

The VTT logo consists of the letters 'VTT' in a bold, white, sans-serif font, centered within a solid orange square. The background of the slide features a repeating pattern of stylized, interlocking shapes in orange, blue, white, and black, creating a sense of movement and depth.

VTT

Hydrogen and P2X in Finland and opportunities for co-operation

Research Professor Juha Lehtonen
Jari Ihonen, Kirsikka Kiviranta

04/12/2023 VTT – beyond the obvious

VTT – *beyond the obvious*

VTT is a visionary research, development and innovation partner for companies and the society.

We bring together people, business, science and technology to solve the biggest challenges of our time. This is how we create sustainable growth, jobs and wellbeing and bring exponential hope.

244 M€

turnover and other
operating income

2,129

employees

45%

of the net turnover
from abroad

32.5%

a doctorate or a
licentiate's degree

Established in

1942

Owned by Ministry
of Economic Affairs
and Employment

VTT Key Competences – CCU, Power to X and Green Hydrogen



Cutting-edge professionals

- 50 persons in hydrogen (production, storage and fuel cells)
- 30 persons in catalysis & synthesis for e-fuels & e-chemicals
- 30 persons in fuel testing and emissions
- 20 persons in concept development & TEA



Diverse research infrastructure

- E-fuels & chemicals pilot (Mobile Synthesis Unit)
- Catalyst laboratories & laboratory scale catalytic reactors
- Engine lab for fuel and engine test
- Fuel cells and electrolyzers



Established networks

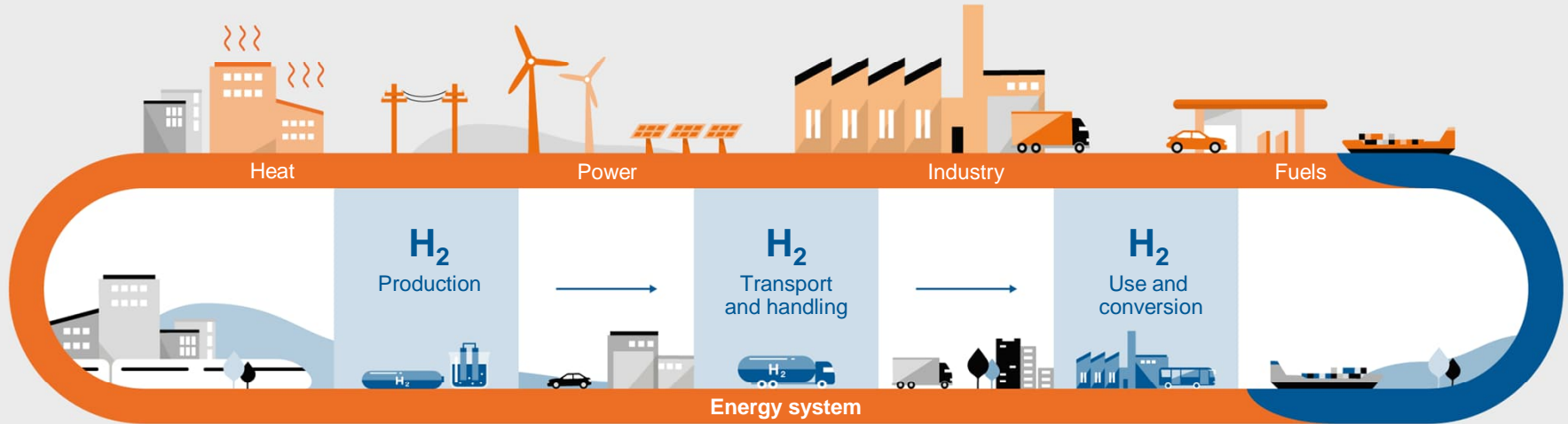
- Business Finland, ministries and EU as public sector networks
- Leading industry companies and NGOs as private sector partners
- Universities and research organizations as R&D partners



Broad IPR portfolio

- Hydrogen
 - 8 patents on electrolysis and fuel cells
- Synthesis of fuels, chemicals and polymers
 - ~ 20 patents on gas cleaning, catalysts, C1 reactions, P2X and CCU

Hydrogen value chain



SOEC technology
development

Electrolyser and
fuel cell systems design,
manufacturing and operation

Hydrogen quality
and safety

Hydrogen and power
to x systems

Hydrogen fuelling
stations and heavy
duty vehicles

VTT Bioruukki will have one of the leading clean energy transition experimental research facilities in Europe

Clean energy pilot platform in VTT Bioruukki will be built in 2022-2025.

End-to-end research facilities for carbon neutrality in transport and industries.

