

Customized Hydrogen Liquefier System for Applications up to 50kg Per Day

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Agenda

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- a. Absolut System knowledge
- b. Current scheme supply for LH2

II. LIQHYD50 description

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- d. Performances
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III. LIQHYD50 Qualification Plan

• Cryostats with Cryomech Cold Heads technology at Absolut System



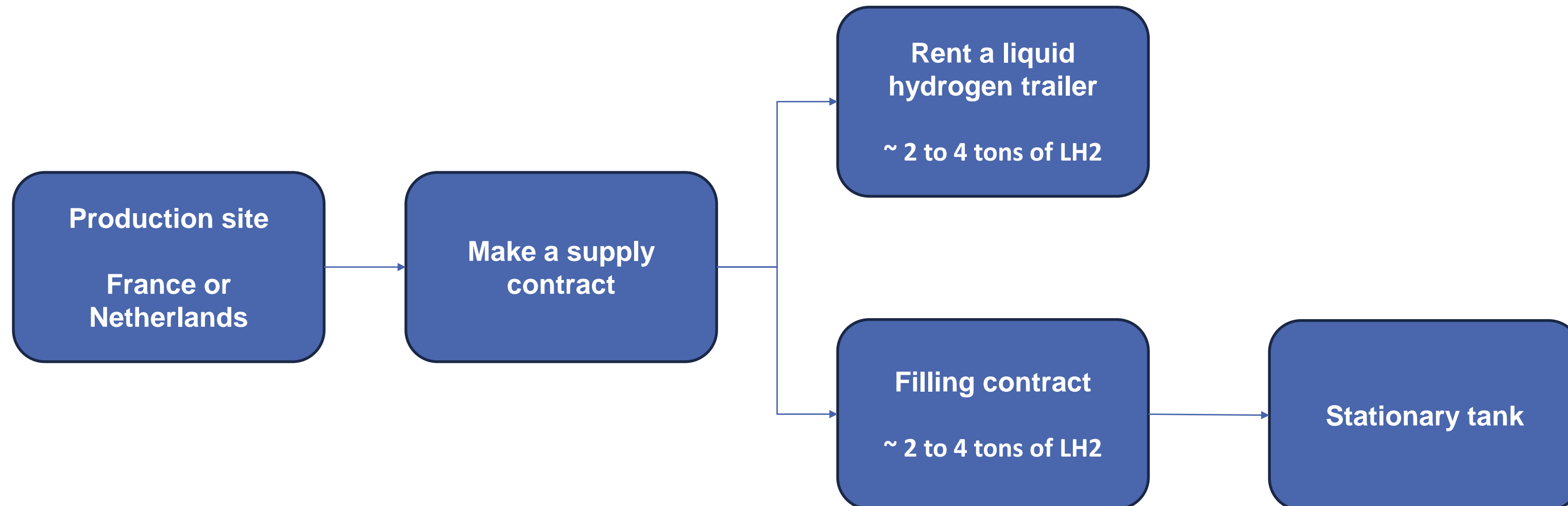
- Absolut System was founded in 2010 by 3 experienced engineers.
- Absolut has developed during years specific adaptations of the standard Cryomech (US) cold Heads to propose the most efficient solution for cryocooling systems up to 4K
- Currently Absolut System is also exclusive distributor of Bluefors* (ex Cryomech) and is managing the preventive and curative maintenance for those supplies
- Absolut System had more than 220 cold heads sold by Absolut so far
- Absolut has already developed and supplied more than 50 custom-fit cryocoolers based on this technology for many type of applications (Aerospace, Universities, National laboratories, Research programs, ...). Some of them are running for more than 12 years

* France (inc. DOM TOM), Switzerland, Belgium, Italy, Spain, Morocco and Tunisia.



