



Large scale energy storage



CryoHub

Developing Cryogenic Energy Storage at Refrigerated Warehouses as an Interactive Hub to Integrate Renewable Energy in Industrial Food Refrigeration and to Enhance Power Grid Sustainability

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- On the project Portal
- On the CryoHub Intranet (<http://CryoHub.psutec.com/>)



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1. Executive summary

CRYOHUB is a European collaborative project that aims to develop cryogenic energy storage using renewable energy to refrigerate food storage warehouses and to enhance power grid sustainability.

In its entirety, the CryoHub concept would contain the following subsystems:

- Air liquefaction for storage of excess renewable energy or when demand is low
- LA (liquid air) storage in a pressurized cryogenic vessel
- Discharge of the LA for warehouse refrigeration and energy recovery when demand is high.

The CryoHub project includes design, build and testing of a demonstrator system which excludes the expensive and proven technology related to liquefaction, but which includes thermal storage, warehouse cooling and power generation from the discharged cryogen.

This deliverable covers the design concept, major components, assembly and installation of the demonstrator.

2. Demonstrator concept and design

The CryoHub project aims to integrate cryogenic energy storage with refrigerated warehouse facilities. In its concluding stages, the project will measure the performance of an industrial scale demonstrator integrated with a frozen storage warehouse operated by Frigolox at Lommel in Belgium.

Mathematical modelling of various system configurations, reported in earlier deliverables, has been used to inform the design of the demonstrator system. The installation primarily comprises a two-storey skid (Figure 1), with the first storey housing the electrical panels and control system, the liquid nitrogen inlet, cryogenic pump and the three-stage turbine generator array. Above this, the second storey houses three custom made heat exchangers, alongside which the nitrogen exhaust is mounted.