Innovation platform for new solutions for hydrogen, electrification and renewable fuels to be completed 2025



Hydrogen in Finland

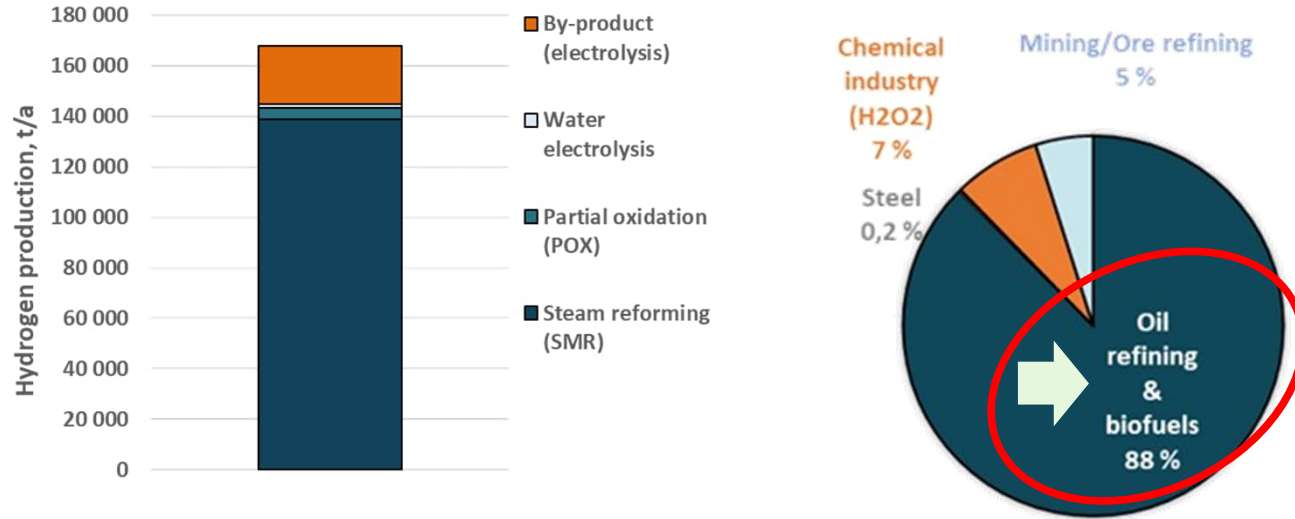
Hydrogen SWOT for Finland

STRENGTHS Good (onshore & offshore) wind resources Strong transmission grid Stable, predictable regulation Industrial hydrogen experience	WEAKNESSES Higher electricity market price vs. Sweden/Norway Less hydrogen experience outside of industry No hydrogen use in traffic No formations for salt caverns
OPPORTUNITIES Production of renewable transportation fuels Cost-efficient decarbonisation of existing hydrogen use CO2-free steel production Lower logistics cost for industry	THREATS Unfavourful changes and/or interpretations of RED II directive Price of technology remains high Low fossil fuel and CO2 allowance prices Delayed scale-up of electrolyser manufacturing capacity

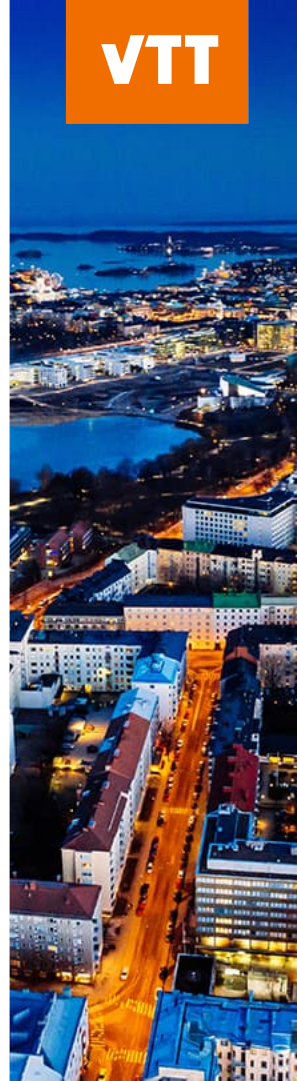
Road map summary and conclusions

- Finland has already a fairly well-populated value chain for hydrogen production and use
- Strong grid and good potential for new renewable electricity generation
- Strong high-tech industry in hydrogen tech
- Identified, potential large-scale targets for new hydrogen use
- Good potential to accelerate RD&D efforts, but also some other cases suitable for public support
- Streamlining of RD&D funding process is needed
- Enlarging hydrogen-related domestic market is necessary

