



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

MARANDA

**Marine application of a new
fuel cell powertrain validated
in demanding arctic
conditions**



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PROJECT OVERVIEW



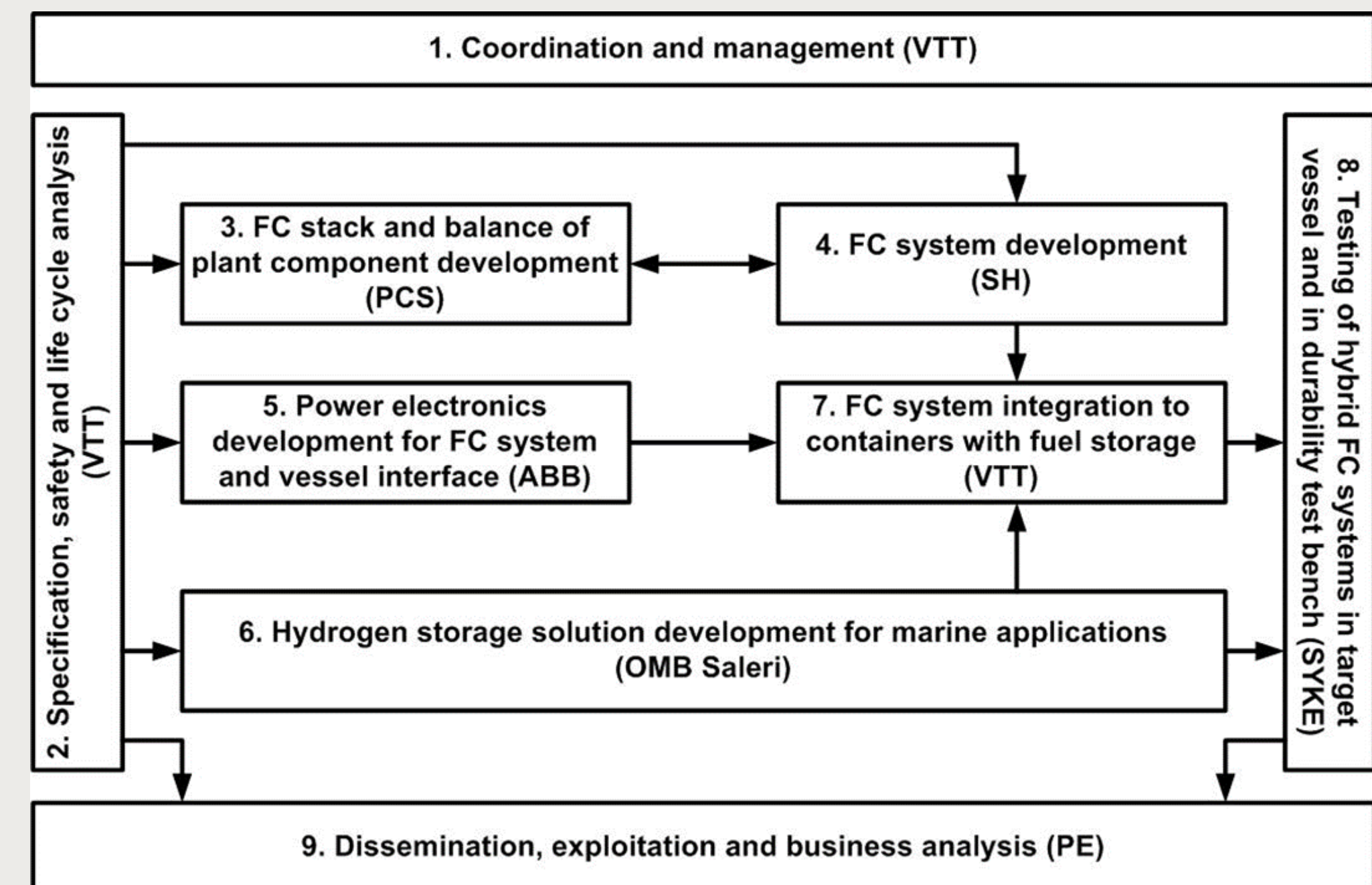
- **Call year: 2016**
- **Call topic: Develop new complementary technologies for achieving competitive solutions for marine applications**
- **Project dates: 01/03/2017-28/02/2021**
- **% stage of implementation 01/11/2018: 40 %**
- **Total project budget: 3704758 €**
- **FCH JU max. contribution: 2939358 €**
- **Other financial contribution: 765000 € from SERI, State Secretariat for Education, Research and Innovation (in Switzerland)**
- **Partners: Teknologian tutkimuskeskus VTT Oy, Powercell Sweden AB, ABB OY, OMB SALERI SPA, PERSEE, SUOMEN YMPARISTOKESKUS, SWISS HYDROGEN SA**



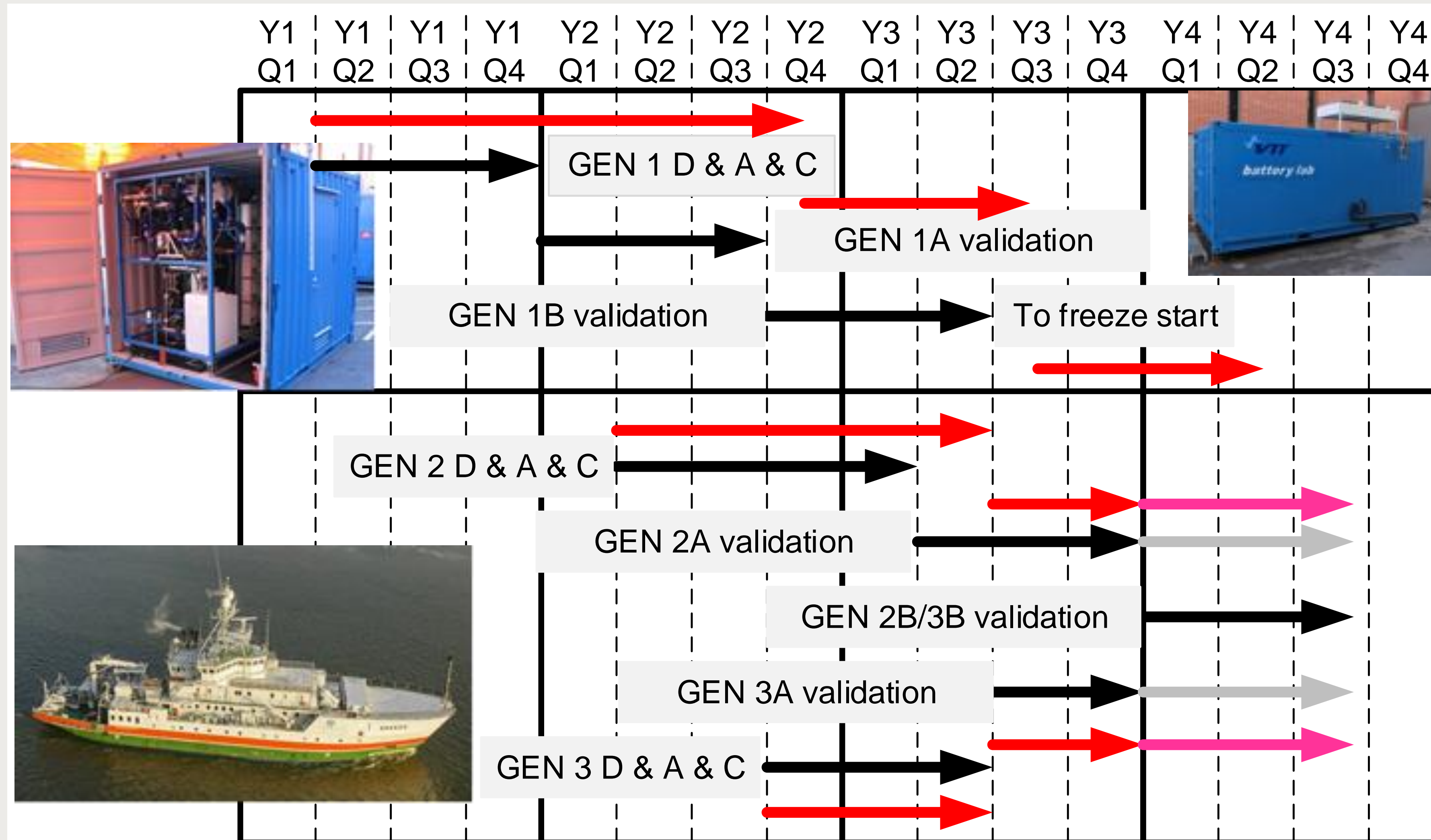
PROJECT SUMMARY for MARANDA - Marine application of a new fuel cell powertrain validated in demanding arctic conditions



- **Project main objectives:**
 - Develop an emission-free hydrogen fuelled PEMFC based hybrid powertrain system for marine applications.
 - Validate systems (3 x 82.5 kW) in test benches and on board the research vessel Aranda.
- **Global positioning vs international state-of the art**
 - Automotive stacks and systems are used for the first time in marine applications.
 - The first marine application in arctic conditions.