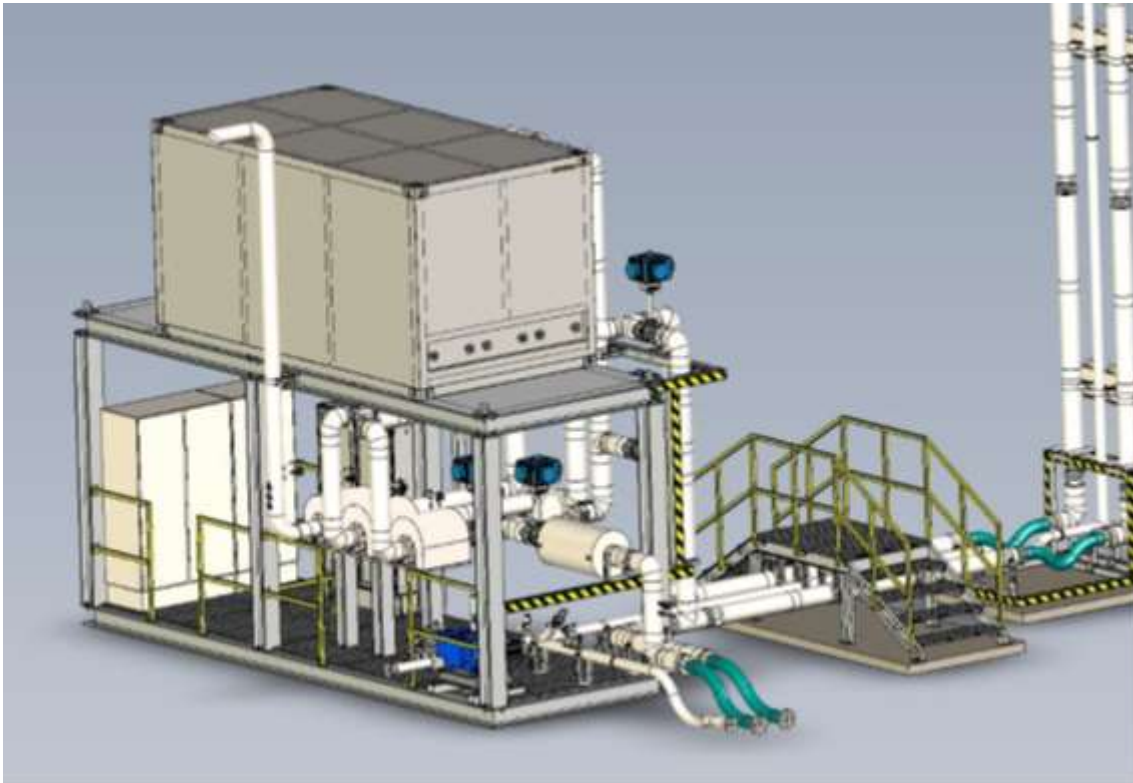


Figure 1. CAD drawing of the main skid.

Leading from the skid, vacuum insulated pipes connect to heat exchangers installed on the pallet racking inside the warehouse (Figure 2). These heat exchangers allow the demonstrator to contribute to cooling of the warehouse, while the turbine generators feed electricity to the grid. The drawing also shows the pipes which connect to the thermal store (not shown).

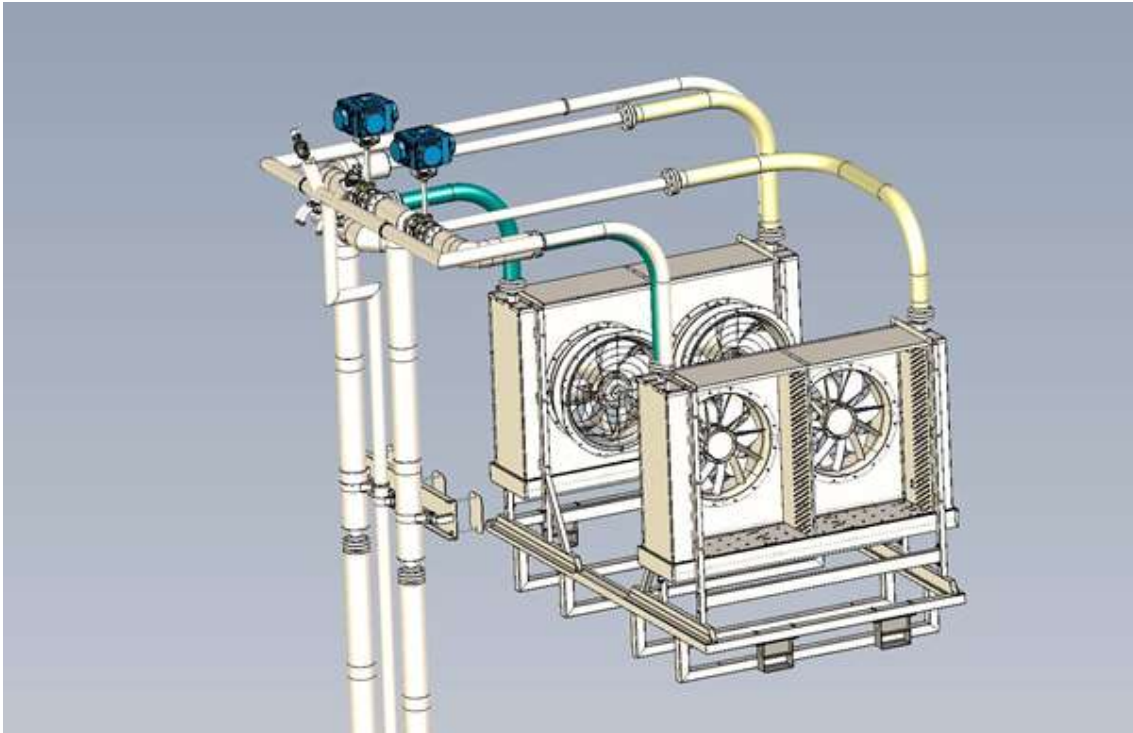


Figure 2. Connection to heat exchangers inside the warehouse.