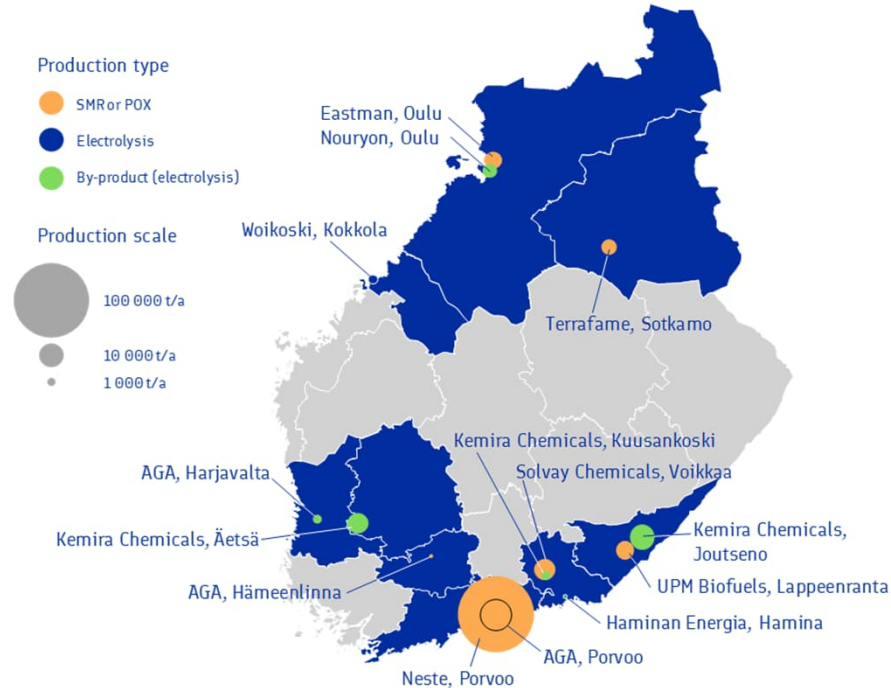
HYDROGEN FINLAND – CURRENT PRODUCTION AND USE



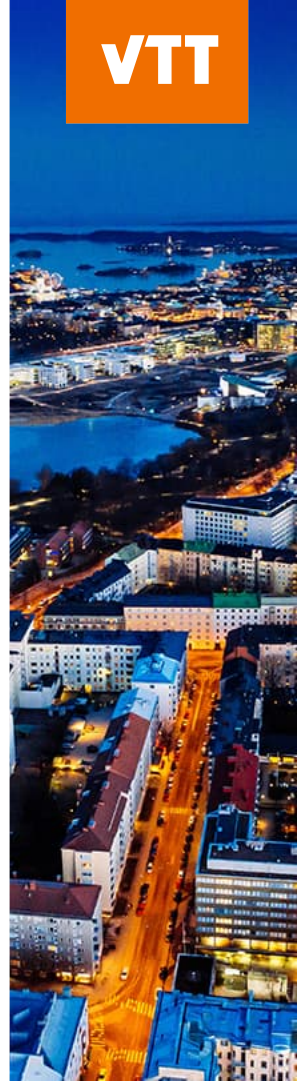
CURRENT PRODUCTION AND USE CA. 150 000 t/a



HYDROGEN FINLAND – CURRENT PRODUCTION AND USE



CURRENT PRODUCTION AND USE CA. 150 000 t/a

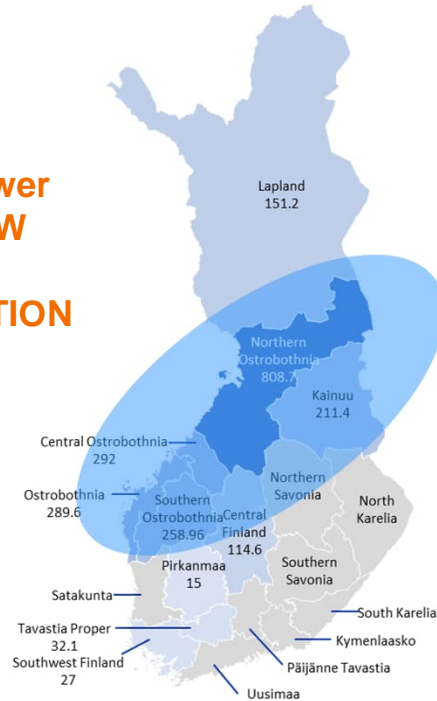


NEW WIND POWER GENERATION IN FINLAND

New Wind Power Capacity in MW

IN CONSTRUCTION OR ON-LINE

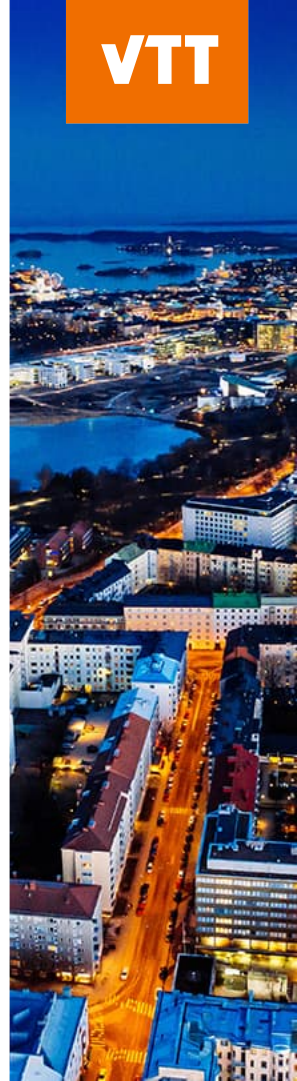
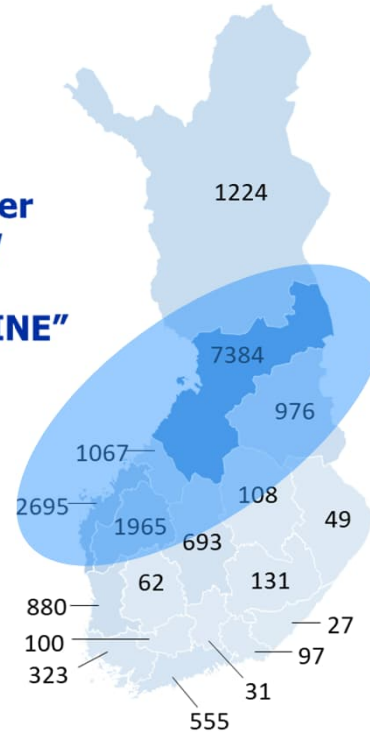
2019-2023