PROJECT SUMMARY – timeline for validation activities



PROJECT PROGRESS/ACTIONS: Fuel cell system and hydrogen storage container design according project specifications and RCS



Status at month 20 of a 48 months project at date 01/11/2018

65%

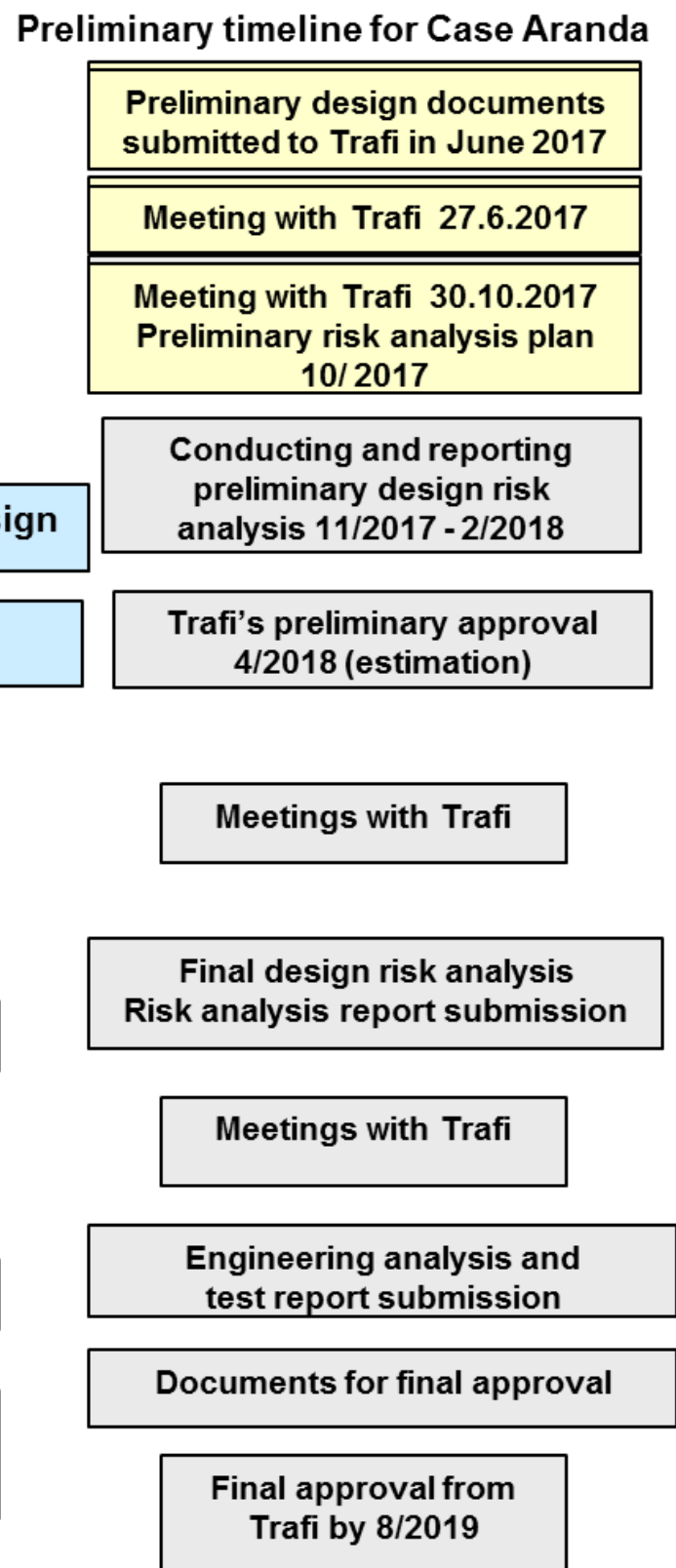
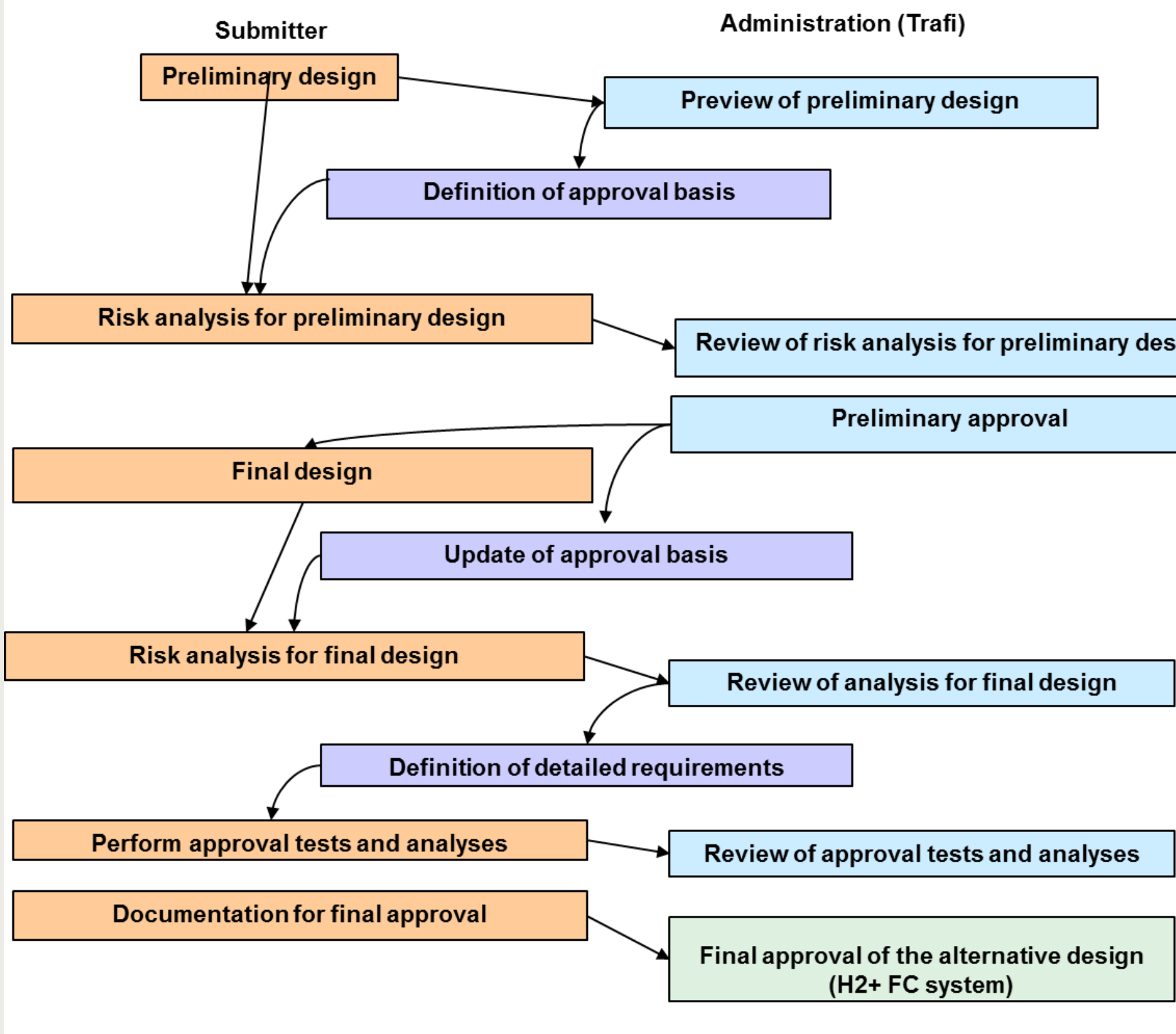
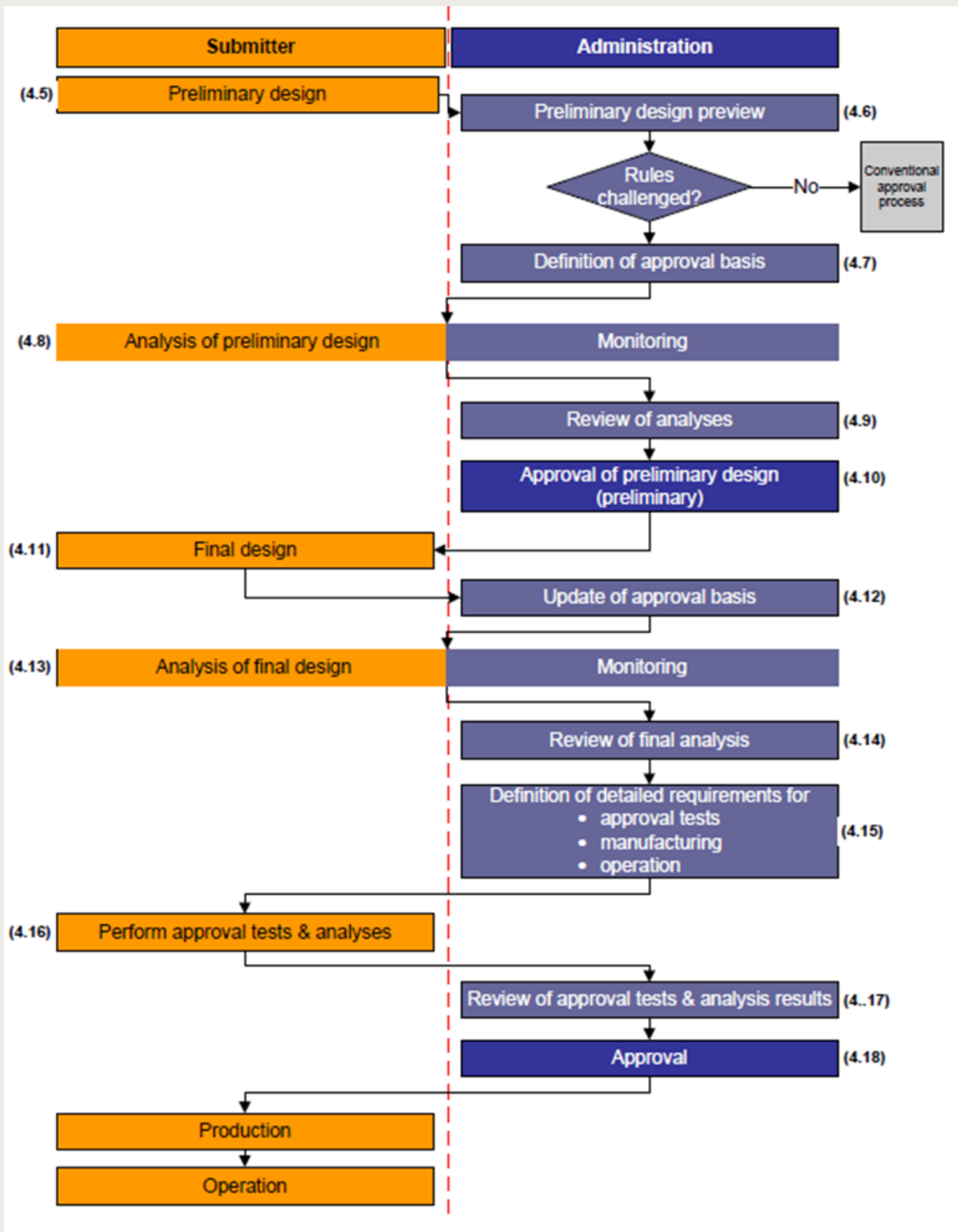
Achievement to-date

