With funding from the:

Flagship Project H_2Mare

Federal Ministry of Research, Technology and Space

Funded by the European Union NextGenerationEU

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Flagship project H_2Mare

Challenges of Electrolysis Systems at Relatively Weak Connection Points

Hydrogen Directly from the Offshore Wind Turbine

Thomas.Schwabe@siemensgamesa.com

H2Mare-OffgidWind Coordinator & Senior Project Manager

Thomas Schwabe

As the Senior Project Manager, I lead the development and construction of offshore wind farms in the North Sea and the Baltic Sea at Siemens Gamesa Renewable Energy in Hamburg.
My journey began after completing my electrical engineering studies when I embarked on my career at Siemens AG in Hanover, specializing in building installations. Over the years, I diversified my experience, working on various projects, including high-speed trains and oil and gas production.
In 2011, I embraced a new chapter as Siemens Gamesa Renewable Energy opened its office in Hamburg. I transitioned into the world of wind energy and played an integral role in establishing and growing the Hamburg office.

Nowadays I lead the H2Mare OffgridWind project.

Overview & Setup

Combined Wind Energy Electrolyser Platform Concept

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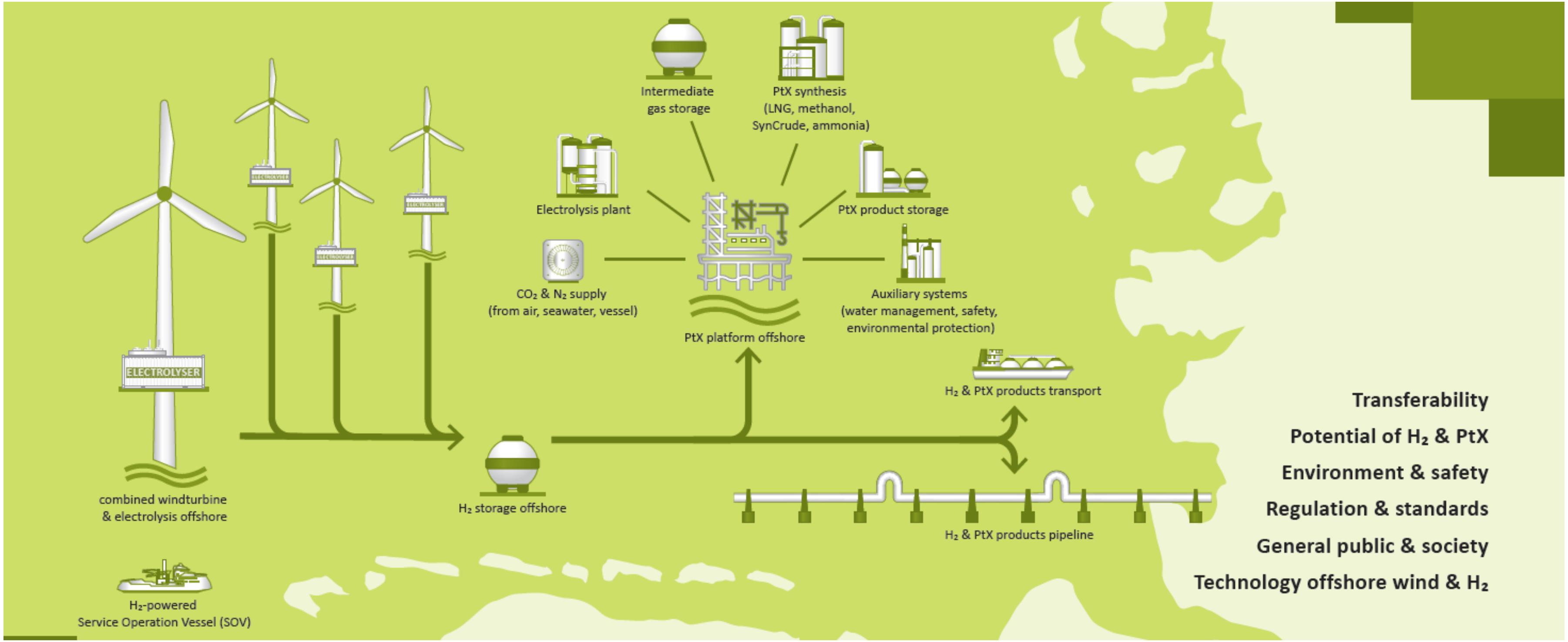
H_2Mare in a nutshell

1.



