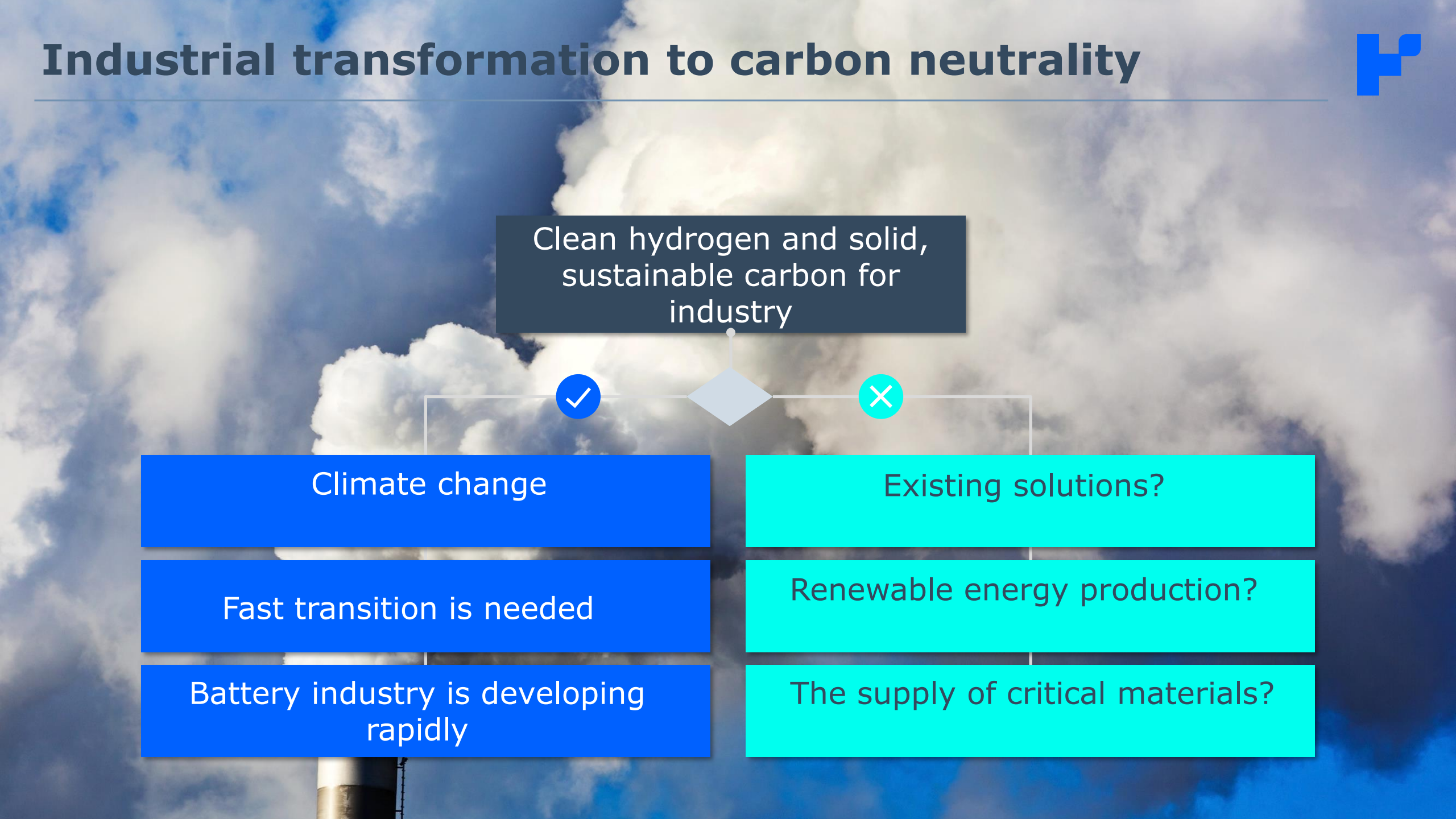
hycamite

A Road to NetZero - Nordic Cleantech Open Finals 16.11.2021

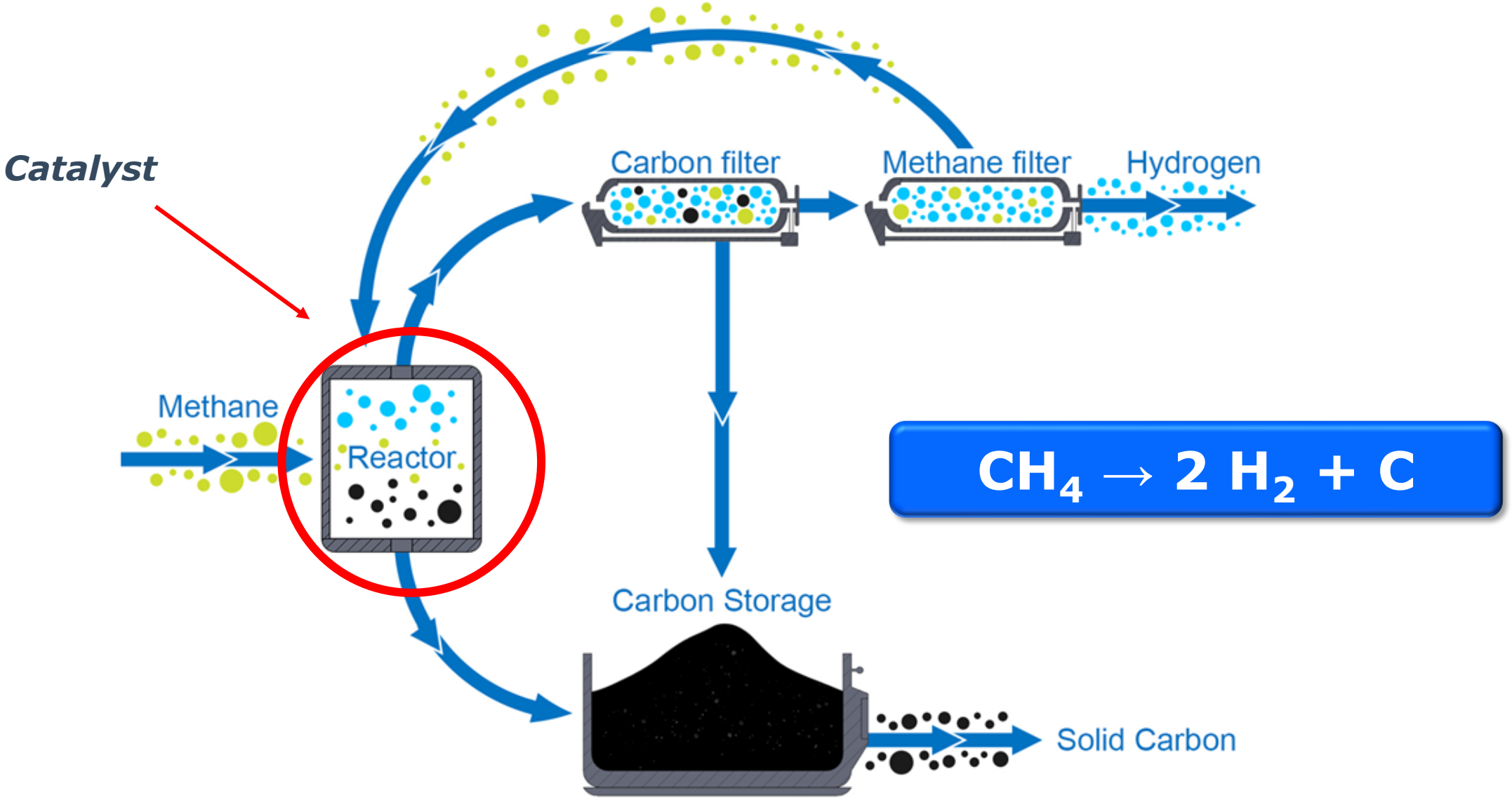
Hycamite TCD Technologies / Niina Grönqvist

Industrial transformation to carbon neutrality



Hycamite's solution: TCD* Process

* TCD – Thermo Catalytic Decomposition (of methane or biomethane)



Why Hydrogen?