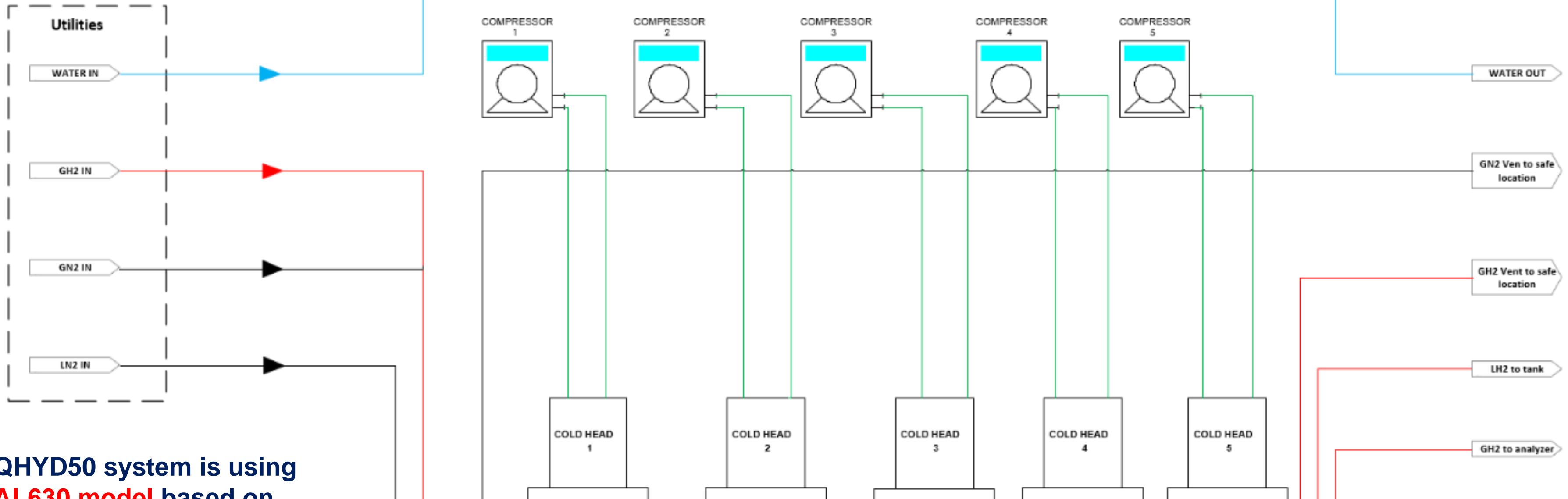
Introduction

- **Current scheme for LH2 supply**



Absolut System decided to develop a small hydrogen liquefier which can promote access to liquid hydrogen for the laboratories or industrials during their development phases