Design final drafts

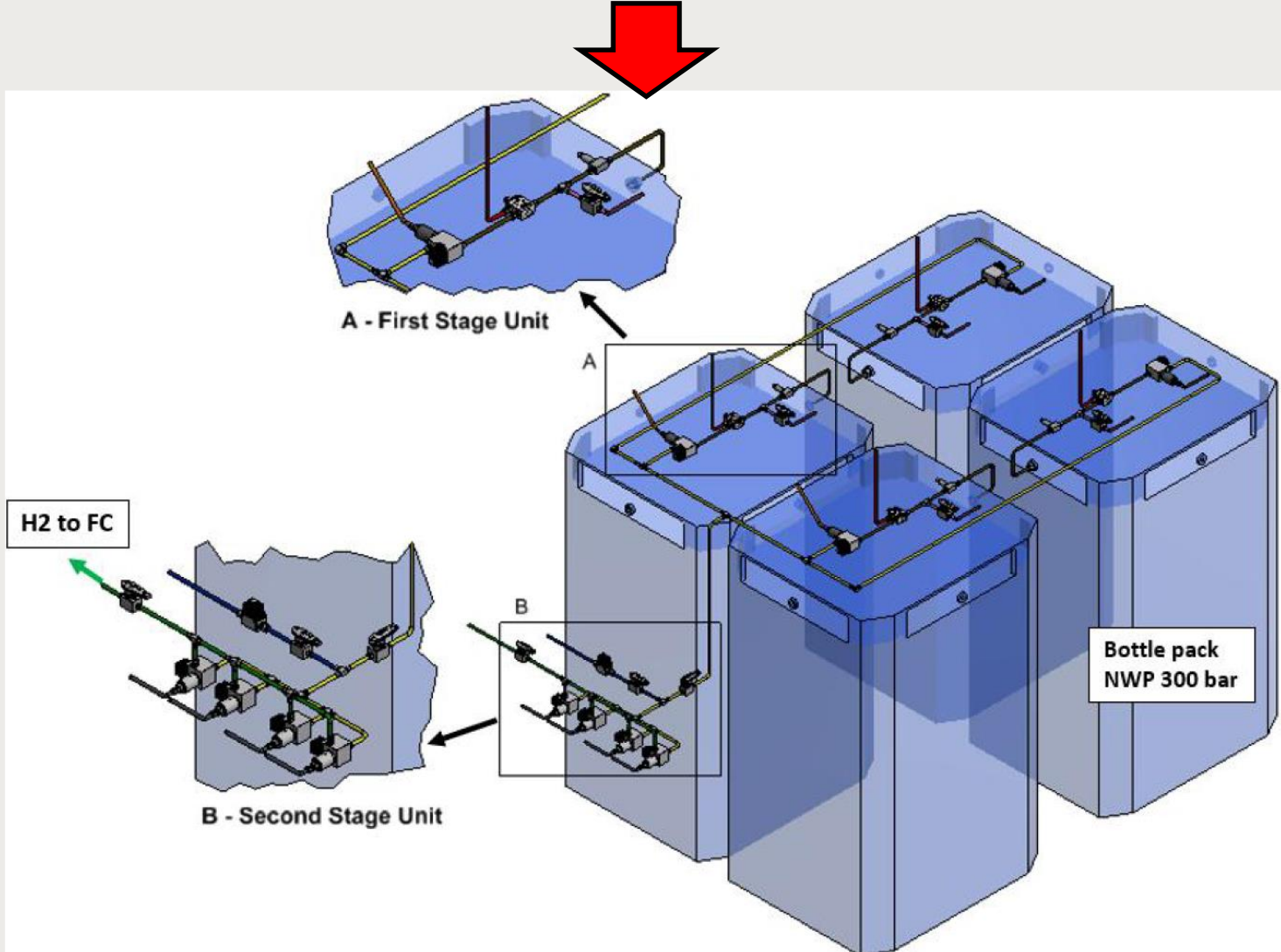
