FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

HAEOLUS

Hydrogen-Aeolic Energy with Optimised eLectrolysers Upstream of Substation

H2AEOLUS

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Programme Review Days 2019

Brussels, 19-20 November 2019

PROJECT OVERVIEW

- **Call year:** 2017
- **Call topic:** FCH-02-4-2017, Highly flexible electrolysers balancing the energy output inside the fence of a wind park
- **Project dates:** 1 January 2018 – 31 December 2021
- **% stage of implementation 01/11/2019:** 33%
- **Total project budget:** 7 613 404 €
- **FCH JU max. contribution:** 4 997 738 €
- **Other financial contribution:** 0 €
- **Partners:** SINTEF, UBFC, Hydrogenics, Tecnalia, UniSannio, Varanger Kraft, KES

PROJECT SUMMARY

- HAEOLUS: *Hydrogen-Aeolic Energy with Optimised eLectrolysers Upstream of Substation*
- Objectives:
  - Enable more wind power in energy grids
  - Test multiple use cases for hydrogen-wind plants
  - Demonstration of 2.5 MW PEM electrolyser, remotely operated
- Haeolus' target: isolated wind resources with weak or no grid (also at sea)
- Comparable projects:
  - HyChico (Argentina), about ¼ capacity of Haeolus, H_2 mixed with NG used in gensets
  - StratosFuel (USA), distribution network of H_2 from "wind farmers"
  - HyBalance (EU), ½ capacity of Haeolus, focus on grid balancing

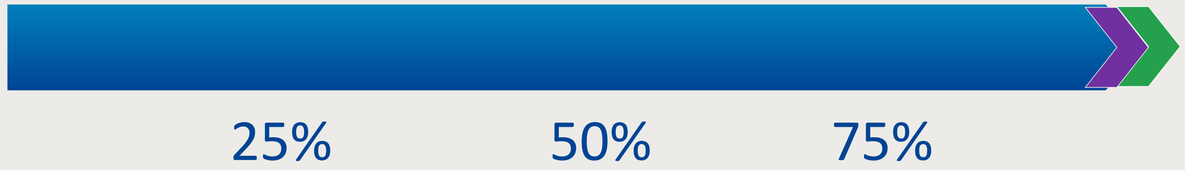
PROJECT SUMMARY

- Raggovidda wind park (45 MW built out of 200 MW)
- Bottleneck to reach main grid
- Low local consumption
- Hydrogen as solution to export energy
  - Total potential is 2 GW (400 t/d of hydrogen)
- Location in Berlevåg Harbour
  - Still virtually *inside the fence* with dedicated power line
  - Access to road and sea for export
- Start-up next year (April/May)

PROJECT PROGRESS/ACTIONS – Electrolyser Efficiency & Cost

Achievement to date

55 kWh/kg
3,7 M€/(t/d)



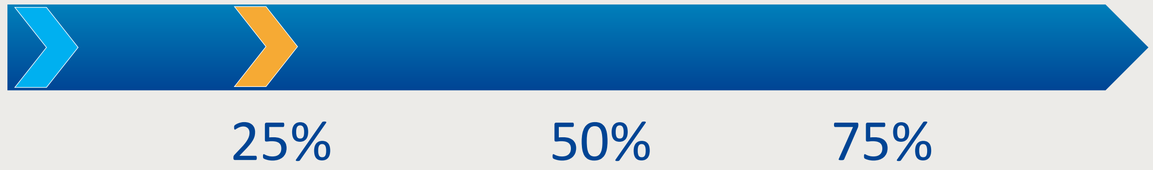
52 kWh/kg
3 M€/(t/d)

- Efficiency targets already met by Hydrogenics' latest stack
  - 52 kWh/kg is the MAWP 2020 target
- Cost is also met (according to budget)
  - Will be verified at installation time (spring/summer 2020)
  - MAWP 2020 target is 2 M€/(t/d)

PROJECT PROGRESS/ACTIONS – Electrolyser Performance

Achievement to-date

20 min / 30 s
2 %/year



½ min / 2 s
1.5 %/year

- Cold and hot start: optimisation work to start in January at Hydrogenics
  - Project targets are MAWP 2020's
  - Next year: report on how to reach MAWP 2023 targets by Hydrogenics
- Degradation will be verified during operation
  - Prognostic approach on system level (UFC)
  - 1.5 %/year is MAWP2020 target