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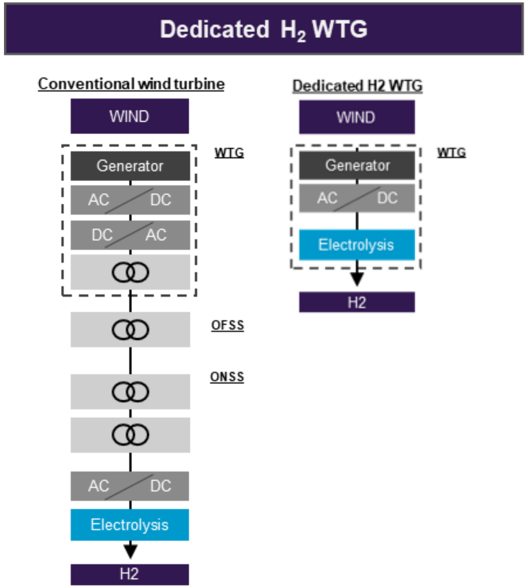
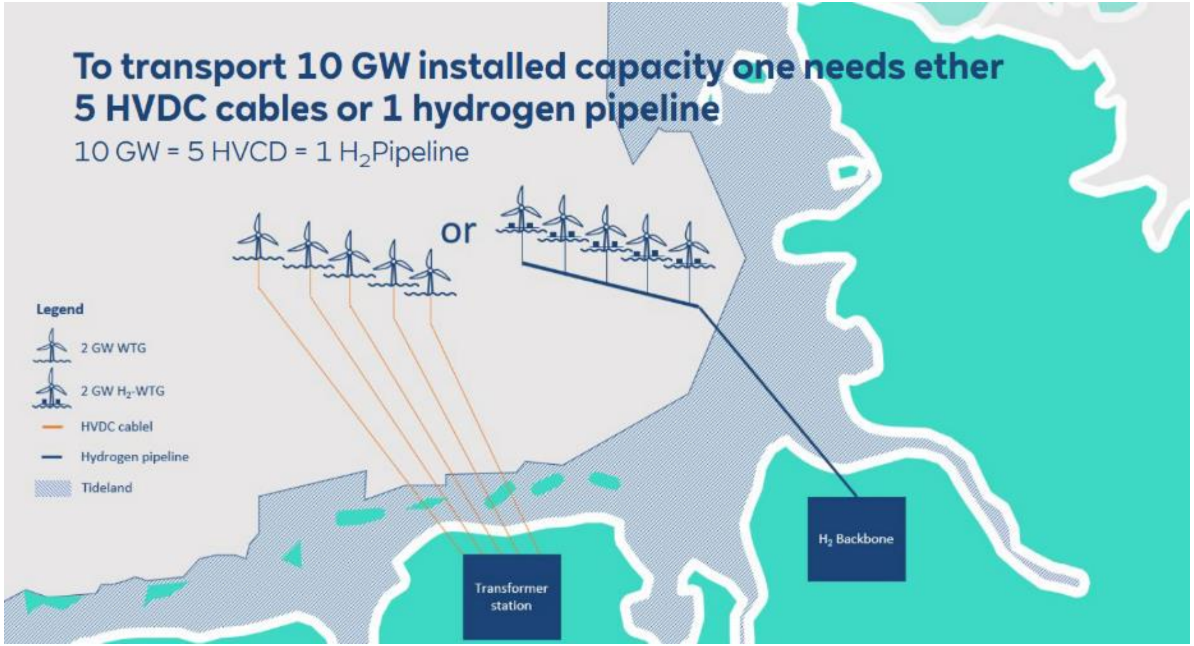
Advantage of H2 Offshore Production - DOHP