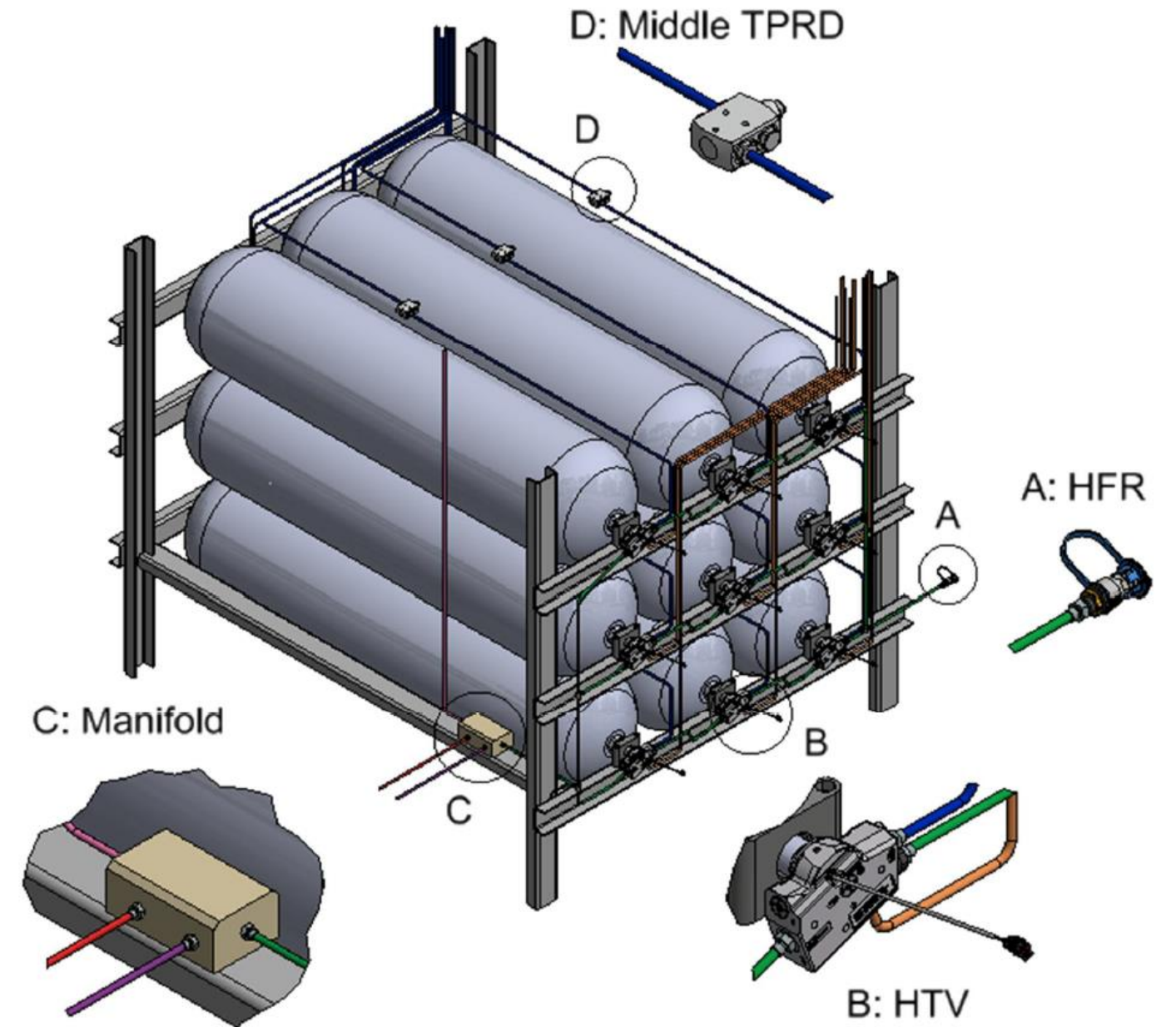
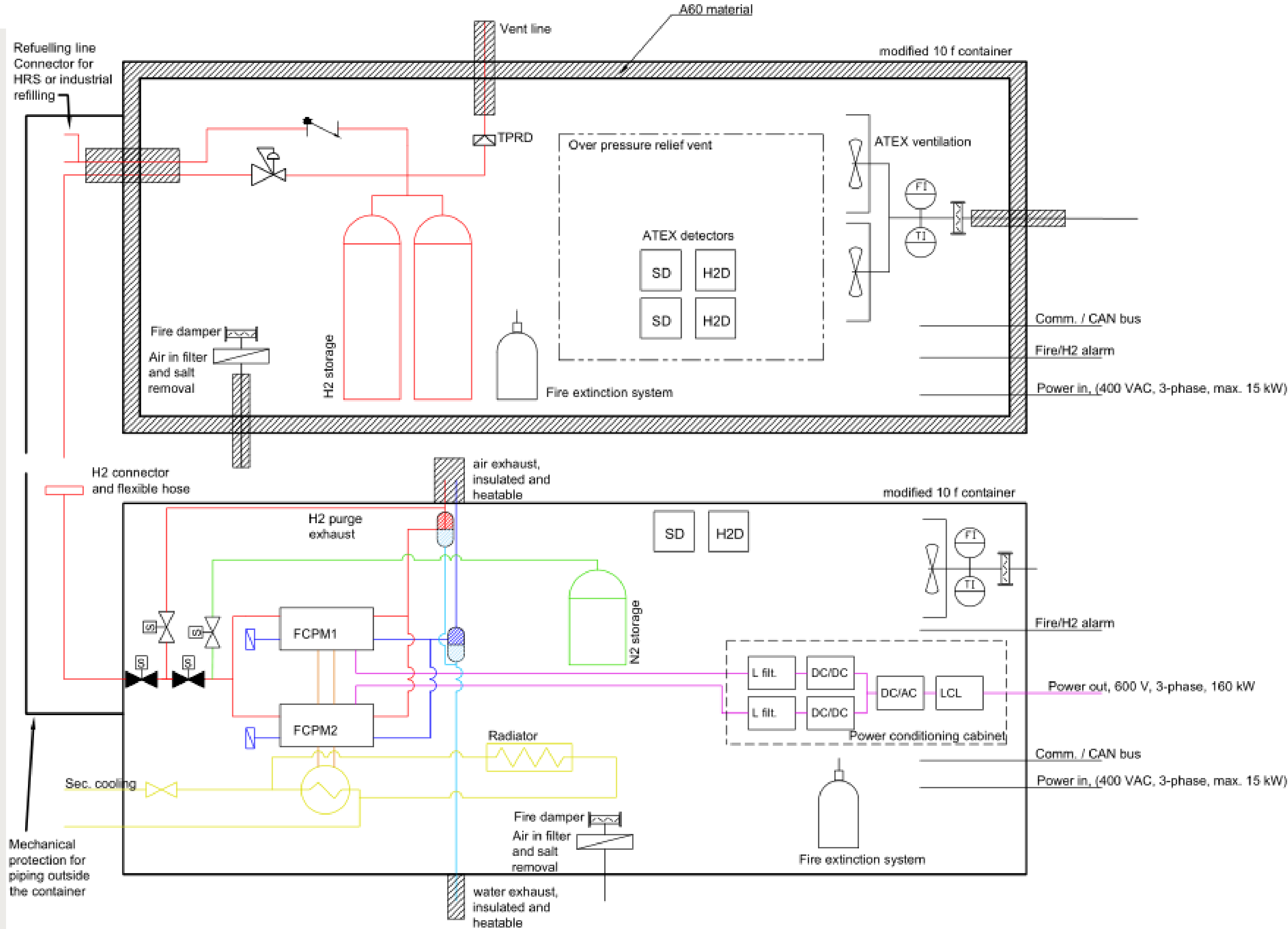