3. Major components

The major components used in the demonstrator are as follows:

3.1. LN trailer

The cryogen used in the demonstrator is liquid nitrogen, supplied by Air Liquide. The nitrogen will be stored until required in an industry standard pressurized trailer (Figure 3) and will be replenished during the test campaign.



Figure 3. Liquid nitrogen trailer

3.2. Cryogenic pump

A Kryotherm cryogenic pump (Figure 4) is used to boost the pressure of the incoming nitrogen.



Figure 4. The cryogenic pump.

3.3. Turbine generator sets

Three 17 kW Deprag Schulz GmbH gas expansion turbine generators are used, running in series over an approximately 15 to 1 pressure ratio.



Figure 5. Side view of the demonstrator during assembly, showing the 3 Deprag turbine generator sets.

3.4. Heat exchangers (on skid)

Heat exchange on the skid is achieved using three custom made exchangers designed and built for Dohmeyer by Cryofin Pty Ltd. There are mounted together in a frame for ease of movement and protection (Figure 6).



Figure 6. Heat exchanger block (with HX 2/3/4).

3.5. Heat exchangers (in warehouse)

Inside the warehouse two further exchangers manufactured by Beehive Limited are mounted on the pallet racking (Figure 7).



Figure 7. Heat exchangers mounted inside the warehouse.

3.6. Thermal store

A thermal store consisting of steel rods and silica beads inside a custom-made pressure vessel is used to store cooling from evaporation of liquid nitrogen. The store (shown in Figure 8) has been manufactured by SPS Cryogenics BV.

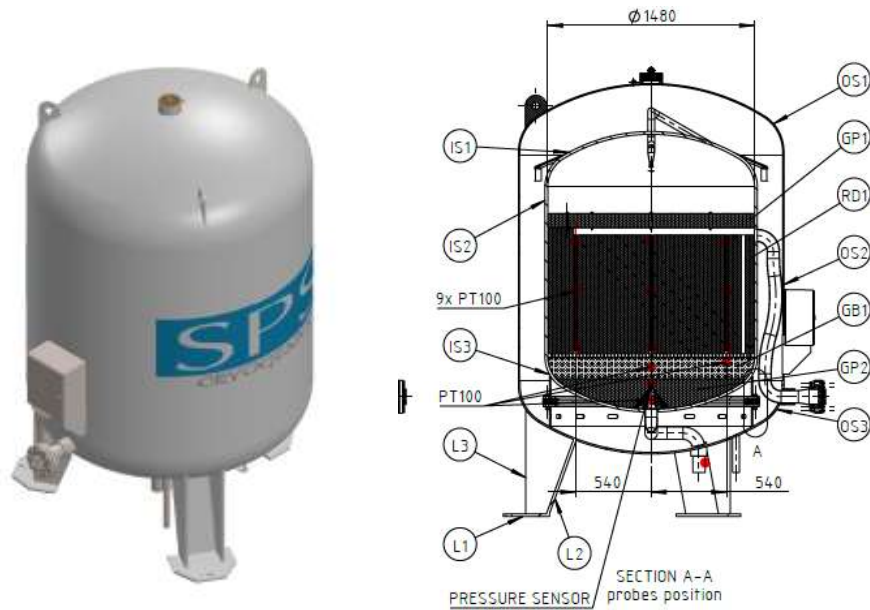


Figure 8. The thermal store.

3.7. Electrical panel and controls

The electrical panel for the demonstrator has been assembled in-house by Dohmeyer. Figure 9 shows the panel and its internal circuitry during assembly.



Figure 9. Electrical cabinet (left) and internal circuitry (right)

Programming of the control system at the operational level has also been implemented by Dohmeyer, and an example of the user interface is shown in Figure 10.

