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# Datasheet

## 1 MW AC Power Container for CrossWind

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| 001 | EZE | Initial release | 2023-11-20 |
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## 1.0 General Description

The stationary fuel cell system is based on 6 FCwave™ hydrogen fuel cells, built into a 40' HC container, capable of delivering 1 MW AC power. A transformer matching the local grid voltage is included in a separate 10' HC container and hence a complete microgrid can be established.

The containerized solution includes all the equipment necessary to operate the fuel cells and converts the DC power generated by the fuel cells into AC power. The container is delivered with a complete cooling system that dissipates the heat generated by the fuel cells and power conversion.

## 2.0 Technical Datasheet

### FCwave™ 1 MW AC Power Container

| Specification: | Value (Metric) | Value (Imperial) |
|---|---|---|
| **Generator Specification:** | | |
| Max. Continuous Power @20 °C Ambient | 1 MW AC | |
| Min. Continuous Power | 0 kW | |
| Output Voltage<br>@DC/AC Output<br>@Transformer Output | <br>400 V @50 Hz – 3p+n<br>(see transformer specs) | |
| Noise Level | 75 dBA @10 m | 75 dBA @32.97' |
| **Fuel Cell Module Performance:** | | |
| Fuel Cell Model (Product Name) | FCwave™ 200 kW DC | |
| Container Configuration | 6 x FCwave™ | |
| Module Load Power Generation | 55 to 200 kW DC | |
| Module Peak Fuel Efficiency | 53 % | |
| **Physical[1]:** | | |
| Fuel Cell Container (40') Dimensions (l x w x h)[2] | 12.2 x 2.5 x 2.9 m | 40 x 8.2 x 9.5' |
| Fuel Cell Container Weight | ≤ 23,262 kg | ≤ 51,284 lb |
| Painted Surface Treatment | C5M - RAL 7035 textured | |
| Container Doors, Intrusion Protection | System locking | |
| Cooling Skid Dimensions (l x w x h) | 12.2 x 2.5 x 3.1 m | 40 x 8.2 x 10.2' |
| Cooling Skid Weight | ≤ 10,757 kg | ≤ 23,715 kg lb |

[1] *Figures are subject to modification during final design work and site adaptation.*
[2] *Based on standard 40' high-cube container*

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| | | |
|---|---|---|
| Transformer Container (10') Dimensions (l x w x h)[3] | 3 x 2.44 x 2.9 m | 10 x 8 x 9.5' |
| Transformer Container Weight | ≤ 7,138 kg | ≤ 15,737 lb |
| **Transformer Specification:** | | |
| Type | TES-R2 EU548 Tier2 | |
| Insulation Type | Cast Resin | |
| Cooling | Air Natural | |
| Loading Conditions | Converter THDi<10% | |
| Nominal Power | 1,250 kVA | |
| Number of Phases | 3 | |
| Frequency | 50 Hz | |
| Voltage Rating $V_1/V_2$ | 400 V / 6,600 V | |
| Tappings | ±2 x 2.5% | |
| LV Current | 1,804.27 A | |
| Vector Group | Dd0 | |
| No-Load Losses | 1,620 W +0% tol. | |
| Load Losses @75 °C (167 °F) | 9,700 W +0% tol. | |
| Load Losses @120 °C (248 °F) | 11,000 W +0% tol. | |
| No-Load Current | 0.3% | |
| Impedance Voltage | 5.0% | |
| Efficiency @120 °C (248 °F) | | |
| 4/4 cosfi 1 | 99.00% | |
| 4/4 cosfi 0.8 | 98.75% | |
| Voltage Drop | | |
| 4/4 cosfi 1 | 1.001% | |
| 4/4 cosfi 0.8 | 3.715% | |
| Thermal Insulation Class | F/F | |
| Primary Insulation Levels | 7.2 – 20 – 60 kV | |
| Secondary Insulation Levels | 1.1 – 3 kV | |
| Core Temperature Rise | 100 °C | 212 °F |