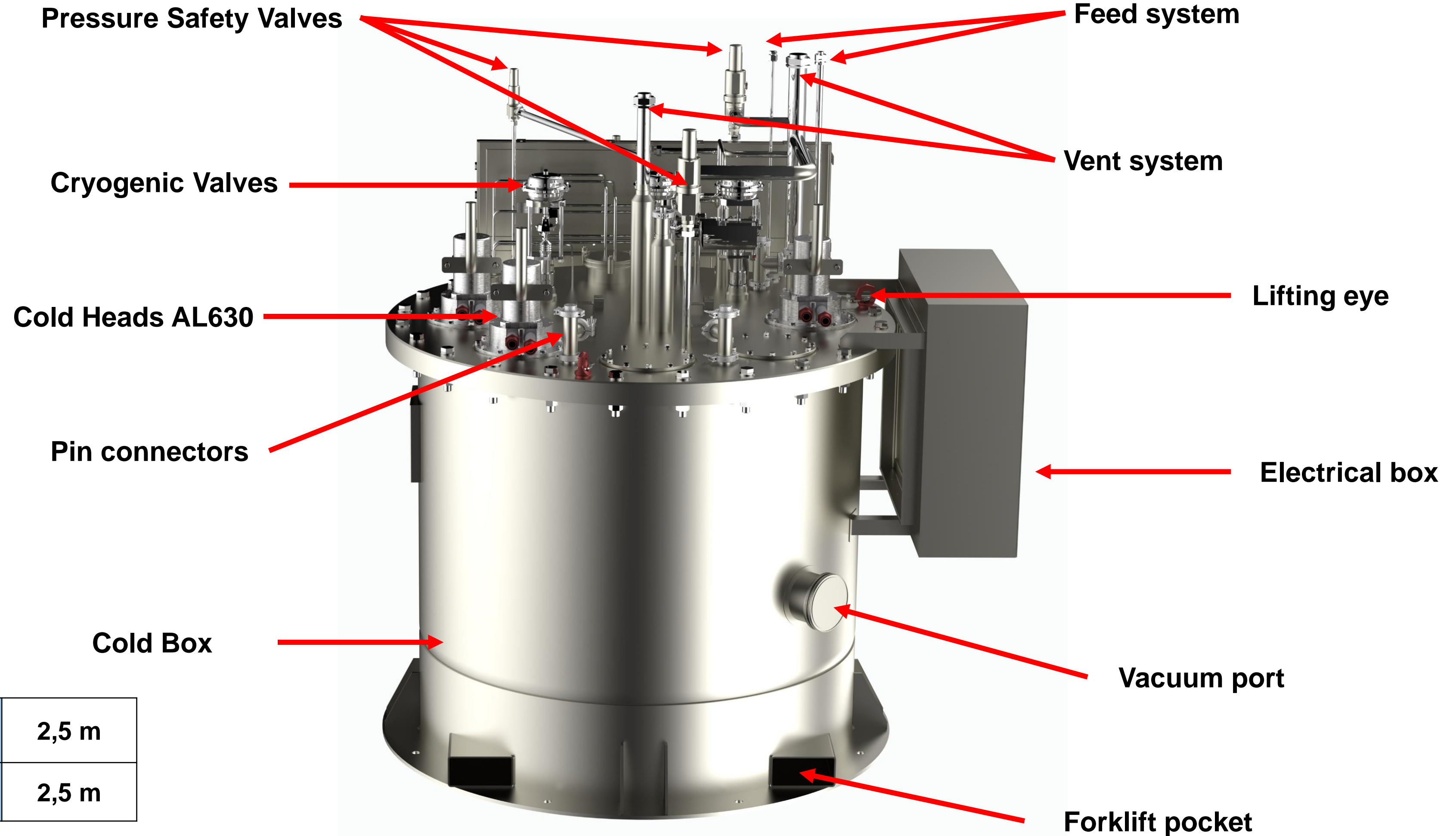


LIQHYD50 system is using **AL630 model** based on Gifford-McMahon cryocooler technology from Cryomech

Delivery 90 W @ 20 K

Outlet Conditions	
T outlet [K]	P outlet [bara]
20 K* – T _{sat}	6





Height	2,5 m
Diameter	2,5 m



•Main advantages

A plug & play solution :

- A compact solution
- easy to transport
- Skidded solution with electrical and mechanical couplings
- Skid pre-cabled at Absolut System workshop
- Limited on-site activities → only utilities and feed/customer application connections

High quality of LH2 :

- No additional impurities added by the liquefier to the initial GH2 feed composition
- High rate of Para Hydrogen which is the most stable state for storage

A system that offers flexibility :