Hydrogen can be used to decarbonise many different industries and applications

- Heat/power
- Metals production
- Chemical/ industrial processes
- Upgrading biomass
- Ammonia / Fertilizer

H_2

+CO/CO2 → CH_4 Methanation

+CO/CO2 → CH_3OH Methanol synthesis

+CO/CO2 → e-Diesel, e-Kerosene

Fuel cell's, internal combustion engines

Team

Matti Malkamäki
Founder and Chairman

Laura Rahikka
Founder and CEO

- **Company established 2020**
- Personnel: 16
- Location: **Kokkola, Finland**
- Status: Growing fast **from pilot scale to industrial scale** (TRL 5-6)

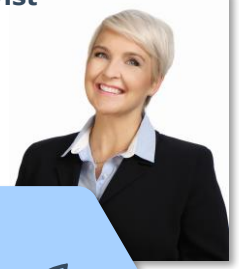
Jussi Kukkula
Project Manager

Henrik Romar
R&D Director

Natascha Skog
HR & Marketing Manager

Susanna Rönnqvist
CFO

Niina Grönqvist
Founder and Commercial Director



Plant project

- Management of the industrial scale pilot plant project

Technology

- Process development
- New product development
- Application know-how

HR & Marketing

- HR and education
- Marketing and communication

Finance

- Finance, financial admin
- Investments
- Business developm.
- Stakeholders

Commercial

- Business development of hydrogen and carbon products

Business model – sales of the output and ownership of plants via SPV(1

1) SPV – Special Purpose Vehicle

Stakeholders

Hycamite

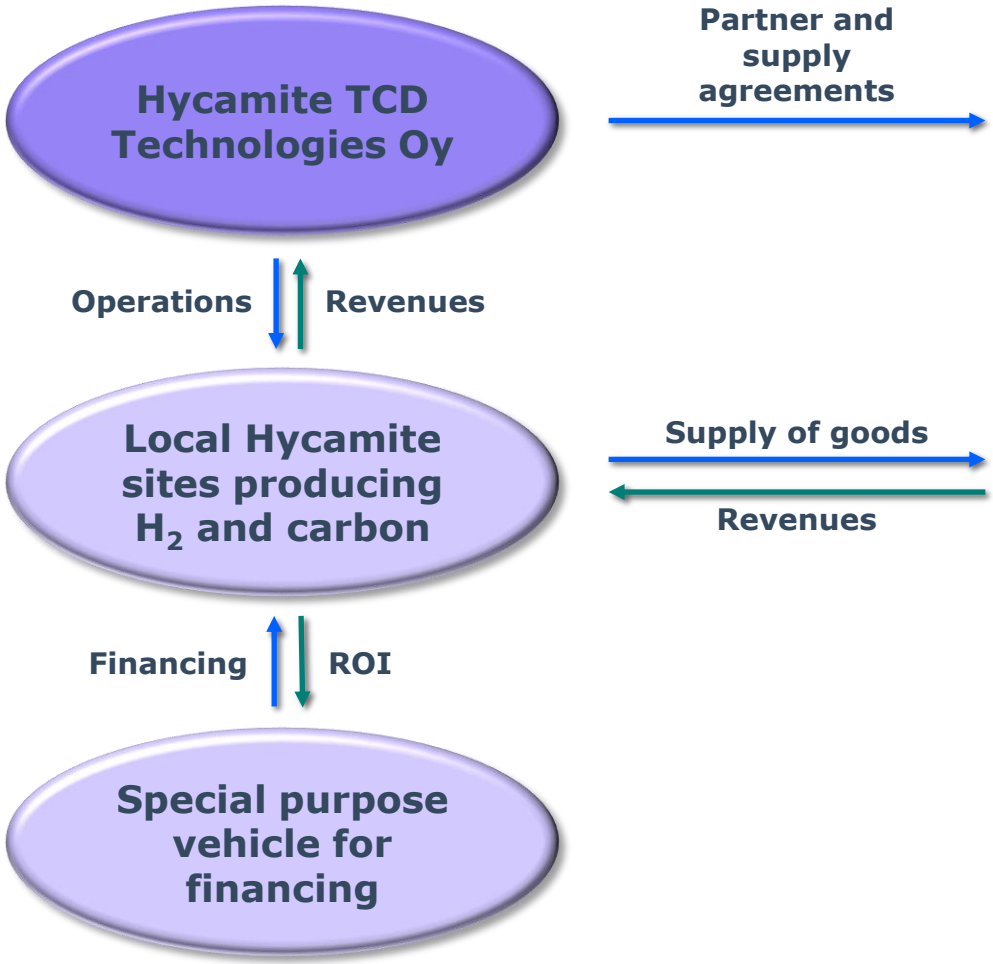
- IP / Tech know-how.
- Business development, cooperation agreements.
- Plant operations.