Source: © SGRE



Source: © RWE

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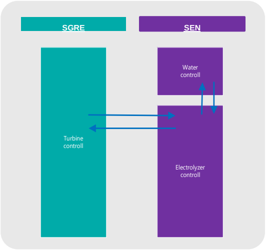
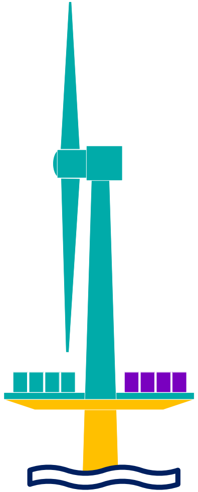
Goals Achieved

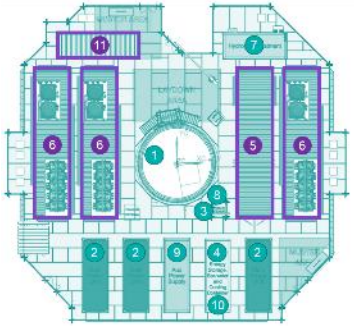


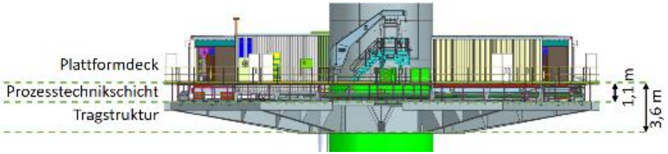
The basic design for

- the electrical interface to connect the offshore wind turbine to the electrolyzer
- the special platform at the turbine level, which contains the elements for hydrogen production and
- an expanded control system to integrate the operation of the electrolyzer into the overall operation of the offshore wind turbine

has been successfully completed.







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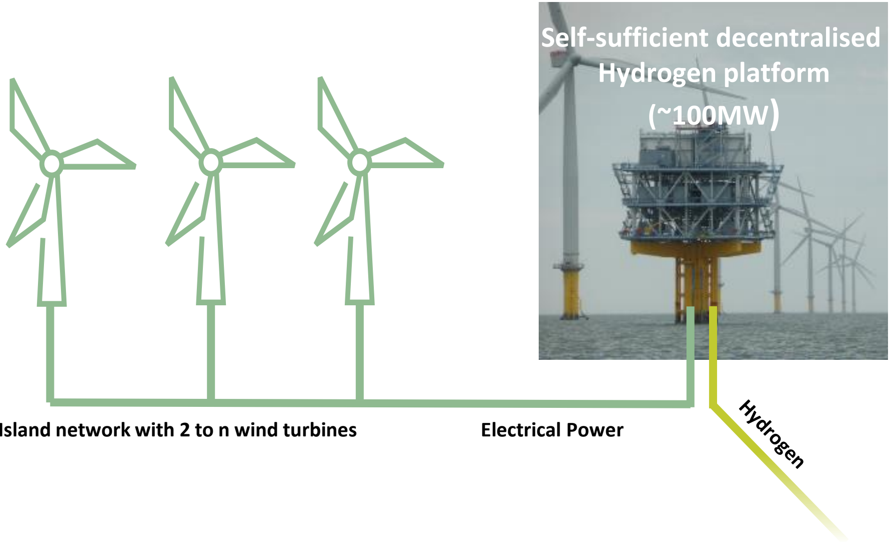
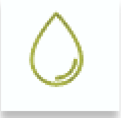
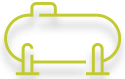
Extending H2Mare with tasks