New Wind Power Capacity in MW

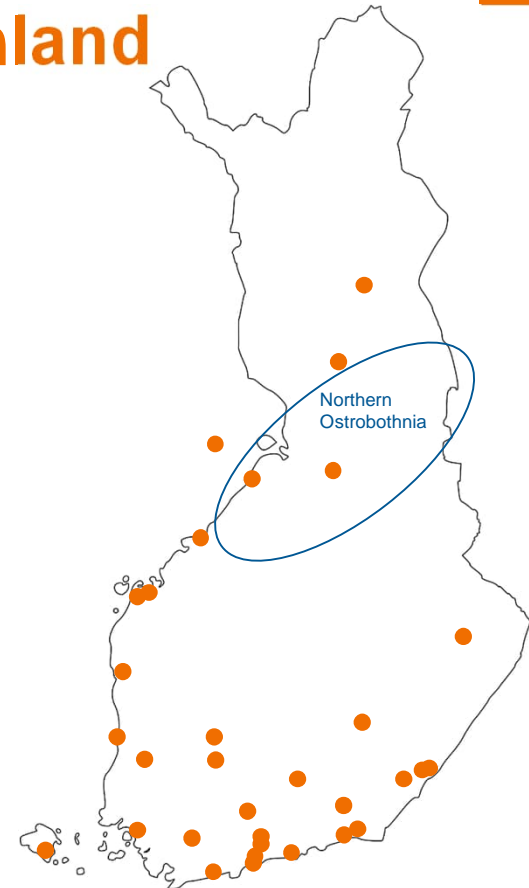
IN THE "PIPELINE"

	GW
Onshore	15.8
Offshore	2.7
in Total	18.5



Hydrogen-related projects in Finland

- Most of the hydrogen-related projects and investments in Finland are related to green hydrogen production with electrolyzers
 - Total of 760 MW electrolyzer capacity based on public sources
- 47 hydrogen-related projects at different stages were identified in Finland



[Pre-study on transition to hydrogen economy, specifically in Northern Ostrobothnia \(vtt.fi\)](#)