Hycamite production sites

- Sites close to local H_2 customers.
- Long supply agreements especially on the hydrogen.
- Operations from the Hycamite, maintenance and service locally.
- Financing through SPV's.

Special purpose vehicle

- Financing of the plants via asset investors.
- Fixed and safe returns.



Revenue streams, customers

High value-added carbon

- Strategic partners, special products.

Hydrogen

- Local, industrial customers that use the H_2 either as a fuel or as a raw material.
- Long supply agreements.

Commodity carbon

- Regional customers with long supply agreements.
- Carbon traders.

Carbon emissions trading

- Where possible.

Commercialising Top European Research

Roots of the technology at the University of Oulu

Catalyst development
- Reduces energy consumption of TCD process
- Enables special high quality carbon products

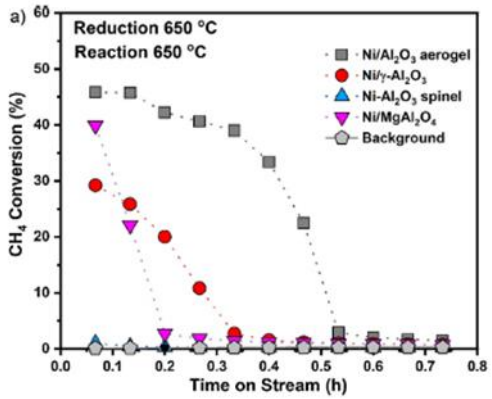
Expertise on carbon product applications
- Advantage compared to hydrogen competitors
- Enables unique position in the market

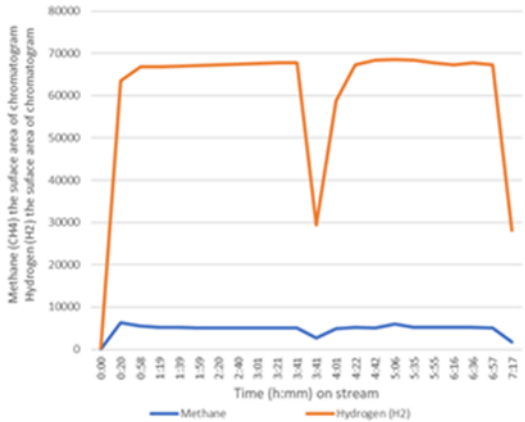
Process technology innovations
- Energy savings through heat exchange, product stream differentiation, catalyst regeneration, and several other innovations

Hycamite has full freedom of operation
- Preliminary patent landscape completed

UNIVERSITY OF OULU

Regarding Hycamite technology, following scientific publications have been published by our researchers:
- 42 Scientific publications
- 4 Dissertation defence (PhD)
- 5 Master of Science Thesis (Technology and Chemistry)
- 3 Bachelor of Science Thesis (Technology)





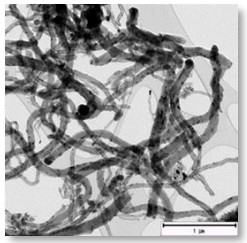
Left: Stability of standard catalysts. Right: stability of one of the Hycamite catalysts. Note, the drops indicate manual shutdowns, no catalyst was changed. The performance of the Hycamite's catalyst in this test remained practically unchanged after 7 hours of testing when the other catalysts loose their activity in minutes.