Wind turbine-grid-forming OffgridWind

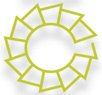




Water treatment

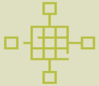


H_2-Storage



H_2-Compression

Platform Power Electronics



Network Technology

SIT & GRID

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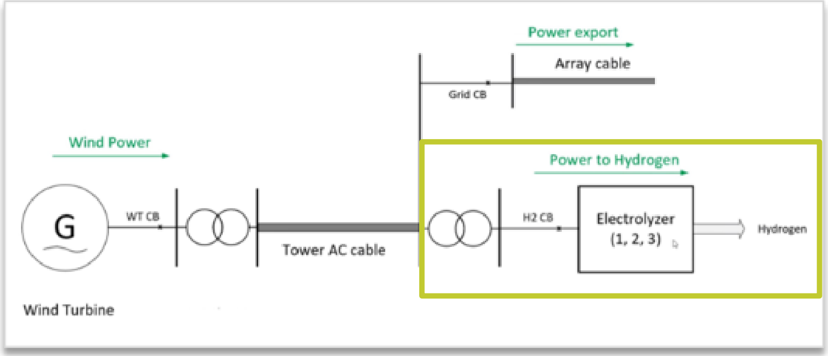
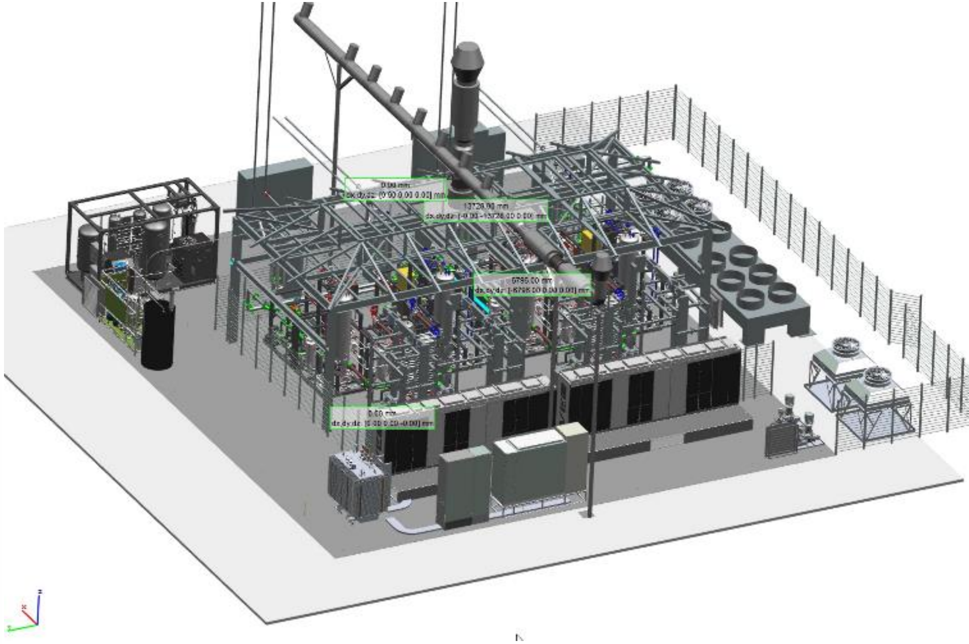
Scaled Integration Test - SIT





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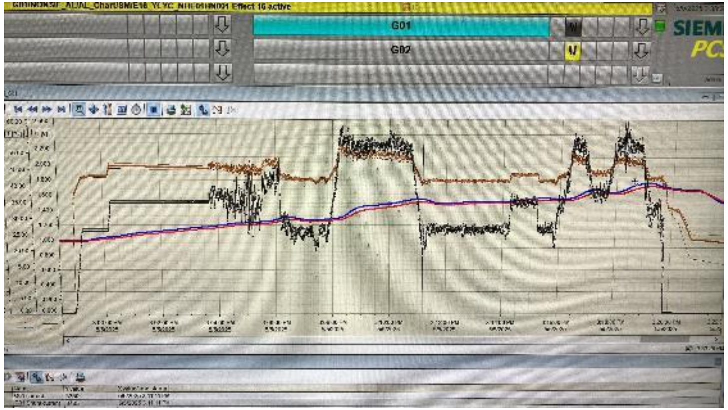
SIT – Various testing activities

- The **P(I) controller validation is complete**. Good tracking of the signals for the power reference and the damping of the powertrain was observed. This completes the scope of development in terms of hydrogen/rectifier and the turbine connection side.

  Both the **upgraded side of the wind turbine** and the **upgraded side of the software** are undergoing software optimizations and bug fixes as we observe unexpected limit or initial value issues that trigger unexpected shutdowns.
  The **process system is constantly being optimized**, especially the process safety system.



