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The Haeolus project in Berlevåg

26 October 2022

Hydrogen production in the Arctic

Outline

The Haeolus Project

Hydrogen Valleys 101

Opportunities in Finnmark

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Opportunities in Finnmark

Raggovidda Wind Park

Berlevåg municipality, **Varanger** peninsula, **Troms & Finnmark** county

- The Raggovidda wind park:
  - 45 MW built of 200 MW concession
  - Neighbour Hamnafjell: 50 MW / 120 MW
  - Bottleneck to main grid is 95 MW
  - Total Varanger resources about 2000 MW

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  - Total Varanger resources about 2000 MW
- Capacity factor 50 %
- Local consumption max. 60 MW
- Local economy based on fishing
- Partner operator of park & grid: VARANGER KRAFT

The Haeolus Project

2018–2023

- EU project, budget 7.6 M€
- Electrolyser beside Berlevåg harbour
- Capacity: 2.5 MW or 1 t/d @ 30 bar
- Production started in June 2021
- New 10 km power line from Raggovidda
- Virtually “inside the fence”
- Accessibility by road or sea
- Partner electrolyser manufacturer:

H2AEOLUS

Co-funded by the European Union

Clean Hydrogen Partnership

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Opportunities in Finnmark

How to Start a Hydrogen Valley

Hydrogen producers want:

- to sell hydrogen regularly
- to have a reliable income
- not to go broke in the “Valley of Death”

Hydrogen users want:

- to be sure hydrogen will stay available
- a reliable supply chain
- a predictable hydrogen cost
- readily available maintenance

How to Start a Hydrogen Valley

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Not a chicken-and-egg problem!

- We *must* start with infrastructure
- How do we make it viable?
  - Identify key niche or one big customer
- Involve the authorities
  - Guarantee buybacks of fuel or vehicle if other is missing

Outline

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Hydrogen Valleys 101

Opportunities in Finnmark

Liholmen Biogas Plant

- Newly opened in “neighbouring” Båtsfjord
  - Produce biogas, burn in turbine, sell power
- Methanation of biogas (CH_4+CO_2)
  - $CO_2 + 4\,H_2 \longrightarrow CH_4 + 2\,H_2O$
  - Biomethane more valuable as marine fuel
- Potential regular customer
  - Steady need for hydrogen
  - Long-term agreement possible
- Båtsfjord biogas plant
  - Right distance (90 km)
  - Right size (80 t/year)

Liholmen Biogass plant in Båtsfjord

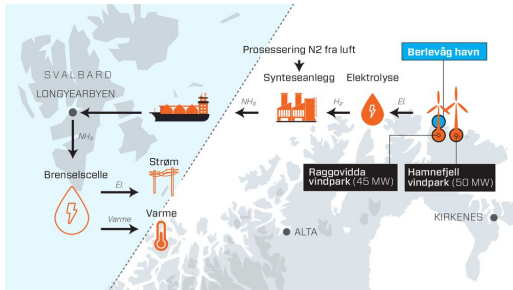
Fishing Boats

- Main activity in region is fishing
- Battery-driven boats already operate
  - *Karoline*, *Angelsen Senior*
  - Diesel remains for propulsion
  - Battery-only on fishing field
- Hydrogen can remove *all* emissions
- Several Berlevåg fishermen interested
- FHF-sponsored SINTEF report (2021:00632)
- Quota system hampers zero-emission propulsion

Design of a zero-emission coastal fishing boat

Ammonia Production

- “Grand plan” of Varanger Kraft
- *Green ammonia* from electrolysed hydrogen
- Extension to over 100 000 tons NH_3
- Electrolyser capacity 40–50 times HAEOLUS
- Key markets:
  - Shipping industry (ZEEDS groups: Aker Solutions, Wärtsilä, Equinor, . . .)
  - Export to Svalbard and similar communities



Conclusions

- Haeolus is a major step, but only a first step
- Potential for hydrogen production in Finnmark is enormous
- Many opportunities are also emerging on the demand side
- Introducing the “hydrogen economy” is a coordination problem

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Thank you for your attention!

H_2AEOLUS

Hydrogen-**A**eolic **E**nergy with **O**ptimised e**L**ectrolysers **U**pstream of **S**ubstation

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Clean Hydrogen Partnership

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Fast Passenger Ferries

- Several shipyards have expressed interest
- Significant activity in other regions in Norway
- Kirkenes–Vadsø a possible case
  - Currently: 15 min plane or 2 hour drive
  - 40 km over the Varangerfjord
- 4 Norwegian counties will place order after Easter
- Earliest operation in 2024

Brødrene Aa's H_2 Aero 42 concept

Coastal Express

- The Coastal Express already stops in Berlevåg
  - Electrolyser is right by the dock
  - Visible application for tourists
- New competitor *Havila* seeks green profile
- 4 new ships (two operational)
- New ships should be “fuel-cell ready”
- Retrofit planned for 2023 with 2.3 MW fuel cells
- Autonomy of 20 hours
- Storage based on liquid hydrogen

Cars

- 1 t/d in enough for 3000 cars, not realistic but…
- Lighthouse effect (“world’s northernmost H_2 station”)
- Finnmark has fewest electric cars in Norway
- Users: local municipalities, Varanger Kraft, taxis…
- Hydrogen cars can drive & return anywhere in East Finnmark from Berlevåg
- All mayors in Varanger want hydrogen stations!

Snowmobiles

- Great lighthouse potential
- Prototype developed in Austria
- Interest from Nordkapp municipality
- Zero-emission day trips for North Cape tourists
- Also relevant for Varanger Kraft to access Raggovidda

The Rotax HySnow prototype

Hydrogen Planes

- Batteries are and will remain inadequate for commercial planes
- Airbus announced grand hydrogen strategy
- Large STOLport network in Northern Norway
- “Milk route” between Tromsø and Kirkenes
- No replacement for current Dash 8 after 2030
- High-activity area (Airbus, Schiphol, ZeroAvia…)

Energy Supply to Svalbard

- 2100 inhabitants in Longyearbyen
- Old coal power plant, planned to be shut down
- LNG would be cheapest, but zero emission has support
  - Politicians, organisations and companies (Statkraft, NEL)
- Hydrogen import or NH_3 as energy carrier?
- µCHP is an off-the-shelf technology
- Gradual introduction of hydrogen into the energy system