Sustainable Carbon as a secondary product supplementing the sales

PRODUCTS

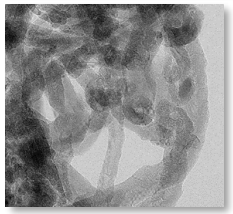
- Carbon nanotubes (CNT)
- Carbon nanofibers (CNF)
- Amorphous carbon → activated carbon
- Graphite

CNT, CNF



- Battery industry
- Electric vehicles (supercapacitors)
- Catalysts

Graphite



- Battery industry
- Lightweight materials for automotive and aerospace industry

Activated carbon

- Water treatment
- Pharmaceutical purification
- Industrial applications

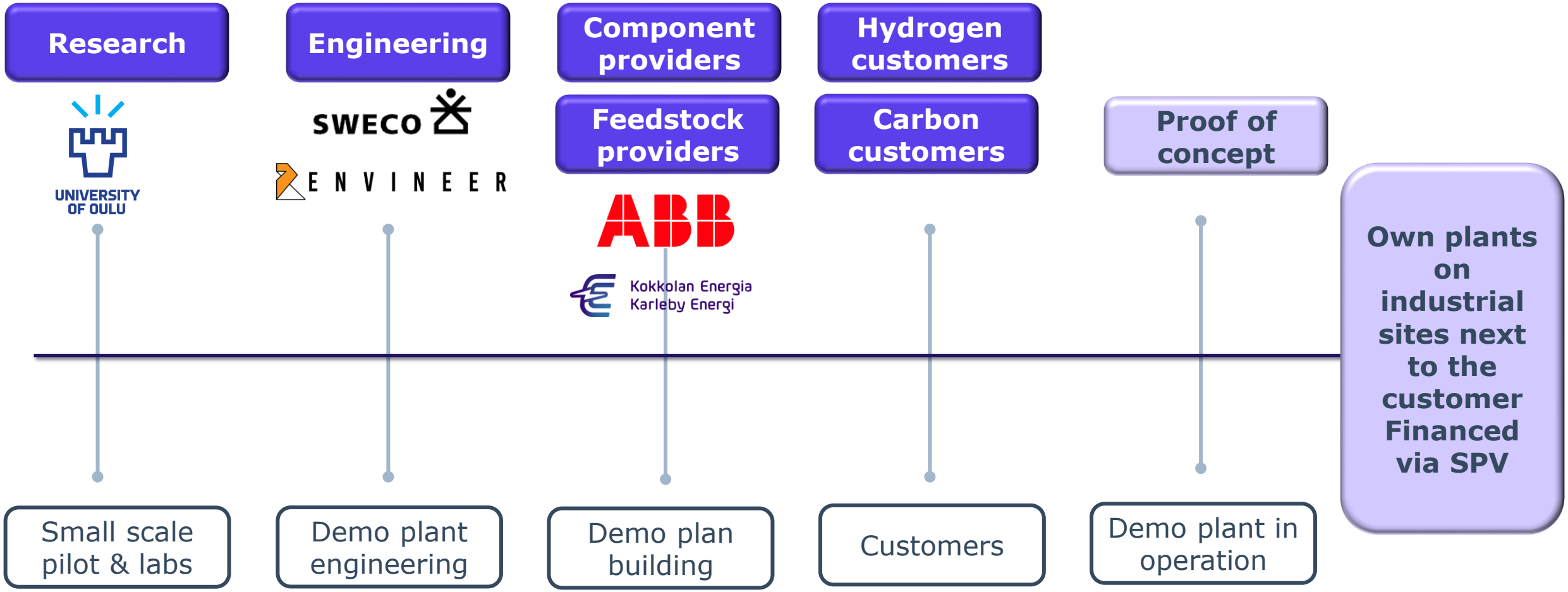
Comparison of different hydrogens

There are many ways to produce hydrogen. Here a quick third party overview.