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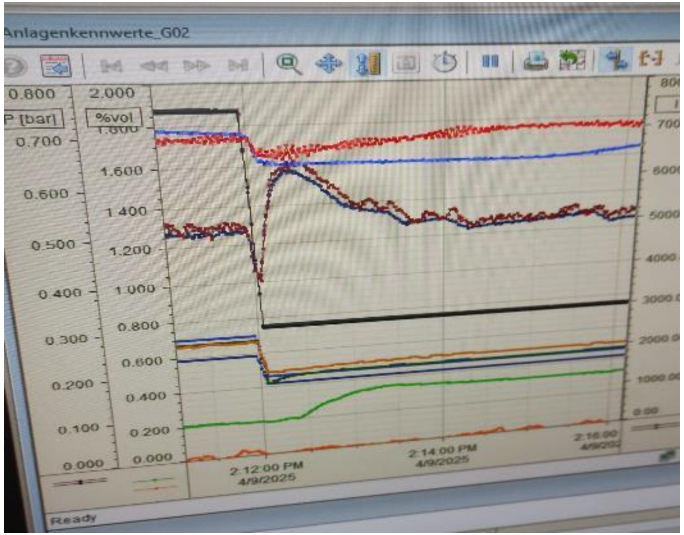
SIT – Various testing activities

- The **Ramp Up / Ramp Down** ability was achieved as a criterion for success.
  The wind turbine inverter is configured **to match the available wind turbine ramp.**

- On the side of **the converter**, this capability **was also achieved**.

- On the process system, it was found that the pressure control on the gas separator was not working as previously expected.
  To overcome this, the release of the spring valve was changed and the problem was solved.



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SIT – Various testing activities

- The **simulated island** mode could be performed. Within this mode of operation, our intention was to be able to follow the available wind power with the system. If the available power increases, the load is to be distributed between both systems. If there is not enough power to run two systems, the first system will go into standby mode and then the second system

- Achievements in simulated island mode:
  - It has managed to achieve **runtimes with strong winds and dynamic mode**. A dynamic but more continuous load on the systems, where the current signal on the stack fluctuates in a narrow band.
  - It has been possible to **achieve transit times with weak winds and dynamic mode**. A dynamic but intermittent load on the systems in nature, triggering retraction and retraction, load balancing and frequent start-up and shutdown.
  - The **dynamic controller** (wind mode) has been **modified and optimized**.

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SIT – Various testing activities

- **Island Mode** – The current step is to get a significant amount of time during which the power connection is disabled. To achieve this goal, the Droop control, frequency control, voltage control and the overall power balance of the plant are evaluated.

- Since the plant does not have a black start capability, it is planned to **start in simulated island mode** and **deactivate the grid connection at a suitable time**. This step has not yet been achieved and is planned for the next reporting period.

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Grid Forming / Robustness

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Grid Forming incl. Grid Robustnes

- Currently, the focus is on **rolling out software features** and testing them on a turbine.
- The tests carried out provided evidence:
  - that the turbine in network formation mode is able to **survive a grid fault (undervoltage)**
  - that the turbine is able to go through a **network fault (overvoltage)** in network formation mode
  - that the turbine can **drive through grid frequency events** in grid formation mode.

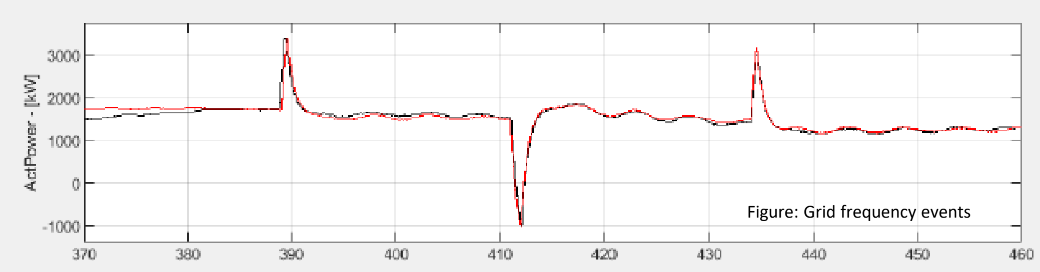

Figure: Grid frequency events

Simulations

- The simulations of the RTDS continued to achieve the lower eSCR for grid robustness required for weak grids. A total of **seventeen solutions** to achieve the lower eSCR are being planned, tested and implemented.
  Five of the seventeen solutions **have already been implemented** in the current software.
- A further **eight** solutions have a very **high degree of maturity** and are expected to be finally validated and released before the end of this year.
- The **remaining solutions** will probably not be tested or finalized until **next year**, as the simulations will have to be further adapted and carried out several times.