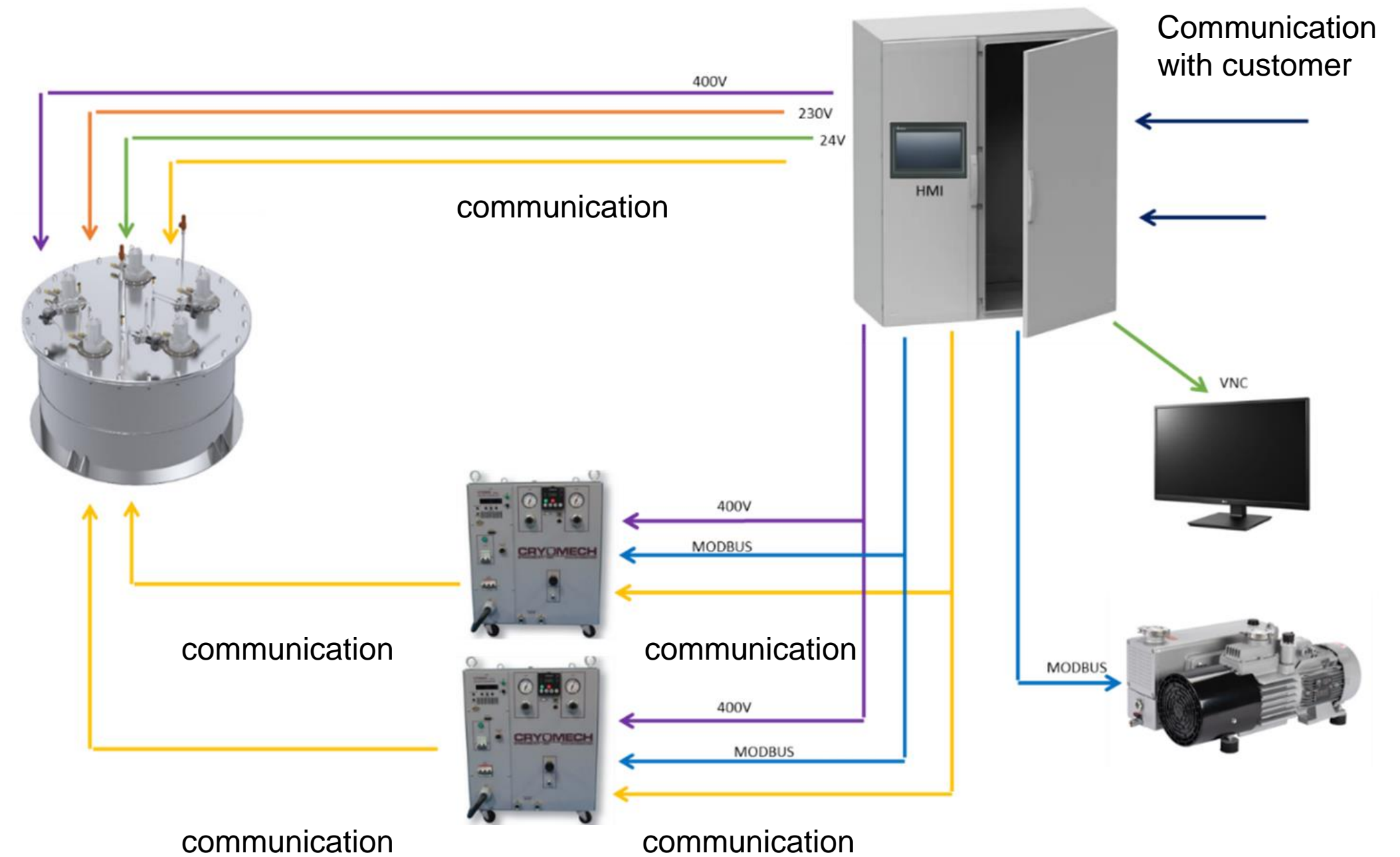
- Several configurations proposed : from 10 to 50kg/LH2 capacity
- Future upgrade in liquefaction capacity possible by adding additional cold modules to the existing system
- Reduced liquefaction mode possible (depending on the chosen configuration)
- LH2 temperature and/or pressure at Outlet of the liquefier can be set by the Operator (impact on the liquefaction capacity)
- The system can run without LN2 Precooling (with an impact on the liquefaction capacity)



•Main advantages

an Unmanned system :

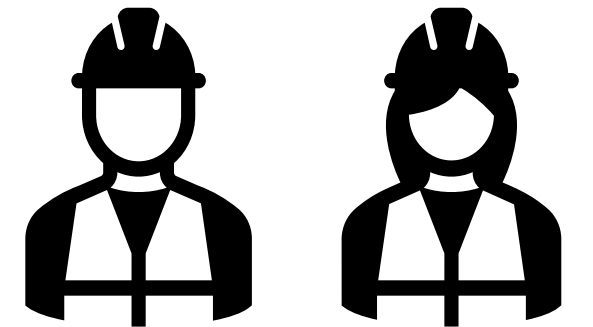
- A fully instrumented system, controlled by a dedicated PLC that may communicate with customer control system
- A fully automated system that can run 24/7 without operators in normal conditions :
 - Conditioning Start-Up Mode
 - Cooldown Mode
 - Cooling Modes (partial or full capacities)
 - Warm up Mode
 - Conditioning Stop Mode
- Remote access for troubleshooting/assistance