Industry

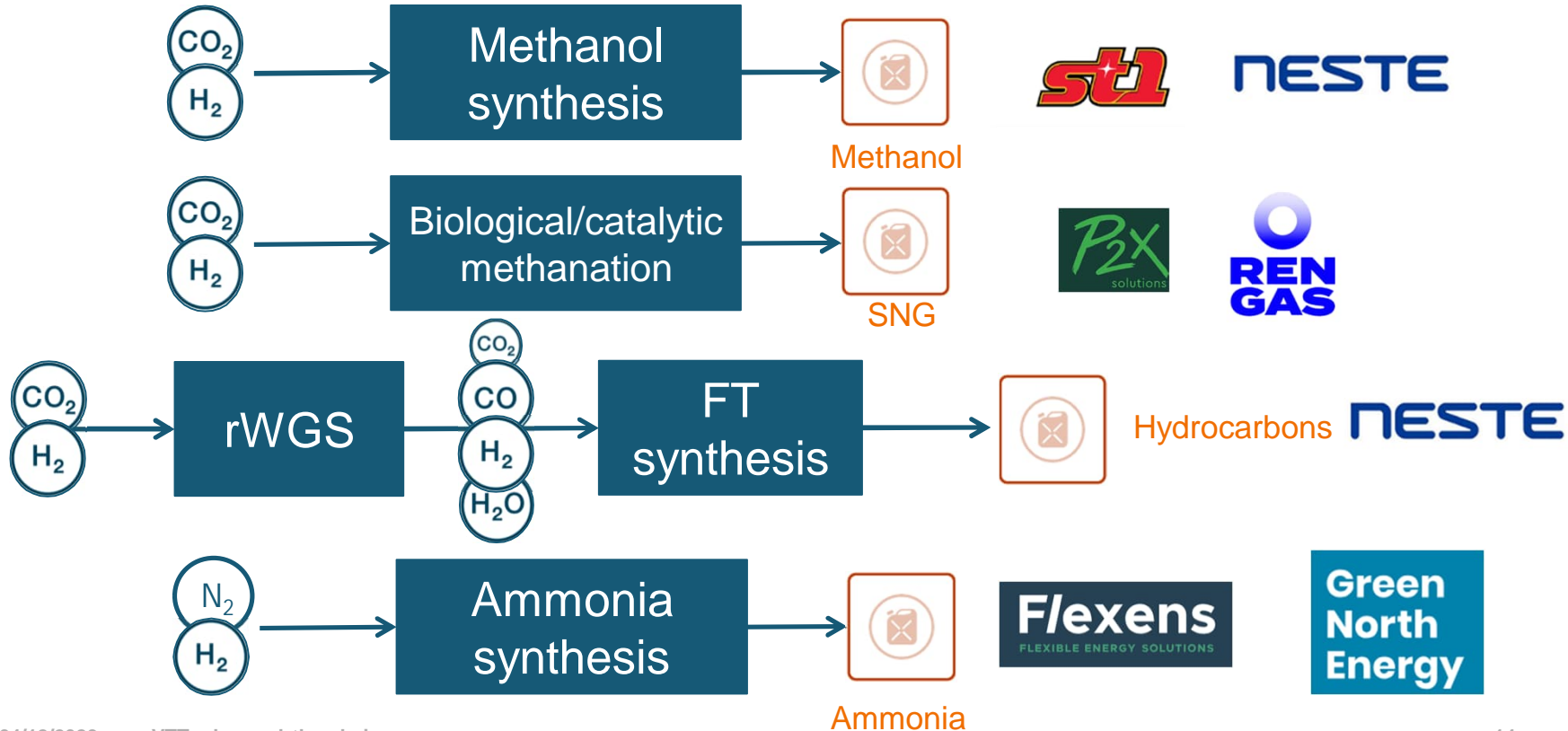
Transport

Heating

**H2 is not a
necessity for
Finland, but a
huge opportunity**

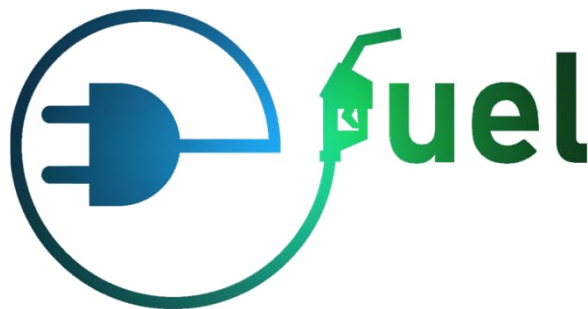
Power-to-X in Finland

Main P2X pathways and some actors in Finland



Example: E-fuel demostration project

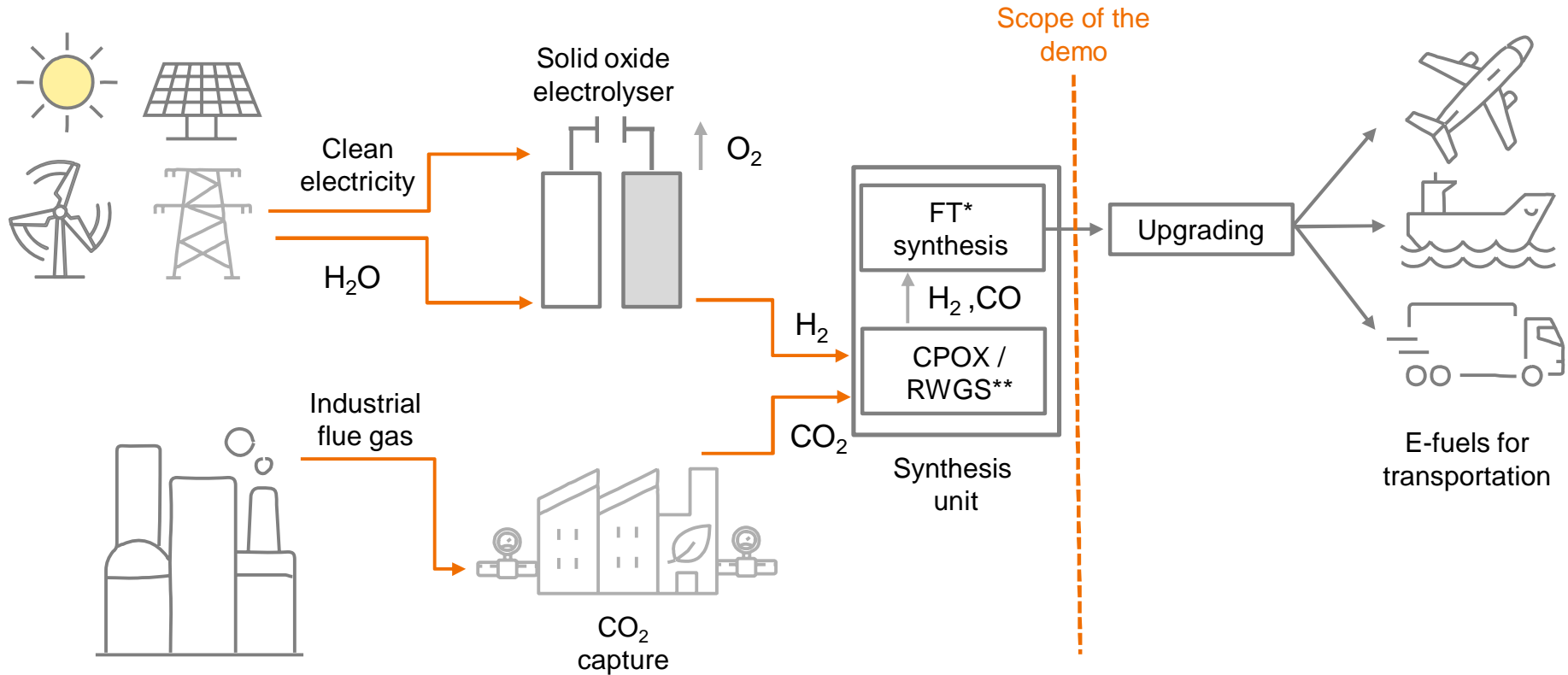
Basics and some numbers



- Business Finland's co-innovation project
- 14 partner companies, VTT as research organisation
- Duration 3 years (1.1.2021-31.12.2023)
- VTT's budget 3.3 M€, total budget ~ 7 M€
- In addition to VTT, Neste's project for demonstration at Bioruukki
Convion & Elcogen projects for SOE development and Andritz
project for CO₂ capture development



