H_2AEOLUS

DELIVERABLE D7.2

Site Ready

PUBLIC

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Abstract: Deliverable 7.2: site preparation, which includes building a hall to house the full system. Further work in delivery: legal authorisations, heating, internet connection, water supply and electrical connection. The original plan was to install the electrolysers on the Raggovidda plateau, close to the wind farm. However, due to the logistics challenges it would involve, such as transporting hydrogen in small tanks behind snowmobiles for export, it was decided to move the facility down to Berlevåg harbour. The building is now finalized, except for internal gas piping and fences around the building area. Since the electrolyzers are delayed, the gas piping will also be delayed, as this work has to be done when the equipment is installed. Several changes were made to optimize size, functionality and safety of the building. All necessary approvals for the building phase have been obtained.

Revision History

Date	Description	Author
2019/Dec/18	Proposed draft	Christian Bue (VK)
2019/Dec/18	QA	Federico Zenith (SINTEF)
2020/Apr/23	Version 2	Christian Bue (VK)

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1 Introduction Haeolus

HAEOLUS is an EU co-funded project that proposes the integration of a new-generation 2.5 MW PEM electrolyser in a 45 MW wind farm. The project will demonstrate different control strategies to enhance the techno-economic performance of the system.

The Raggovidda wind farm is in a remote area of Norway, the Varanger peninsula. The wind farm is situated at an elevation of approximately 400 m above sea level and 30 km south of the town of Berlevåg. Raggovidda has a granted concession of 200 MW, but only 45 MW of capacity have been built due to limitations in the grid export capacity. Steady winds result in high capacity factors of about 50 %. Raggovidda wind farm is owned by Varanger Kraft and produced just short of 200 GWh in 2015.

HAEOLUS project impact is expected to be relevant for the following aspects:

- The wind farm is in a sub-grid with limited export capacity (95 MW at Varanger) compared to its full concession of 200 MW;
- Storing excess energy as hydrogen will help reduce uncertainty in wind power production, which is much larger than total consumption in the Varanger peninsula: relatively small uncertainties can destabilise the grid;
- In the long term, Varanger Kraft are strategically interested in exploiting their full wind power potential by producing and exporting hydrogen in large scale.

This report summarises the work performed on site preparation. This includes: legal authorisations, building the building, heating in the building, internet connection, water supply and electrical connection to the wind farm.

2 Site Preparation

The original plan was to install the electrolysers on the Raggovidda plateau, close to the wind farm. However, due to the logistics challenges it would involve, such as transporting hydrogen in small tanks behind snowmobiles for export, it was decided to move the facility down to Berlevåg harbour; this will also speed up the building process. The “within-the-fence" nature of the project is guaranteed by the construction of a new power line from Raggovidda to the Berlevåg plant.

The design of Hydrogenics’ electrolyzers enables them to be placed outside further south in Europe. However, Berlevåg, located in the far north of Norway, has a very long winter season – with low temperatures, strong winds and a generally harsh climate. The electrolyzers will therefore be placed inside a building in the Haeolus project.

The building design has seen several changes to optimize size, functionality and safety. As neither Hydrogenics nor Varanger Kraft have experience with such buildings, a lot of work was put down in designing and specifying the building. The building must be safe, have all the necessary functionalities, as well as handling the rough climate in Berlevåg. This caused some challenges regarding ventilation (among others), and the resulting noise level from the equipment. The location has quite strict acoustic requirements, leading to an unforeseen need for acoustic consultancy from an external company. Several mitigating actions were taken into the design, resulting in an acceptable noise level.

There will be an interface between the chosen construction company and Hydrogenics when installing the equipment. This has also been worked on in heavy detail, as this needed to be described in the tender documents. The documents were sent to 10 construction companies, whereof four contractors gave an offer. All necessary approvals for the building have been obtained from the relevant authorities. The tender process and the start-up of the building phase was delayed, mostly due to the change of electrolyser vendor in the beginning of the project. In addition:

- Increased technical difficulty of the building (moving from a simple wall/roof building to a highly detailed building, with a lot of interfaces, ventilation, acoustic challenges, etc.);
- Delayed drawings, specs and interface details for the electrolysers/container solutions.