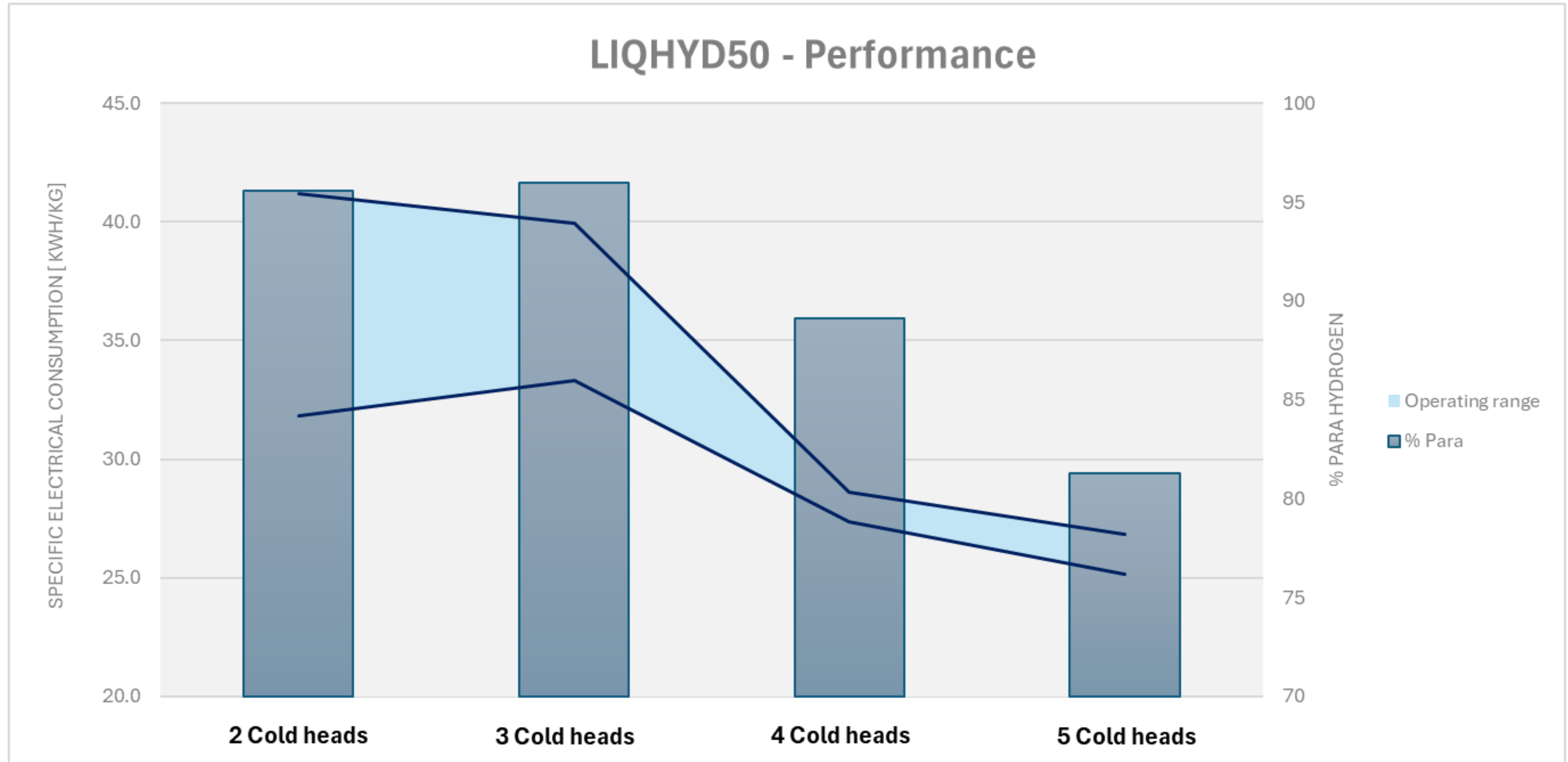
•Main advantages

an system that operates in safe conditions :

- The LIQHYD50 unit is an instrumented system compliant with International standard IEC 61508 that intends to perform specific and automatic control of the system,
- Specific control functions (alarms, trips) to prevent unsafe process operations from happening,
- Safety analysis (HAZID, HAZOP, ATEX) performed with H2 Safety experts using proven methodology of the Oil & Gas industry : at the completion of the engineering design phase a formal process of hazard identification has been performed to operate in safe conditions by defining the necessary safety devices of the system : Pressure relief valves, electrical switches, safety control loop in the PLC,
- Very low volume of LH2 in the liquefier
 - no ATEX zoning impacting the others equipment installed closed by,
 - permitting ease for local regulation,
- All vents shall be collected by customer for safety reasons.