E-fuel Power-to-X concept

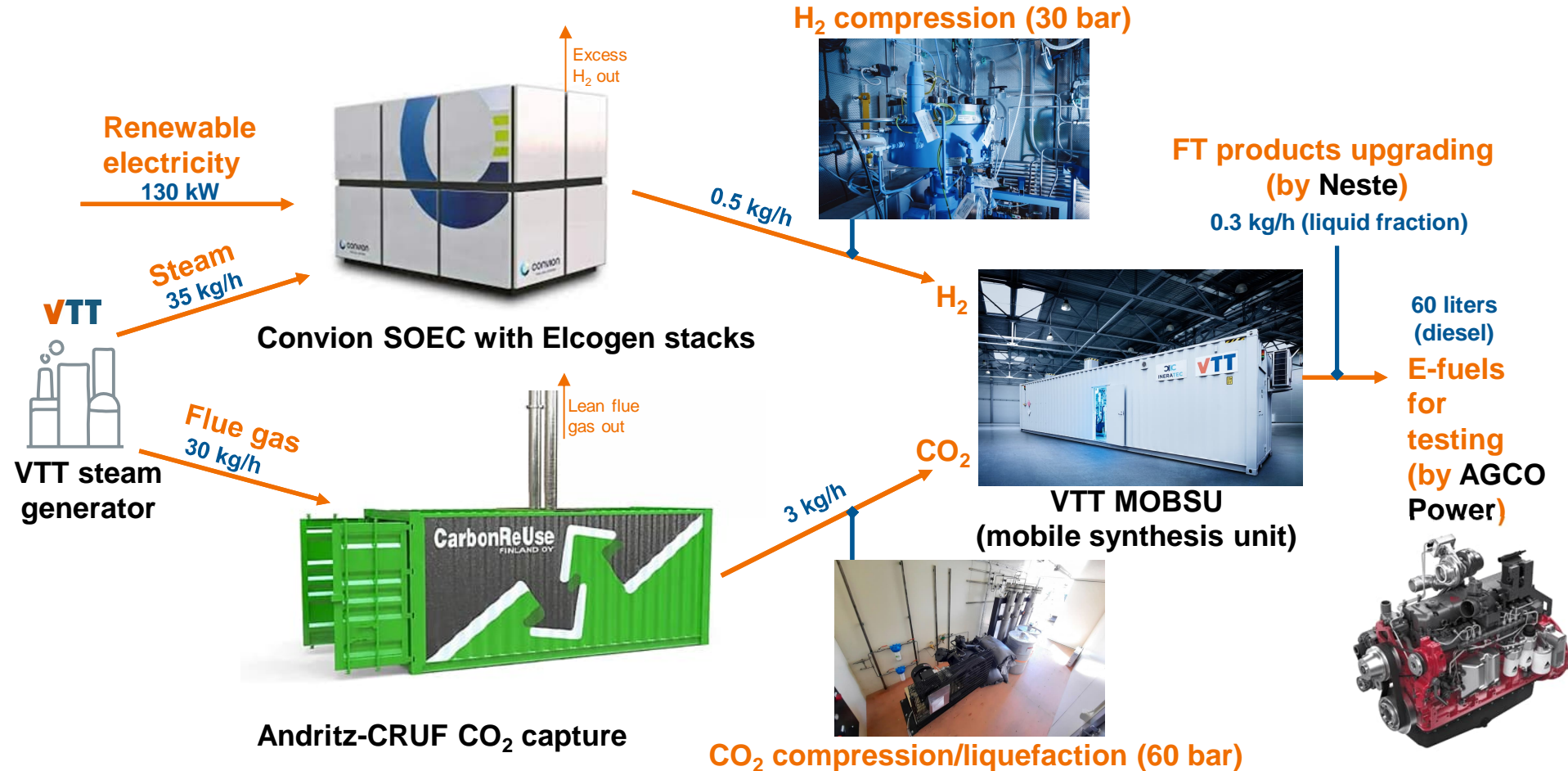


E-fuel production demonstration

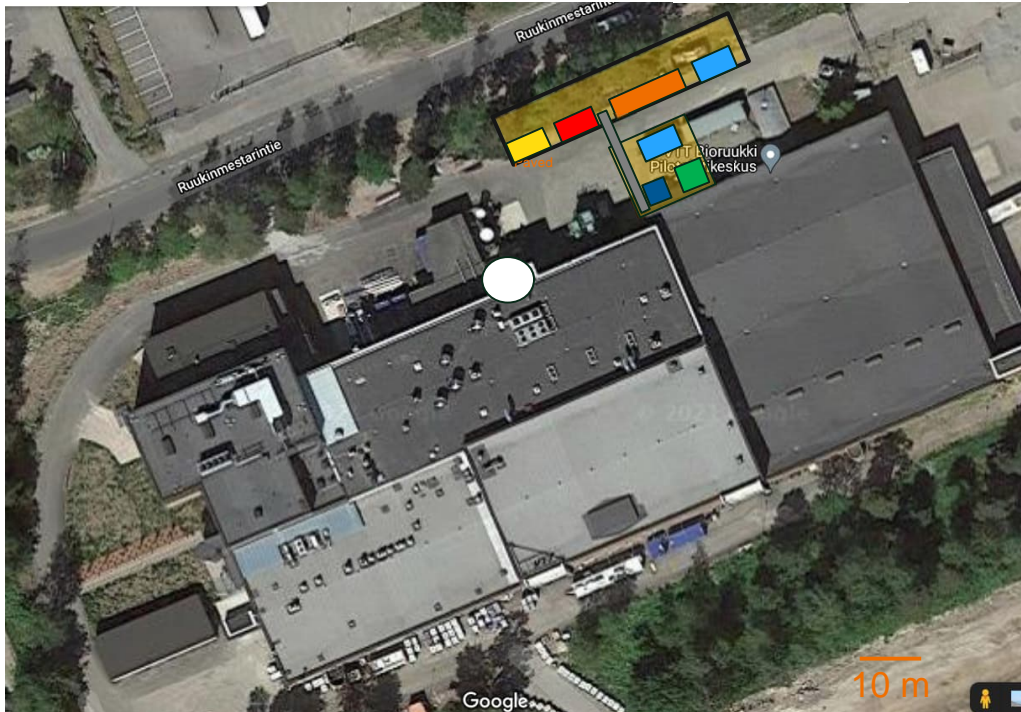
- **Objective:** Power-to-X demonstrator of integrated E-fuel concept at industrially relevant site
 - Target production of 300 kg FT crude and 1000 h operation time
- **Timeline:** Spring/Summer 2023
- **Location:** VTT Bioruukki



E-fuel demonstration – Integration of 6 units



Bioruukki demo site



Container modules:

- MOBSU
- ELECTROLYSIS
- H₂ COMPRESSION
- GAS CONTAINER
- CO₂ SEPARATION
- CO₂ COMPRESSION
- STEAM/FLUE GAS

Production of e-diesel

- Product upgrading and e-diesel testing