	SMR[1] (Grey H_2)	SMR with CCS[2] (Blue H_2)	Electrolysis (Green H_2)	Hycamite TCD (Clean or Turquoise H_2)
Low or no CO_2	✗	✗ / ✓	✓	✓ / <0
No need for additional, massive power generation capacity and thus rapidly scalable	✓	✓	✗	✓
Possibility to load-following production and thus no or only a small need for storage facilities	✗ / ✓	✗ / ✓	✗	✓
No need of rare earth metals in the production units	✓	✓	✗	✓
Additional revenue from carbon sales	✗	✗	✗	✓
Estimated costs EUR per kg H_2	1.47 – 3.90	1.91	2.37	0.91

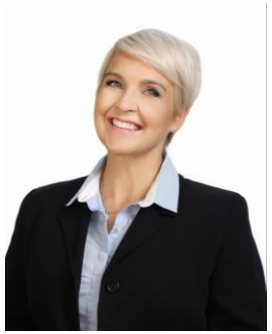
1) SMR – Steam Methane Reforming
2) CCS – Carbon Capture and Storage

Business development – Scaling up requires partners



Contact us – It is time to act NOW!

- Ms. Laura Rahikka, CEO
  - laura.rahikka@hycamite.com



- Ms. Niina Grönqvist, Commercial Director
  - niina.gronqvist@hycamite.com

- Mr. Matti Malkamäki, Chairman
  - matti.malkamaki@hycamite.com

European Clean Hydrogen Alliance

BotH$_2$nia

KasvuOpen®

Cleantech Scandinavia

H2cluster FINLAND

CHEMICAL ENGINEERING
ESSENTIALS FOR THE CPI PROFESSIONAL

PILOTING A PROCESS THAT MAKES HYDROGEN AND CARBON FROM METHANE

By Gerald Ondrey | August 1, 2021

Hycamite preparing for large-scale hydrogen production with new Finnish test facility

gasworld

New test facility to rese hydrogen production ir

Finnish clean hydrogen and pure carbon technology produc launched a test facility which will conduct research into tec dioxide (CO2)-free hydrogen from natural gas.

Suomeen kaavaillaan laajaa vetyputkistoa, joka yhdistäisi teollisuuden keskittymät Ruotsiin, Viroon ja Keski-Eurooppaan

Kerromme tässä jutusta, mistä vetyputkihankkeessa on kysymys. Tuulivoimalla voisi saada vetyä myös vientiin.

Uutinen

Kokkolaan nousee vedyntuotannon pilottilaitos

aa tehdastuotannossa uutta steknologiaansa.

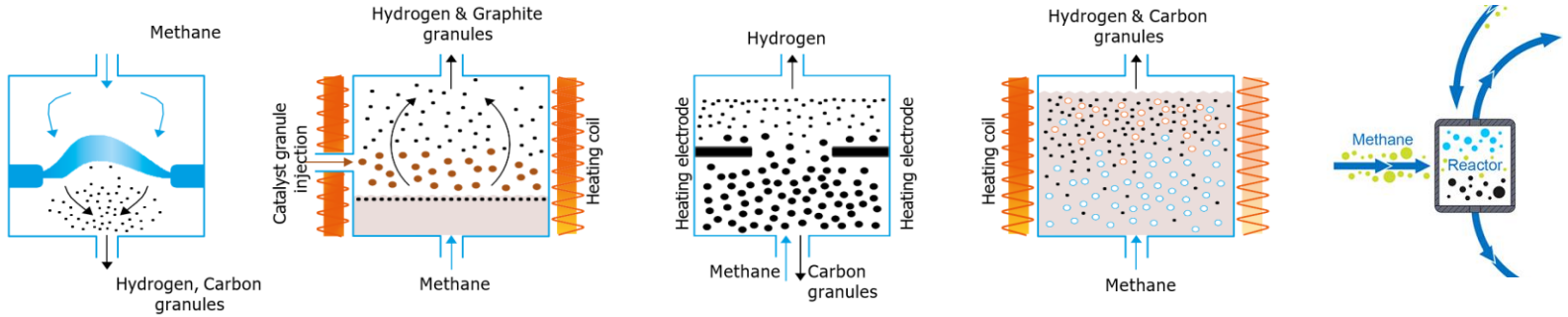
Hycamite TCD Technologies valmistelee teollisen pilottilaitoksen rakentamista vedyntuotantoa varten. Pilottilaitoksessa Hycamite testaa tehdastuotannossa uutta vedynvalmistusteknologiaansa.