Approval by TRAFI

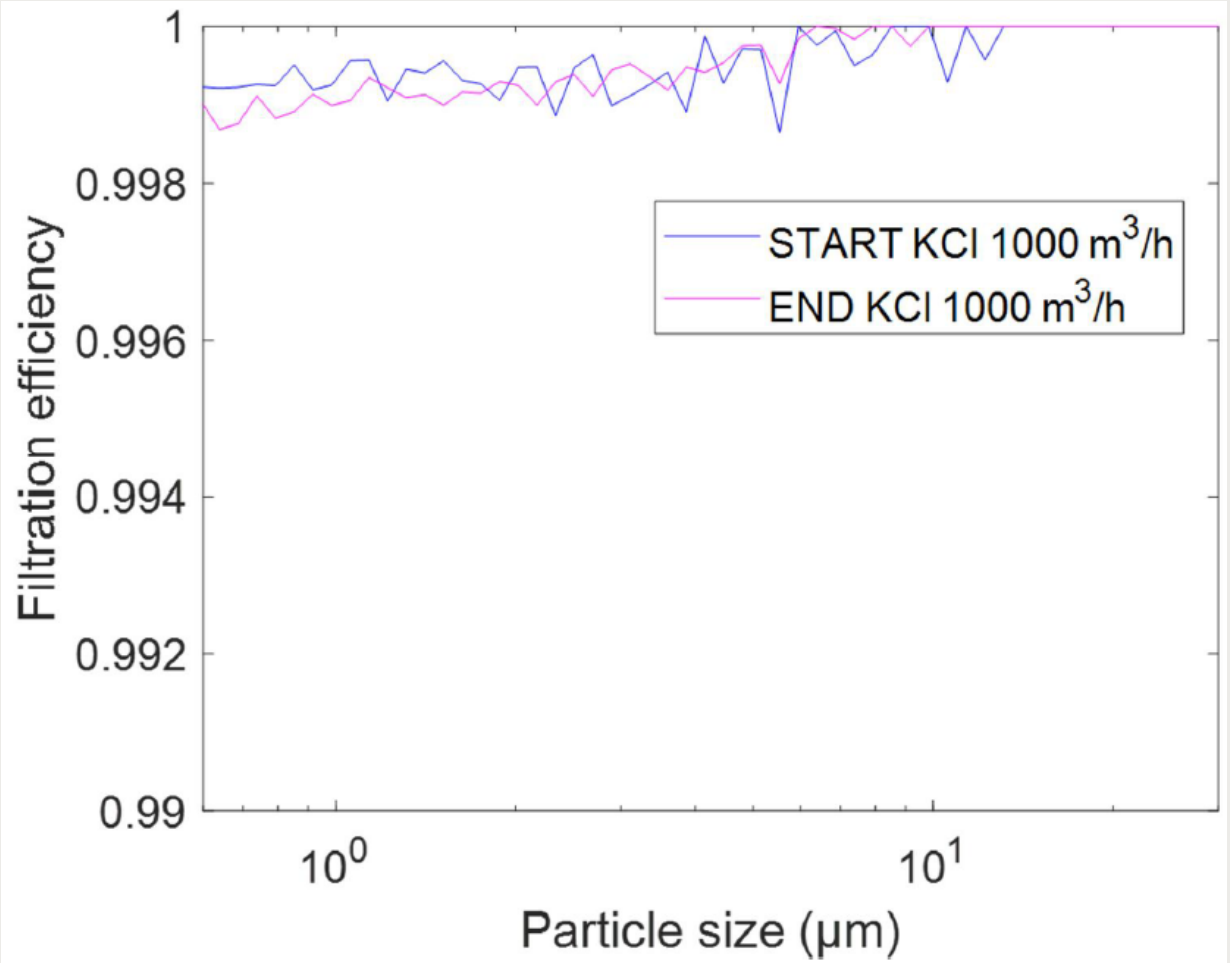
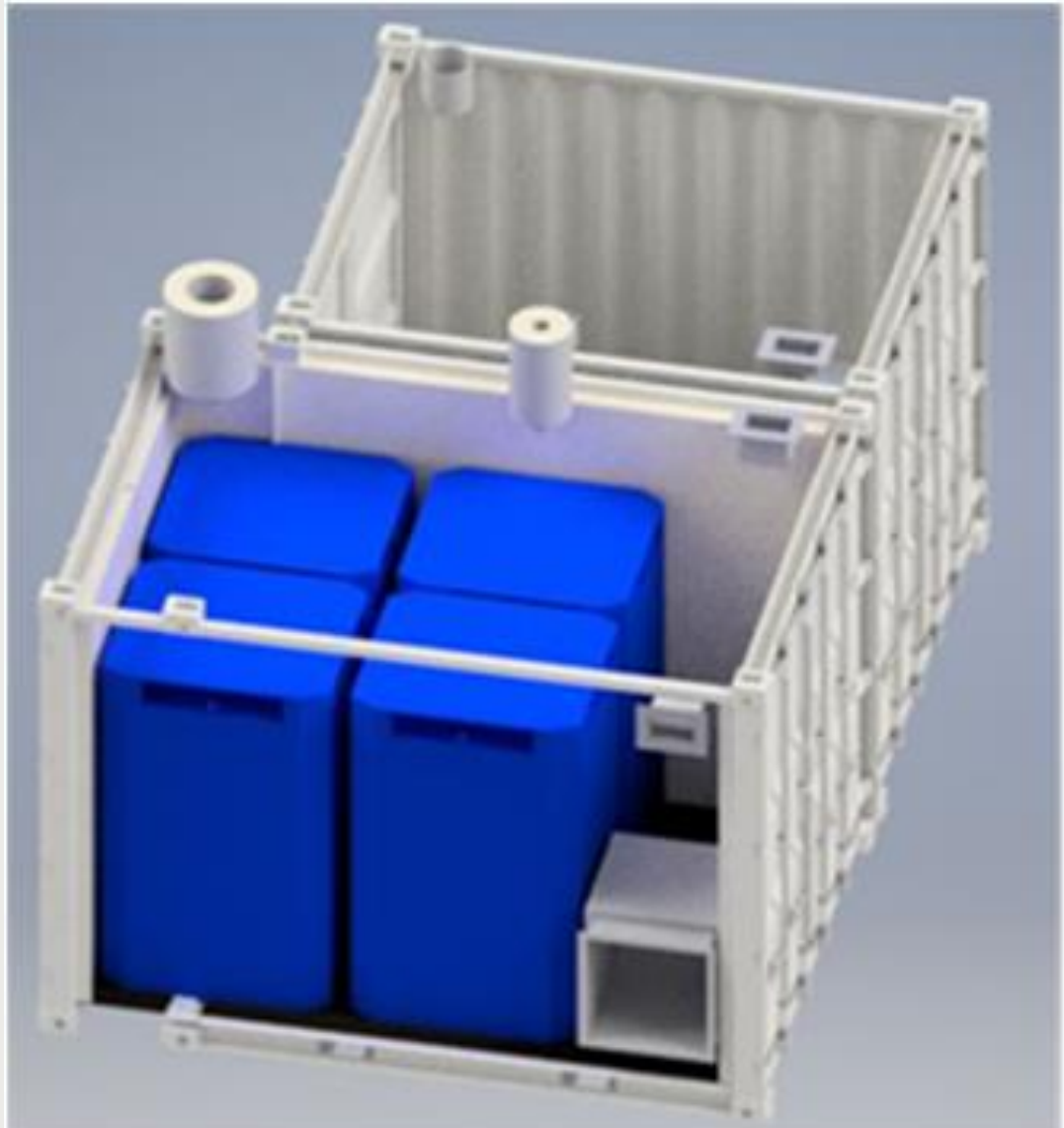
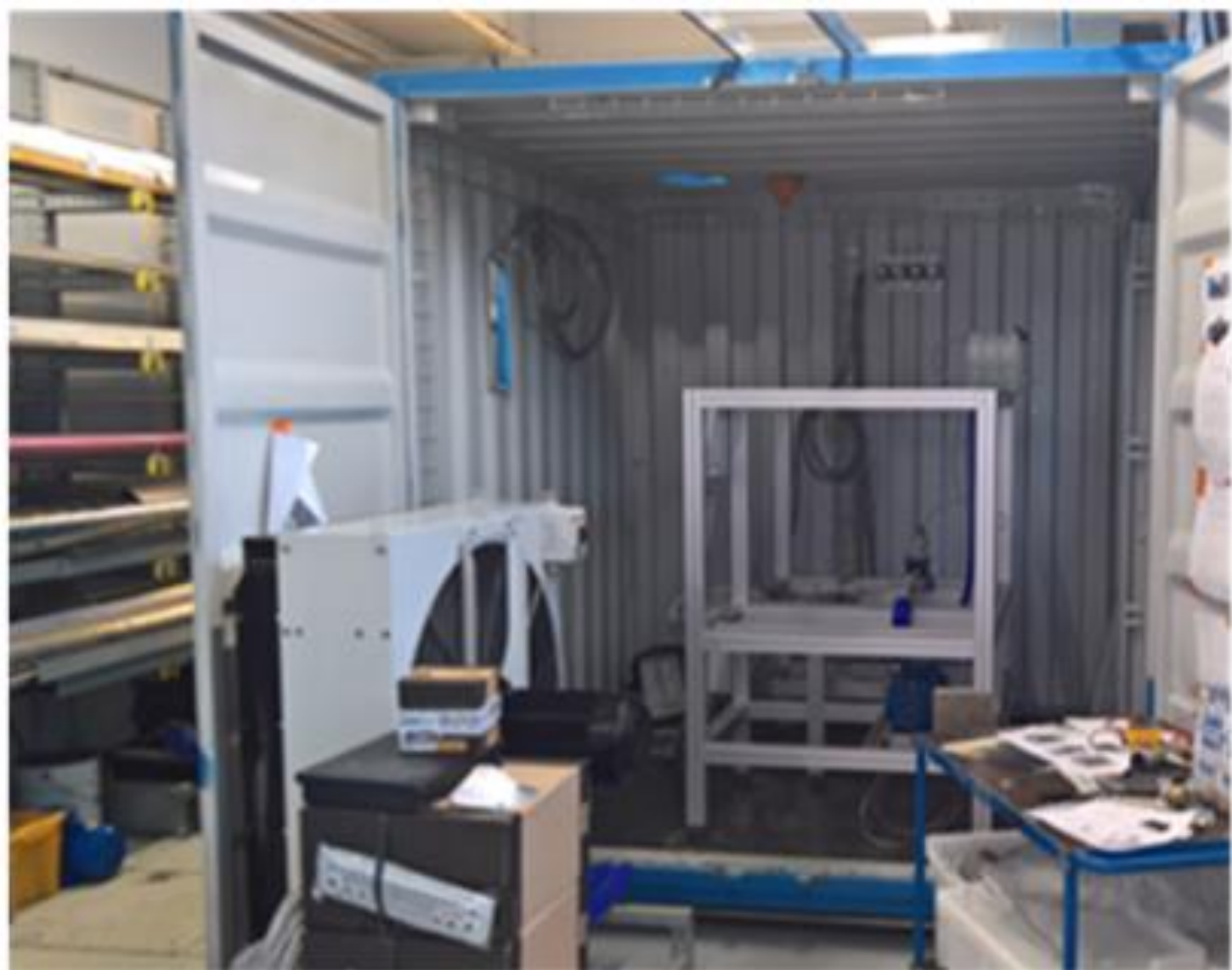
The procedure for the approval of alternative design is prescribed in IMO's MSC.1/Circ.1455