[3] *Based on standard 10' high-cube container*

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| | | |
|---|---|---|
| **Reactants & Cooling:** | | |
| Fuel Type | Gaseous hydrogen | |
| Hydrogen Grade | As per SAE spec. J2719 or ISO 14687:2019 Type I, Type II – Grade D | |
| Hydrogen Supply Pressure | 3.5 – 6.5 bar(g) | |
| Hydrogen Consumption Rate, BOL | 3 to 75.6 kg/h | 6.61 to 166.67 lb/h |
| Cooling Media | Ethylene-glycol / DI-Water | |
| Cooling Mix | 50% / 50% | |
| Total Cooling Media Volume | 2,000 l | 528.34 gal |
| **AUX standby connection:** | | |
| AUX Voltage (3P+N+PE) | 400 V AC | |
| AUX Current | 32 A | |
| **Safety Compliance:** | | |
| Certifications | CE, non-hazardous area | |
| Fire Alarm | Smoke detectors<br>Warning by sound/light | |
| **Monitoring:** | | |
| HMI, Basic Operation | In container, basic operation only | |
| SCADA/Control Interface | Modbus TCP/IP | |
| Safety Interface | Hardwire | |
| Remote Monitoring Interface | VPN Ethernet | |

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| **Operating Conditions:** | | |
|---|---|---|
| Altitude | < 100 m | < 328’ |
| Minimum Ambient Temperature, Operating | -8.4 °C | 16.9 °F |
| Maximum Ambient Temperature, Operating | +25 °C | 77 °F |
| Humidity | 5% to 95% RH | |
| Wind Velocity[4] | 31 m/s | 69.35 mph |
| Weather | Designed for all year operation in temperate offshore areas, including wind driven rain and snow | |
| Salt Mist and Sea Salt Protection | Yes | |
| Flooding | Approximately 10 cm above ground level | Approximately 3.94” above ground level |
| Earthquake | Not earthquake safe, but designed to withstand customer-defined accelerations | |

Note: If there are discrepancies between metric and imperial, it will be metric that applies.

[4] *10-minute mean wind velocity at 10 m elevation with 50 years return period*

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## 3.0 System Layout

The isometric views of the layout shown below are taken from the General Arrangements drawing. The cooling platform, incl. HT coolers, HT cooling pump sub-assemblies and LT cooler, is mounted on top of the 40' HC container. The 10' transformer container is installed next to the 40' container in an L-type arrangement. For more information, incl. details on the interface connections, please refer to the General Arrangements drawing (K559-2254-CWIWP4202202-B01-001).