Building related approvals is listed below:

- The Norwegian Labour Inspection Authority – Approval related to the labour required to build the building.
- The Norwegian Public Roads Administration – Approval to build a road from the County road to the building.
- Local Municipality (Berlevåg Municipality) - Approvals for building permit, dispensation from local acoustic regulations.

When placing the electrolysers inside a building, several risk aspects follows. Hydrogen accumulation is then a possibility, which needs to be handled. The building has therefore an angled roof and is equipped with big louvers in the front and back of the building to enable natural ventilation of any leaked hydrogen. In the louver section, the upper part is permanently open (approximately 1 m2), the rest is motorized and connected to the sensor system. Hydrogen detection sensors is placed inside the containers, as well as in the roof. The louvers and power are connected to these sensors, enabling automation of operating the louvers and shut-down of any power if a leak is detected. The louvers are equipped with springs, so when the power cuts, they will automatically open. The permanently open louvers cause a big need for heating capacity during winter and direct wind. However, we are aiming to keep the need to heat the entire building low, by installing heat tracing on all water pipes to avoid freezing. The containers can handle minus 20 degrees Celsius. The louvers will also be traced with high amounts of heating tracers to prevent freezing in stuck position.

A separate room is made for the nitrogen storage. Nitrogen is needed to purge the system when shutting it down. This is to remove any hydrogen that could mix with oxygen and cause an explosion.

The building is connected to the fresh water grid in the Municipality. Several water samples have been analysed from the point of connection, to make sure that the processing equipment is set up for the actual water properties.

The existing power line did not have the necessary capacity to run the electrolysers on full power (in addition to supplying Berlevåg with power). A new power line was therefore built. The new line was finalized in November 2019.

Norwegian authorities require a document describing risks, probabilities and consequences involved with this kind of facility. The document also needs to include all mitigating actions taken to prevent an accident. To prepare such a document, an external company, which specialises in these matters, was hired.

Varanger Kraft established a new daughter company in January 2019, which is called *Varanger KraftHydrogen* (VKH). All responsibilities connected to the Haeolus project, both financial and technical, were moved from VKV to VKH. An amendment was submitted early 2019.

The original budget that was put up from Varanger Kraft, estimated that Varanger KraftEntreprenør (VKE, VK's own daughter company) would perform most of the construction work. However, since the building design has changed, and since the building needed to be put out as an open tender, this was not the case. Most of the direct costs budgeted for VKE, as well as its subcontracting, were therefore moved to subcontracting for VKH. The amendment addressed this aspect as well.

Building details:

- ~18 x 18m = 324 m^2
- Approximately 3 degrees angle on roof
- Permanent open louvers ~1m^2 in the front and in the back
- Louvers area: ~20m^2
- Concrete below the storage tank

Safety measures:

- Hydrogen detection in containers and in building
- Automatic power shut-down if hydrogen detection, no power equipment in EX-zones
- Automated louvers; open if no power, opens if hydrogen is detected
- Automatic shut-down of production if detection in container or building
- Natural ventilation and angled roof will evacuate any hydrogen leak
- Mechanical ventilation during production
- Louvers act as controlled pressure relief valves if an explosion would occur
- Alarm and fences
- Risk evaluations and risk distance calculations – no buildings or other within the safety zones

Learnings/Recommendations:
In less Arctic environments, it is recommended to investigate if the containerized solutions could be placed outside, avoiding an expensive building. The equipment would then need to be further optimized with regards to cold temperatures, and possibly by placing the equipment on an elevated frame to handle the snow.

Norwegian authorities require an explosion study for facilities of this sort. The risk evaluation is only required to be qualitative when storing less than 5 tons of Hydrogen. Nor is it a requirement to obtain any approvals for Hydrogen production, as long as it is below 5 tons. The only requirement is to register the facility in the The Norwegian Directorate for Civil Protection (DSB) register for business handling dangerous goods/substances.

3 Pictures