Thank you! - Danke! - Mange Tak! - Gracias!

Questions? – Fragen? - Spørgsmål? - ¿Preguntas?

Thomas.Schwabe@siemensgamesa.com

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BackUp

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RWE

WP 2.3.1 Offshore foundation development

- 3D modelling to
  - Align on interfaces
  - Visualize and check design changes
  - Optimize installation and service concepts
  - Marketing opportunities
  - Future usecases

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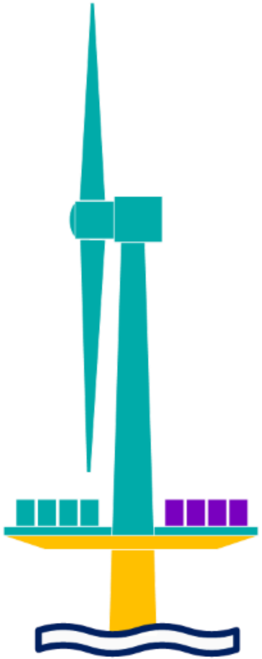
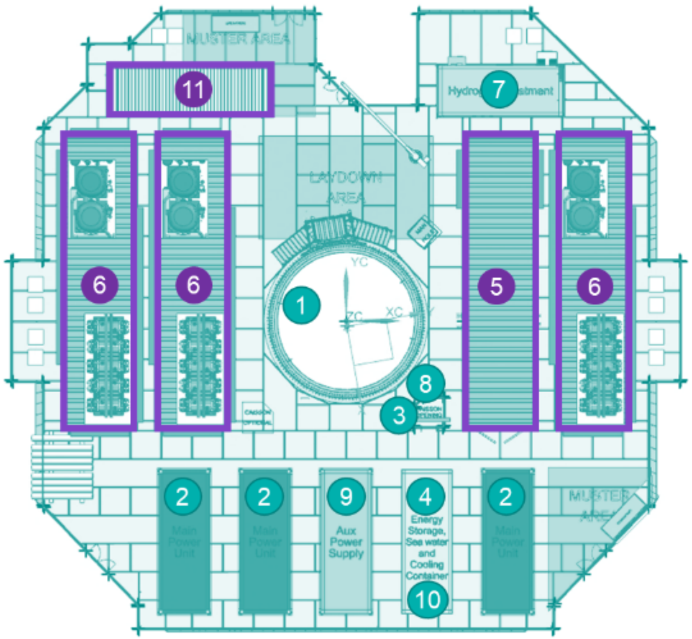
Plattform Design

SGRE **SEN**





1. **Reference WTG: SG DD-236**
   - Delivers 14 MW nominal rating + 1 MW power boost
   - Controls the overall process
2. **3 main power supply containers**
   - Transform 5 MW AC power each and rectify it to DC
3. **2 submersible seawater pumps**
   - Take in seawater (coarse filtered)
4. **Seawater container**
   - Pre-treats the seawater (fine filter, UV)
5. **Water management container**
   - Generates demin water using electrolyzer excess heat
6. **3 electrolyzer containers (PEM technology)**
   - Split demin water into H2 and O2 using 5 MW DC power each
7. **Hydrogen treatment container**
   - Dries the hydrogen
8. **Offtake manifold**
   - Sends the hydrogen to the offtake pipeline
9. **Electrical auxiliary power supply container**
   - Transforms and distributes the LV auxiliary power
10. **Energy storage container**
    - Stores electrical backup energy in batteries
11. **Electrolyzer control container**
    - Controls the electrolysis process