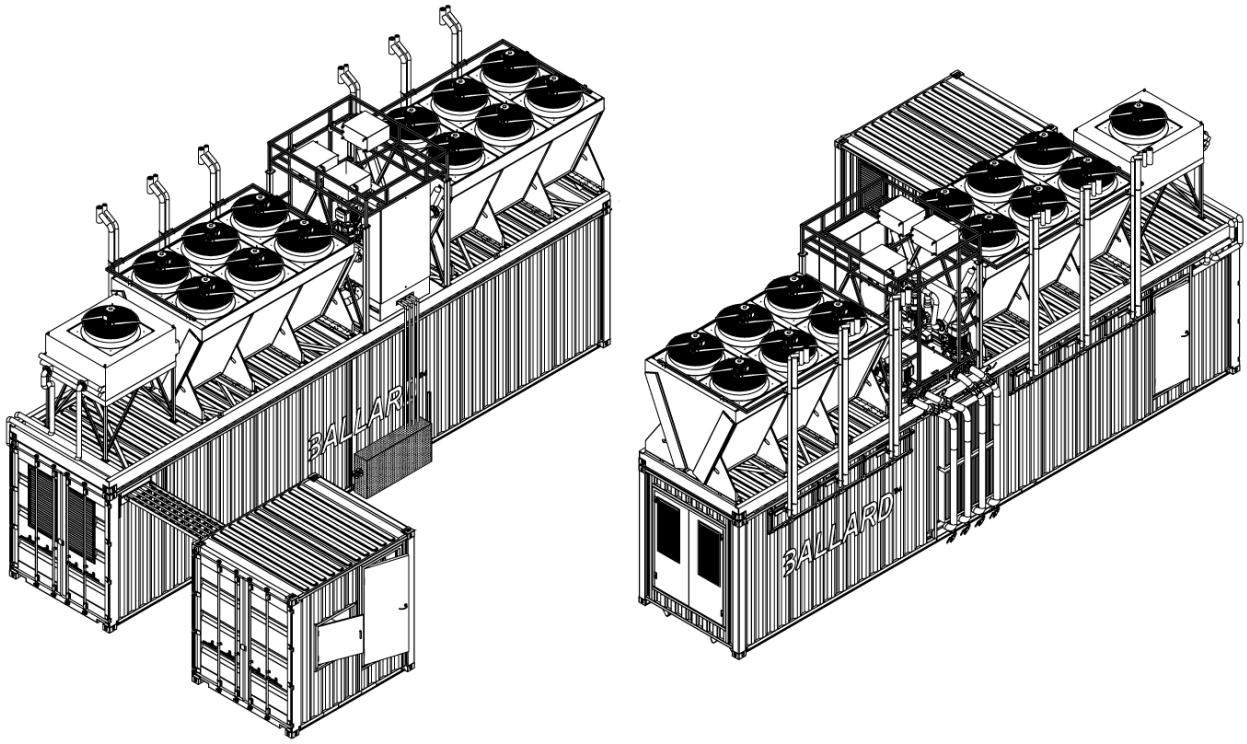



Figure 1. Isometric views of the 1 MW AC containerized solution.