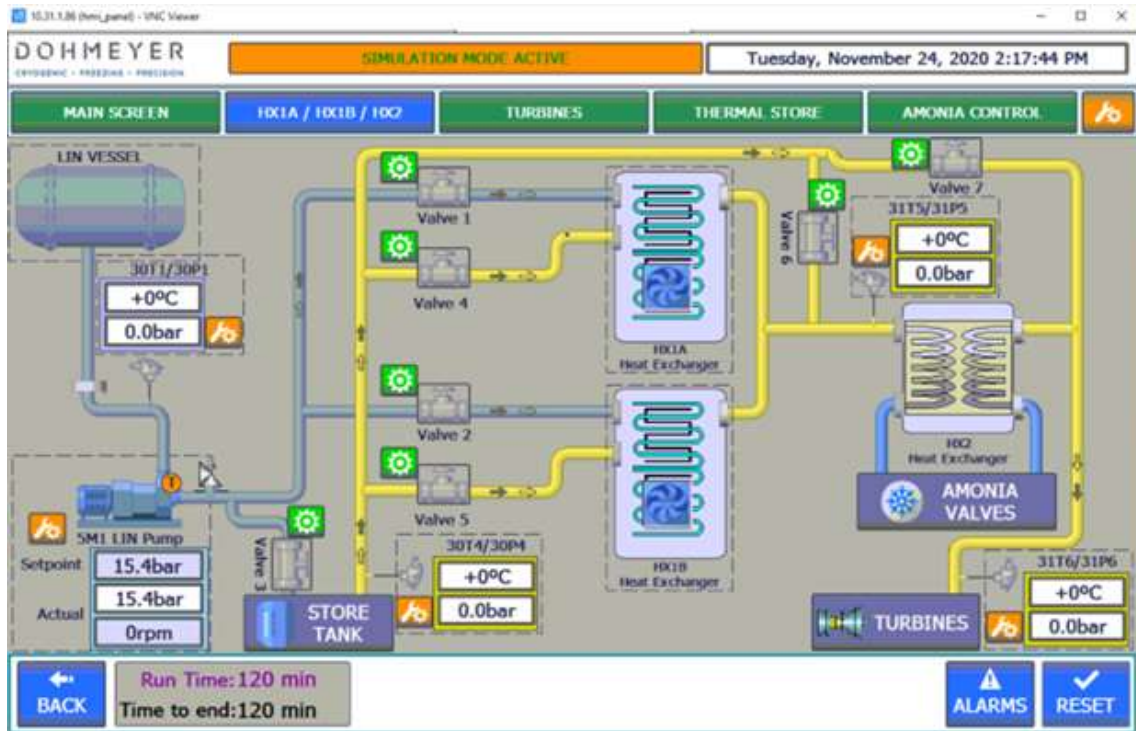


Figure 10. Control program (primary window).

4. Assembly

The majority of the assembly of the demonstrator was completed at the Dohmeyer facilities at Mielec in Poland, after which it was transported to Frigologix for installation. A view of the part-completed skid is shown in Figure 11 below.



Figure 11. Demonstrator skid without the heat exchanger block.

5. Installation

The demonstrator has been assembled and delivered to Lommel and integrated with the warehouse and the electrical grid. Figure 12 shows the skid positioned on site at Frigologix, with the heat exchanger block now connected on the top layer, prior to delivery of the thermal store.



Figure 12. The skid and heat exchanger block connected and installed at Frigologix.

Figure 13 below shows the skid alongside the warehouse wall, with the thermal store now in position and the vacuum insulated pipes leading to the warehouse heat exchangers.



Figure 13. Side view of the demonstrator skid, with thermal store now delivered and ready for connection.



6. Conclusion

After some delays in acquiring and assembling major components, the demonstrator skid has been installed and integrated with the Frigologix cold storage warehouse at Lommel in Belgium. It will now be commissioned and used to test a range of operating scenarios, for which the measured results will be compared with the predicted performance modelled earlier in the CryoHub project.