PROJECT PROGRESS/ACTIONS: Fuel cell system and hydrogen storage container design according project specifications and RCS



PROJECT PROGRESS/ACTIONS: Fuel cell system and hydrogen storage container design according project specifications and RCS



PROJECT PROGRESS/ACTIONS – Stack and system performance



Status at month 20 of a 48 months project at date 01/11/2018

Achievement to-date

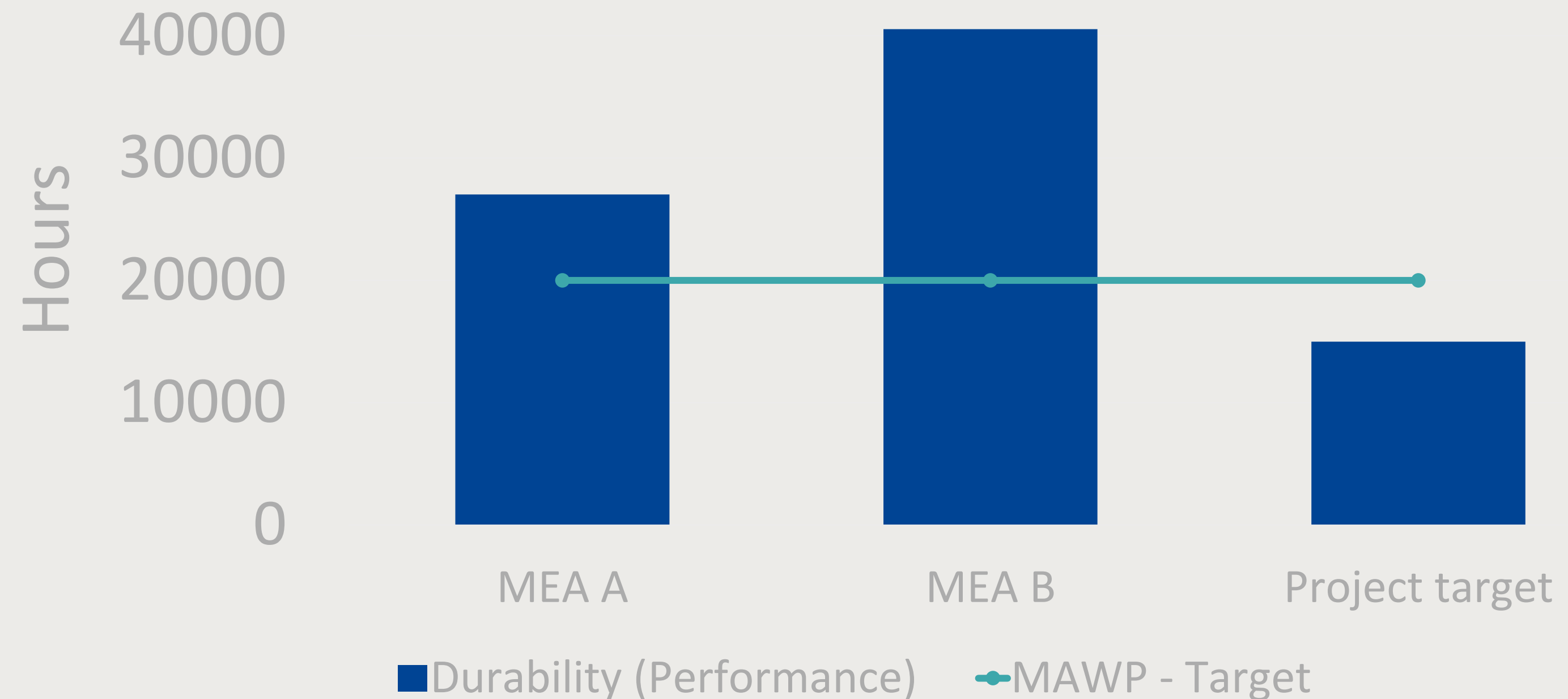
1.7 $\mu\text{V/h}$ (A)
2.6 $\mu\text{V/h}$ (B)
45% (AC)