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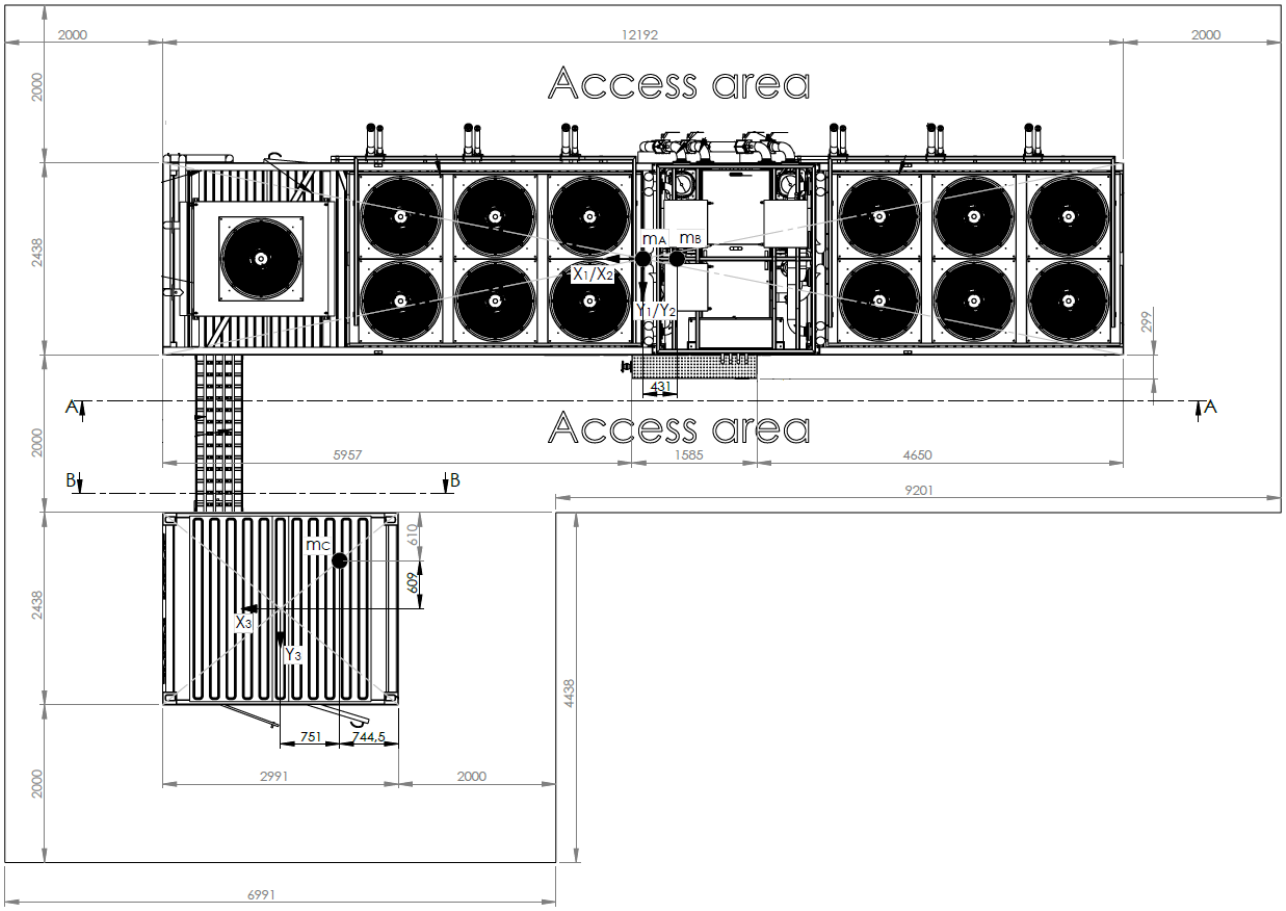