•Performances



•Options

○ **Liquefaction Capacity Upgrade :**

The LIQHYD50 offers the possibility of upgrading the production of Liquid Hydrogen capacity by installing additional cold heads (up to 50 kg per day maximum) and associated components by keeping the same cold box envelope and interfaces. For the upgrades, the system shall be shipped back to Absolut System premises.

○ **Atmospheric conditions :**

The LIQHYD50 product is designed to be operated in indoor conditions. Absolut System has also developed a shelter solution to address specific customer needs that impose to install the unit outdoor.

○ **LH2 storage tank :**

Dedicated storage tank fully instrumented and equipped with safety and regulation devices with a storage capacity of 600 L. Distribution line is proposed in addition to the tank.

○ **LH2 flowmeter :**

Flowmeter, based Coriolis technology and designed for LH2 purpose, can be installed on the distribution line.

○ **LH2 gas analyzer (Para concentration) :**

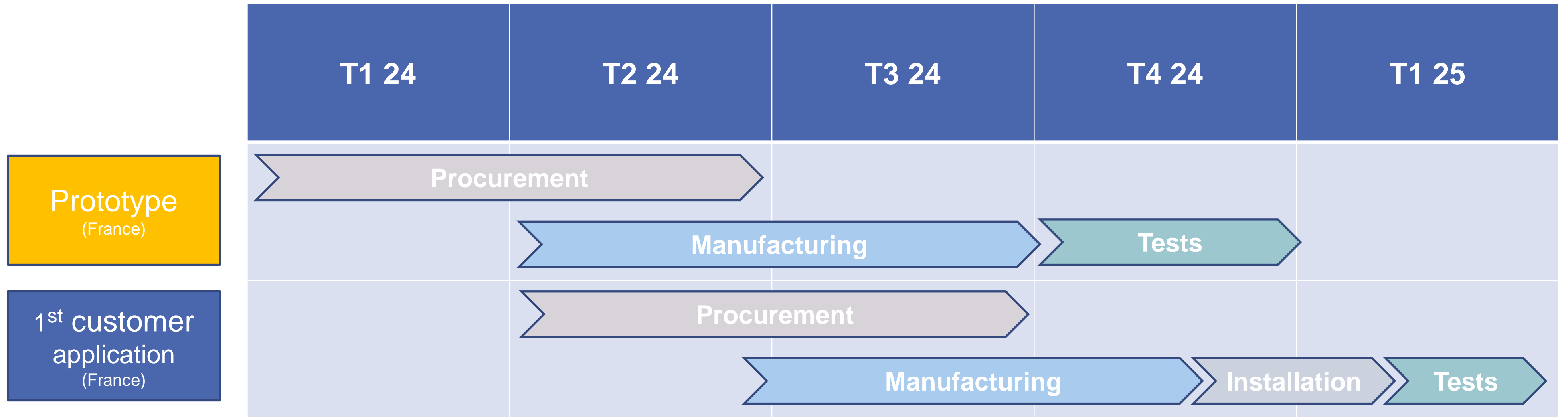
Gas analyzer, based on thermal conductivity technology, can be connected to the liquefier to measure ortho/para relative composition at the outlet of LIQHYD 50 by automatic sampling.

○ **Cooling water system :**

An on the shelf solution perfectly adapted to LIQHYD50 cooling requirements can be installed. Associated transfer lines are proposed in addition to the chiller



•Qualification Plan



Main objectives :

- Demonstration of the liquefaction capacity
- Ortho/para measurement
- SEC measurement
- Automatic sequences tested



Thank you

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Florian DIEUDEGARD ; Alice GOLVA ; Coralie MURRU**