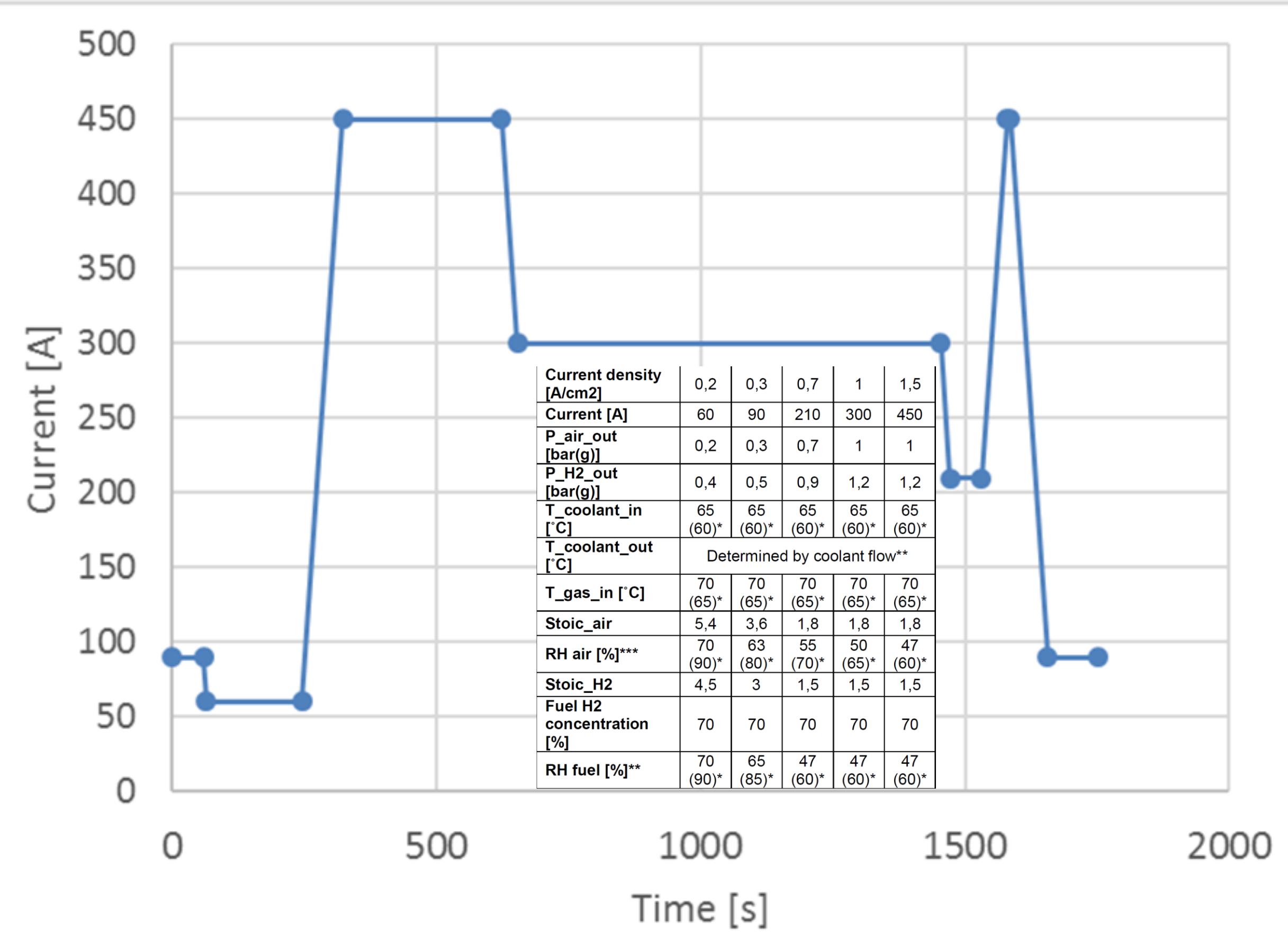
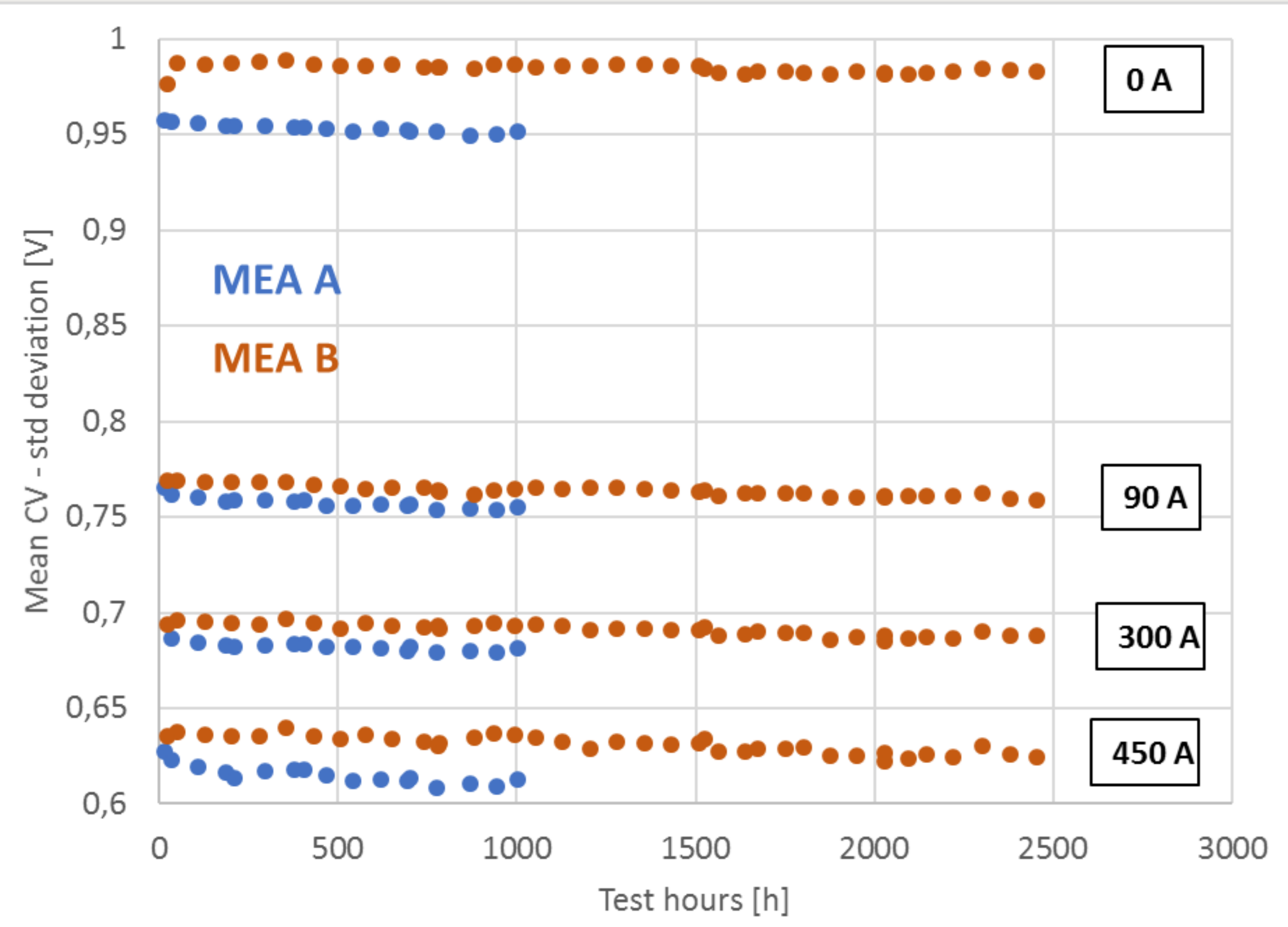
4.6 mV/h
48% (AC)