Figure 2. Top view of the 1 MW AC containerized solution.

The installation requires at least 2 meters (6.56’) service clearance to other installations.

To ensure proper function of the coolers, any buildings taller than 6.6 meters (21.65’) should be located at least 5 meters (16.4’) away.

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## 4.0 Container Overview

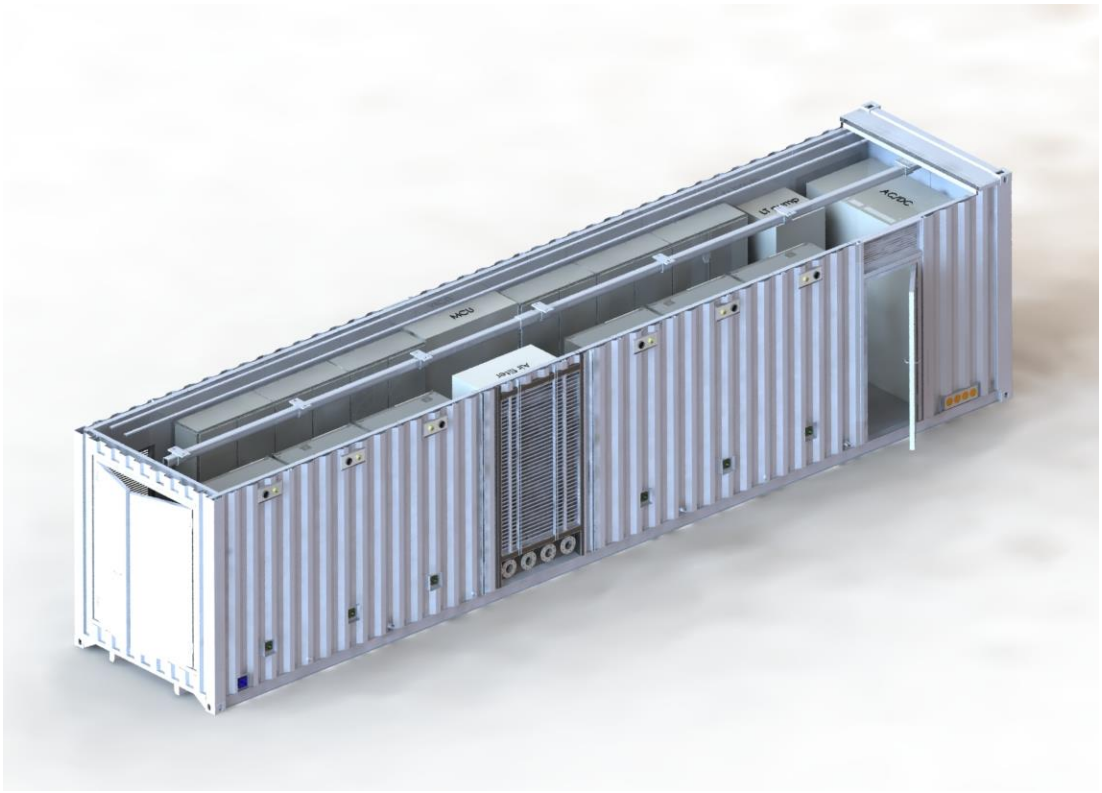


Figure 3. Visualization of the inside of the 40’ container (indicative).

The container contains the following main components:

1. Air filter with dampers and rain protection.
2. Container ventilation fans.
3. FCwave™ fuel cell modules.
4. $H_2$ intake manifold, incl. safety shut-off valves (opposite side).
5. Raised floor. Cooling, electrical, and interfacing is installed below the floor.
6. Container control unit (CCU) cabinet, which contains the computers and controls required to manage the container and all peripherals (e.g., coolers, transformer, power conditioning), manage load distribution and start/stop sequences as well as safety of the container. The CCU is the interface to the customer’s control system.
7. DC/DC cabinets for connecting each FCwave™ to a shared DC power bus, including necessary filters.
8. DC/AC cabinet for converting the full power capacity to the AC required, inclusive filters and connecting points for transformer.
9. Transformer to boost the AC output voltage to the customer-required voltage level (not shown).
10. Low temperature pump arrangements for cooling of power electronics, compressors, etc.
11. High temperature cooling for fuel cell stacks (not shown).
12. 2 access doors.
    The interior of the container is not to be considered a working area, and access should be prohibited during operation, unless by a trained service engineer.
13. Ventilation and process exhaust piping above FCwave™ (not shown).

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## 5.0 Water Drainage System

The fuel cell process will produce a max. of 18 L/min of deionized (DI) water at full load. For sizing purposes, it is assumed that all of this DI water condenses and exits through the process water drain. The DI water exiting from the system may be disposed of similar to tap water or reutilized for other purposes if needed by the customer.

The drainage system is internally designed so that it shall not freeze nor block the water flow. The drainage system outlet pipe is guided to the outside of the container, where care must be taken to ensure proper functionality, also during freezing.

## 6.0 Requirements for Upstream $H_2$ Delivery System

The integrator must provide sufficient hydrogen of quality, pressure, and temperature as specified in section 2.

The integrator must provide a block and bleed capability upstream of the module.

The hydrogen supply must be designed to prevent the inlet pressure to exceed 6.5 bar(g).

## 7.0 Hydrogen Safety

Every FCwave™ is equipped with a comprehensive safety system, preventing any leakages of Hydrogen inside the FCwave™ to develop into an explosive or flammable mixture. The safety system is verified and tested according to maritime safety codes and has been certified by the DNV for installation on ships.

