetic methane. The produced methane can then be used as raw material for producing new, high quality materials like plastics.