 - 300 kg hydrocarbons delivered to Neste for upgrading
 - 60 l e-diesel produced returned back to VTT early November
 - Produced e-diesel tested in a tractor powered by AGCO power diesel engine
 - Emissions measured



E-fuel usability: field test

Tractor. location

- Valtra T235D
- AGCO Power, Linnavuori, Nokia

Four fuels

- EN590 diesel, HVO (Neste My), e-Diesel, EN590 diesel/e-diesel blend

Emission types

- Gaseous emissions
- Black carbon (soot)
- Non-volatile particles (PN23)

Tests

- Dynamometer
- Real driving



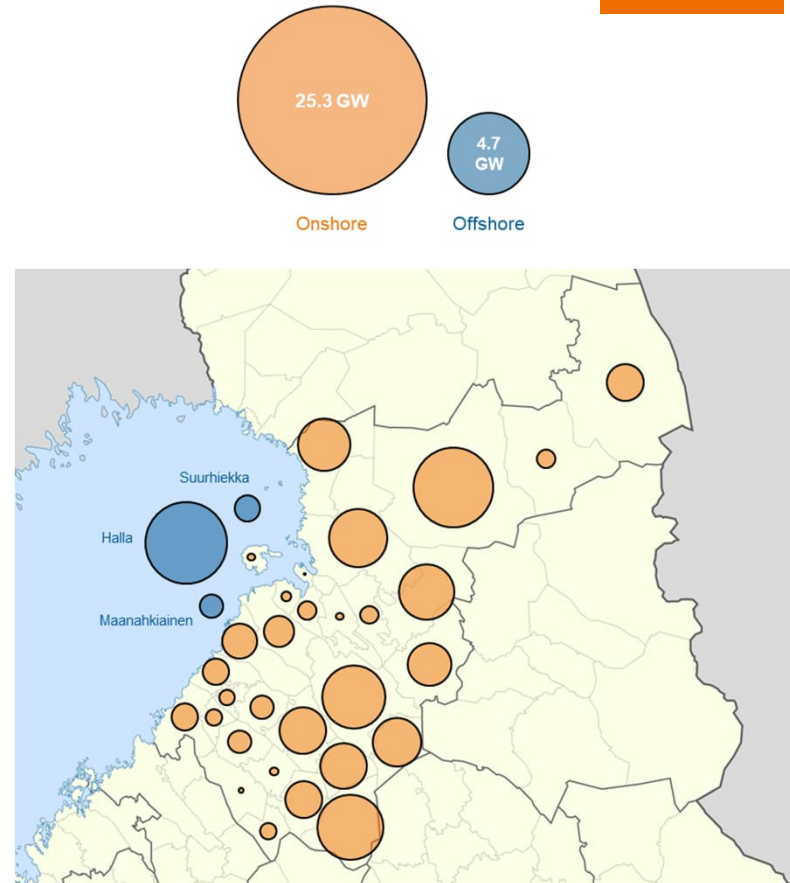
Portable measurement system for heavy-duty applications' field testing.