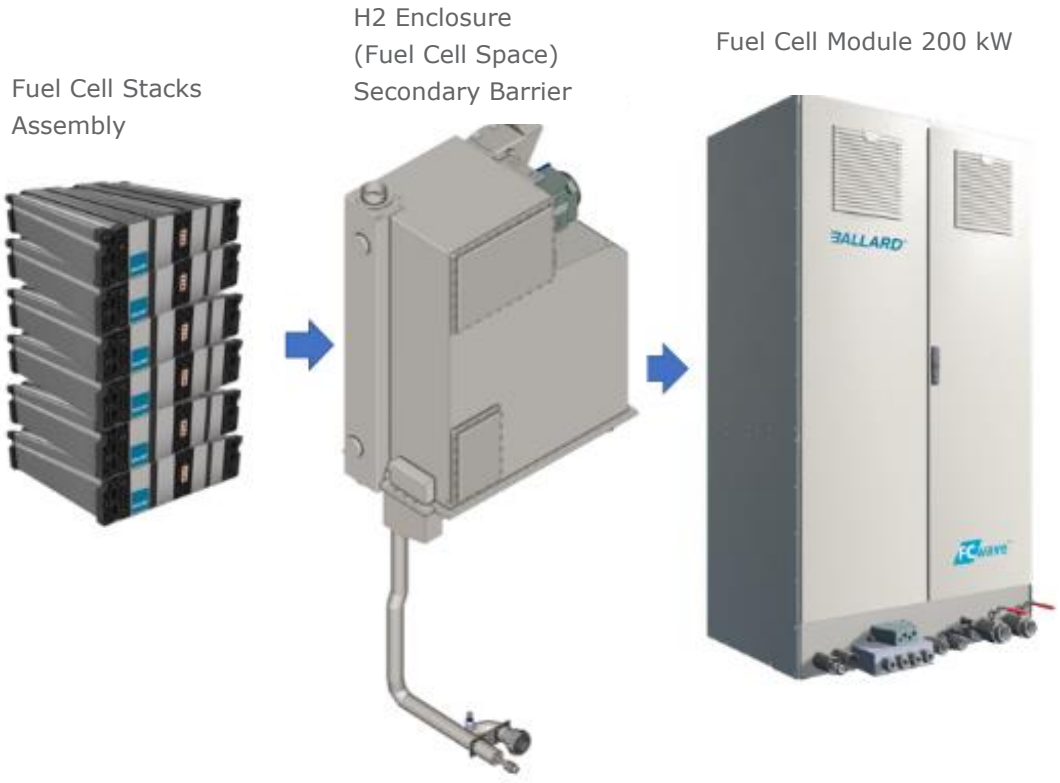



Figure 4. FCwave™ module, hydrogen enclosure, and stack assembly.

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The FCwave™ module has been designed with a hydrogen enclosure. The hydrogen enclosure is a unique design concept, which allows to separate the hydrogen related components such as fuel cell stacks from the auxiliary electrical components and control units.

The internal hydrogen supply installation is made as double wall piping, with a ventilated outer tube. Any leaked hydrogen will escape outside and will not build up to an explosive atmosphere inside the container.

With the hydrogen enclosure and the double wall barrier, the container is not regarded as an Atex zone, and is furthermore ventilated during operation.

The immediate outlet of the exhaust is typically to be considered an Atex zone.

The safety system for each FCwave™ is integrated with the CCU safety controller, such that any error will lead to a warning or safe shutdown, depending on the severity. The container is equipped with hydrogen sensors, which are integrated into the safety system.

For more information, please refer to the Hydrogen Safety Concept document (K559-2254-CWIWP4202202-C99-001).

## 8.0 Control and Monitoring System

Included in the delivery from Ballard is a Container Control Unit (CCU) for the complete embedded control of the container and auxiliary equipment required for the container to operate safely. The CCU will monitor and manage the power production according to the power requested by the customer.

The CCU is the interface to the customer's control system. The customer must supply a control system for communication with the CCU via Modbus Ethernet. Communication is bidirectional, sending operating instructions to the CCU and receiving status and alarms from the CCU, preferably to be visualized for the operator (must be included in the SCADA supply).

The CCU includes the option for connecting a PC-based engineering interface typically used during commissioning and service.

## 9.0 Emergency Shutdown

Emergency shutdown for the Stationary fuel cell system is an event, in which the hydrogen flow is stopped immediately, and the currents and voltages of the fuel cell modules are brought down to zero. Hydrogen flow will be handled in the gas handling unit.

The emergency shutdown procedure for the container system can be triggered by any of the FCwave™ fuel cell controllers or the CCU (e.g., due to an unsafe operating state):

- a safety system trip.
- a hydrogen alarm.
- a fire/smoke alarm.
- fuel cell control system.
- the container safety system.