Hycamite on varannut uudelle laitokselle alueen Kokkolan suurteollisuusalueelta eli Kokkola Industrial Parkista (KIP), joka on Pohjois-Euroopan suurin epäorgaanisen kemianteollisuuden keskittymä.

Thank you!

Methane pyrolysis (cracking/splitting) for turquoise hydrogen production

Third party based comparison on different turquoise (clean) hydrogens



	Plasma Pyrolysis	Fluidised Bed	Moving Carbon Bed	Molten Metal or Molten Salt	Hycamite
Process shown	Monolith Materials	Hazer	BASF	TNO or C-Zero	Hycamite TCD Technologies
Hydrogen content at reactor outlet	~ 95%	~ 92%	~ 92%	Up to 95%	~ 92%
Carbon production	Carbon black as powder or granules	80 – 95% graphite encapsulating catalyst dust particles	Carbon black as powder or granules	Carbon black as powder or granules	• Graphene, nanotubes, nanofibers • Graphite like carbon
Catalyst required	No	Iron oxide granules	Carbon bed	• Molten 27% Nickel - 73% Bismuth • Molten Manganese Chloride	Own development
Heating mechanism	Direct heating with plasma	Indirect heat applied around the reactor	Electrodes to heat the carbon bed and indirect heat applied around the reactor	Indirect heat applied around the reactor or electrodes to heat the melt in a separate vessel	Indirect heat + own heat management
Reactor temperature	2 000 °C	900 °C	1 000 to 1 400 °C	Depends on melt, 650 to 1 100 °C	Depends on desired carbon, 600 to 800 °C
Reactor pressure	Close to atmospheric pressure	Close to atmospheric pressure	Close to atmospheric pressure	Up to 5 bar	Close to atmospheric pressure
Major disadvantages	Energy inefficient, produces only carbon black	Produced carbon difficult to separate from porous iron catalyst	Reactor clogging not solved, produces only carbon black	Produced carbon difficult to separate from catalyst, produces only carbon black	

Partially courtesy of sbh4 consulting GmbH.

Demand for sustainable carbon

Drivers

- Environmental **regulation** pushing non-ecological production methods.
- Companies eager to **decrease** their **carbon footprint**.
- Willingness for self-sufficiency and shorter logistics chains create demand for carbon production in Europe for crucial industries such as battery industry, electronics, solar and wind power construction.

Prices and market sizes

Product	Market price [€/tn]	Market size [kt] Current → 2030	Market size [USD] Current → 2030
Graphite	500 – 1 600[i]	2 892 (current) [iii]	16.13 bn → 31.55 bn[i]
Graphene	150 000[iv]	1 → 12[iv]	60 M → 620 M[iv]
Carbon nanotubes (SWCNT)	2 000 000[iv](est.)	0.005 – 0.26[iv]	0.1 – 5.2 bn[iv]
Activated carbon	1400 - 2300	2700 – 3900[v]	2.8 bn – 4 bn
Carbon black	1 500 – 2100[i](av.) 30 000 (special grade)	14 000 – 18 000[ii] (est.2025)	18.5 bn → 24 bn[i]

Hycamite Advantages

- Hycamite offers an alternative to imported carbon products. We deduct or even remove the dependency of the overseas providers with a local, yet sustainable and clean product.
- Hycamite focuses now on the carbon use in electronical appliances, such as batteries. The need for batteries is growing and we have the access to test our products directly with the UniOulu laboratories that are well-known and renowned R&D partner within the industry.
- Global increase of steel production due to growing urbanization and rising demand for graphite for production of lightweight aircraft materials are expected to augment the graphite market outlook.
- In addition, Hycamite develops high-value-added carbon allotropes such as carbon nanotubes and carbon nanofibers, which have huge potential in demanding applications.

NB. Prices are average prices/ranges of different qualities, thus the market size seem not to be equal to the market price and size.
[i]Frost&Sullivan, [ii]Expert Market Research, [iii]Mordor Intelligence, [iv]IdTechEx, [v]prnewswire

Miten - Innovaatio

- Katalyytti
- Katalyyttiperhe, kuinka katalyytti toimii yleisellä tasolla
  - Tuotetaan energiatehokkaasti vetyä ja haluttua hiiltä