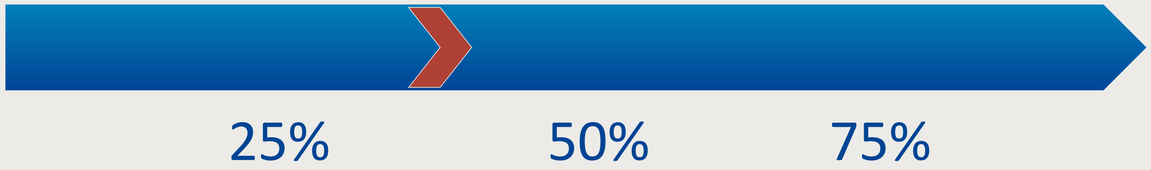
PROJECT PROGRESS/ACTIONS – Control & Monitoring System

Achievement to-date

- 3 operation cases being considered
  - Energy storage (and re-electrification)
  - Mini-grid (islanded operation or weak grid)
  - Fuel production
- Achieved:
  - Dynamic model and control algorithm for Energy Storage
  - Control & monitoring infrastructure design

PROJECT PROGRESS/ACTIONS – Wind-Hydrogen Integration

Achievement to-date



7 main reports

- 7 public reports on various aspects of hydrogen-wind energy
  - Raggovidda energy analysis (hydrogen cost 4-5 €/kg) ✓
  - Valorisation plan for produced hydrogen ✓
  - Techno-economic analysis for multiple sites (due 2019)
  - Impact of wind-hydrogen on energy systems & RCS (due 2019)
  - Environmental performance analysis (due 2020)
  - Roadmap to 2023 MAWP targets for electrolysers (due 2020)
  - Business case for wind-hydrogen in Europe (due 2020)

Risks and Challenges

- Choice of electrolyser site
  - Raggovidda (wind park) of Berlevåg harbour (easier access)
  - Solution: Berlevåg with dedicated power line

- Tight construction window due to winter conditions
  - Rough start, missed 2018 window for experimental hall
  - Building now mostly complete, ready for electrolyser

- Accidents during operation
  - More attention after Oslo explosion
  - Thorough safety protocols
  - Site far from residential areas

Communications Activities

- Presented at 3 conferences and several smaller seminars
- 1 presentation at Oil & Energy ministry of Norway
- 1 workshop and 1 seminar organised by project
- 1 journal paper
- Presentations at IEA-HIA Task 38 (Power-to-H_2)
- Web site: http://www.haeolus.eu
- Social media:

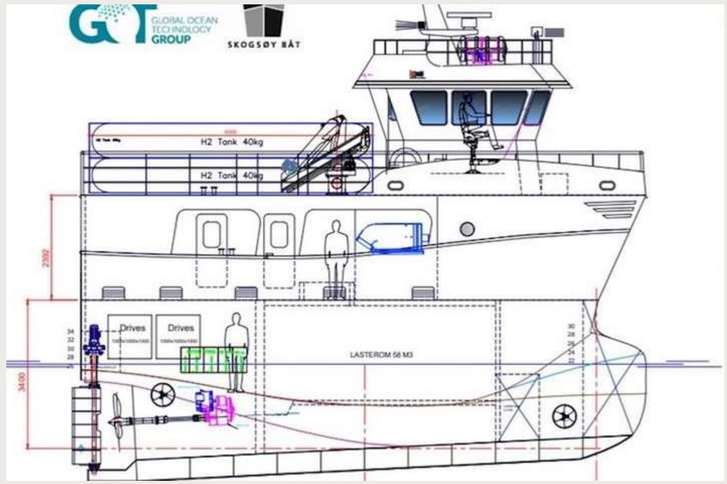
- Planned:
  - Real-time demonstration data on Web site
  - Plant visit for external observers
  - 2 more academic seminars

EXPLOITATION PLAN/EXPECTED IMPACT

Exploitation

Local valorisation of produced hydrogen:

- Maritime: fishing boats, fast passenger boats, aquaculture (also by-product oxygen)
- Land: cars (taxis), buses, snowmobiles
- Air: replacement of Dash 8 in local transport
- Export: Svalbard decarbonization (7 t/d)



Impact

Strong involvement of local community

- Both county and municipal governments
- Positive influence from local businesses
- Multiple potential users are preparing for hydrogen

Workshop on hydrogen organised by Finnmark County Council for local stakeholders

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