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## 10.0 Block Diagram

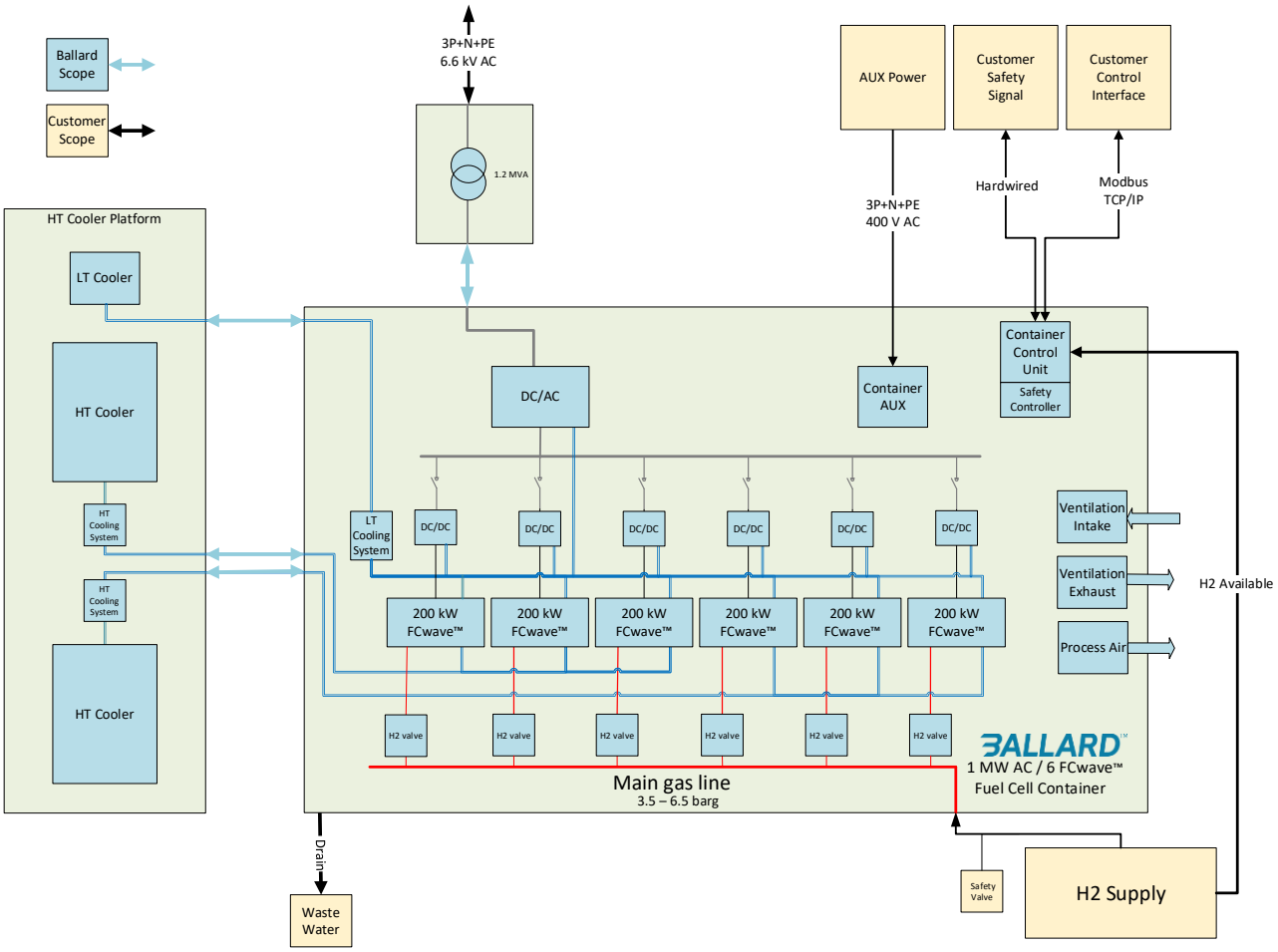



Figure 5. Block diagram of the 1 MW AC containerized solution.

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