Collaboration opportunities

Wind power in Northern Ostrobothnia

- Suitable conditions for wind power in the region and a lot of ongoing wind power projects
- Current wind power capacity in Northern Ostrobothnia is app. **2.3 GW** and under construction is app. **0.8 GW**
 - Current wind power capacity in Finland is **~5.7 GW**
- The maximum capacity of the planned wind power projects in different stages in the region **by 2030** is **30 GW**
 - The maximum capacity of 30 GW assumes, that all planned projects reported by the Finnish Wind Power Association are completed on their maximum capacity
 - Public plans do not cover the timeframe from 2040 and beyond

[Pre-study on transition to hydrogen economy, specifically in Northern Ostrobothnia \(vtt.fi\)](#)



Some planned hydrogen infrastructure

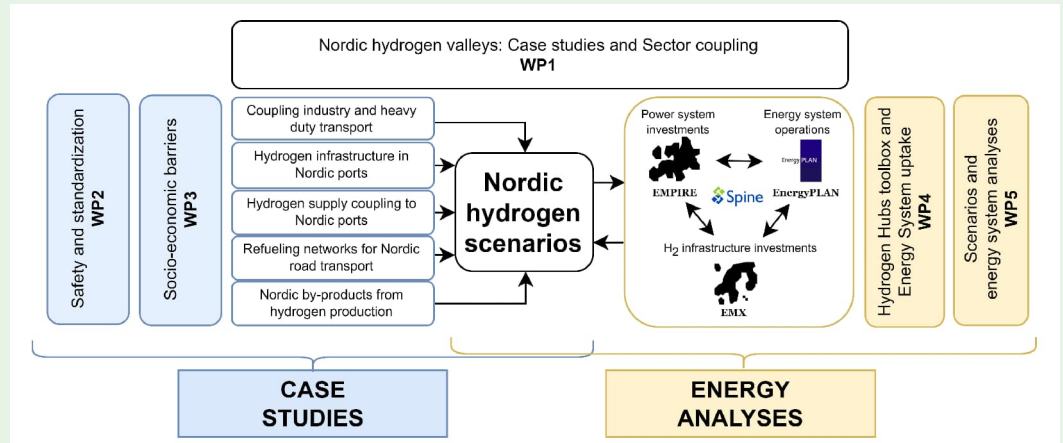
- Gasgrid Finland has several on-going projects related to national and cross-border hydrogen transmission, also in Northern Ostrobothnia
- **Nordic Hydrogen Route**, cross-border hydrogen pipeline network around Bothnia Bay estimated to be in operation by 2030
- The long-term vision to link the pipeline to a wider European hydrogen infrastructure
 - **E.g. Baltic Sea Hydrogen Collector**
- The pipelines would enable to connect Northern Ostrobothnia to the Baltic Sea region

[Pre-study on transition to hydrogen economy, specifically in Northern Ostrobothnia \(vtt.fi\)](#)





Nordic H₂ubs



- Full name: Nordic Hydrogen Hubs - Roadmaps towards 2030 and 2040
- <https://nordich2ubs.com/>
- Duration: August 1st 2023 to August 31st 2026
- The project will:
 - Connect the Nordic countries
 - Cover multiple markets and sectors
 - Find synergies between both countries and sectors

Summary

Summary

- Green hydrogen has a high potential in Finland, especially in Gulf of Bothnia and Northern Ostrobothnia region
 - Green hydrogen and P2X strong areas for VTT and many universities (e.g. Aalto University, LUT University, Univ. of Oulu)
- However, significant investments for green electricity are needed for the production of targeted volumes of green hydrogen
- Hydrogen can be utilized for the production fuels, chemicals and materials through Power-to-X in Finland
- There are many collaboration opportunities on green hydrogen and P2X between Finland and Sweden
 - Research
 - Join infrastructure

beyond the obvious

Juha Lehtonen
Juha.Lehtonen@vtt.fi
+358 50 407 1075

@VTTFinland
@your_account

www.vtt.fi