Marine APU duty cycle and conditions

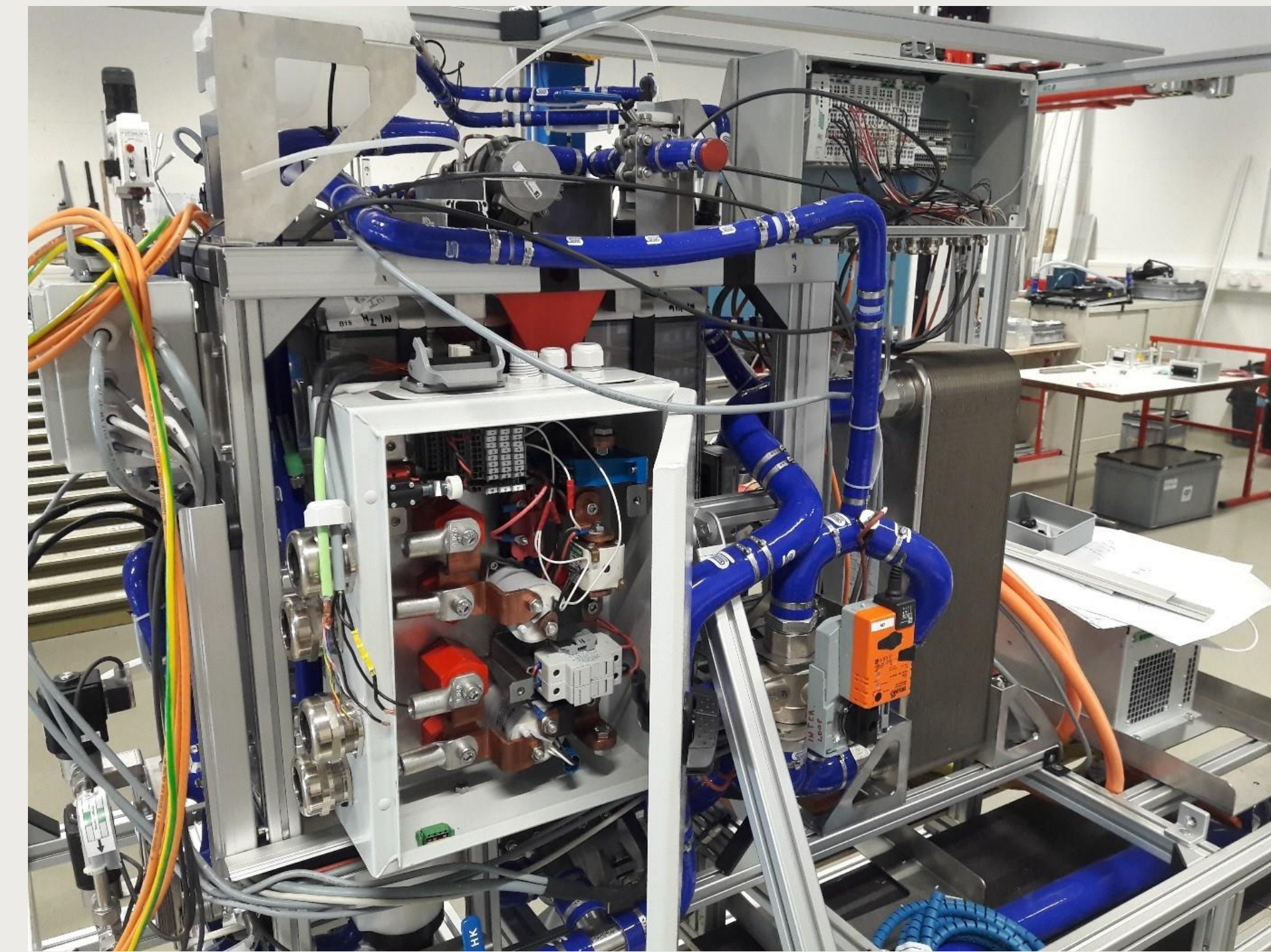
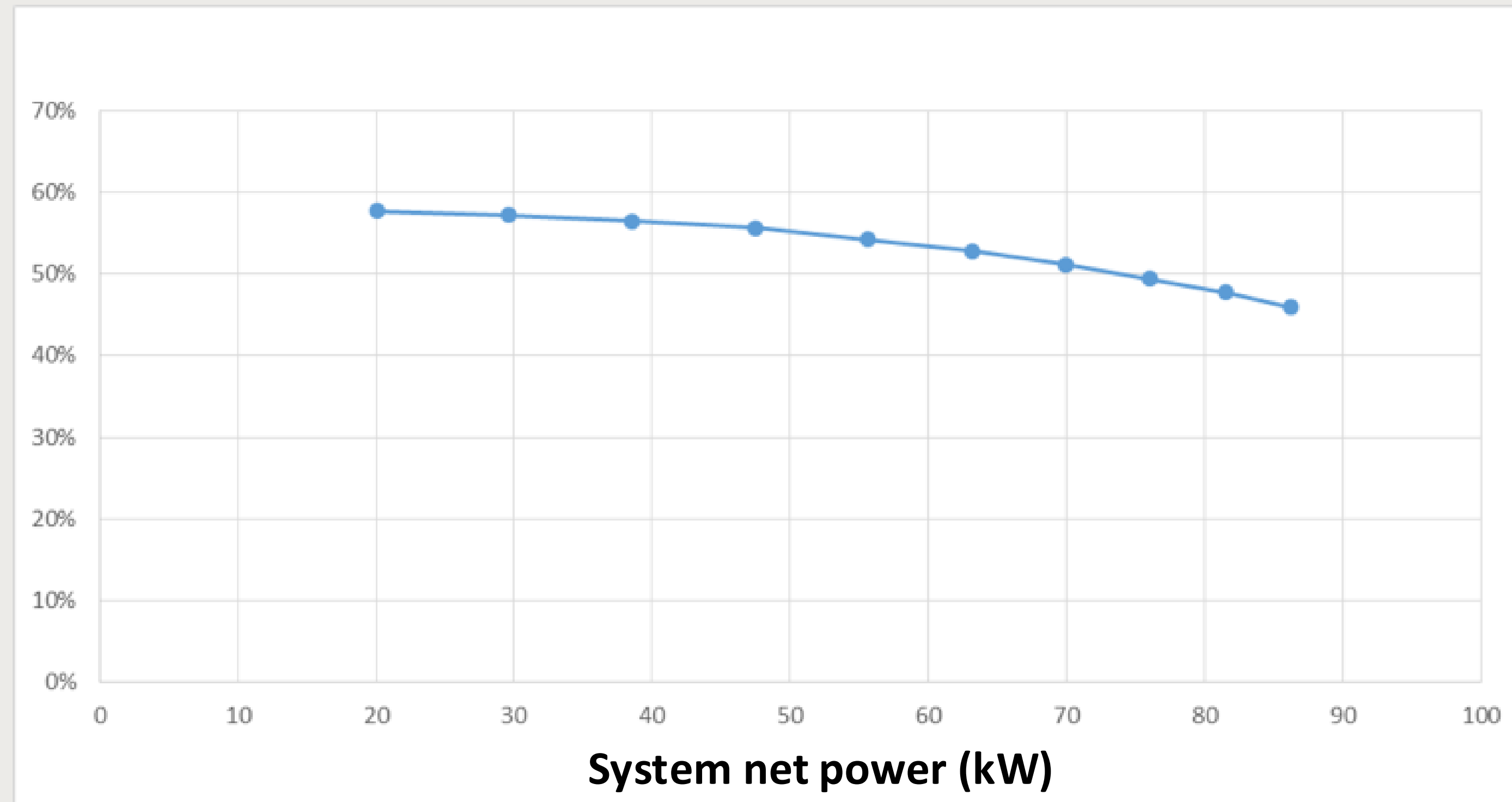
Short stack testing:
MEA A: 1000 h
MEA B: 2500 h



PROJECT PROGRESS/ACTIONS – Stack and system performance



PROJECT PROGRESS/ACTIONS – Stack and system performance

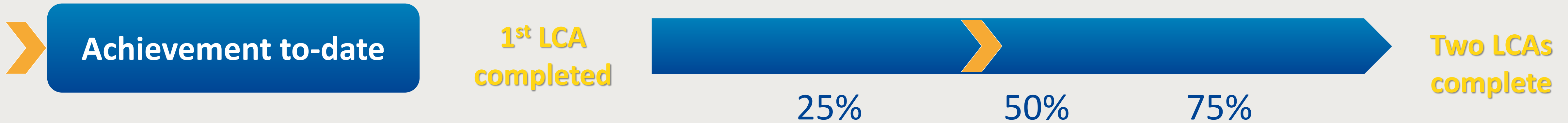


Calculated system efficiency as a function of DC net power

1st FCS during final assembly



PROJECT PROGRESS/ACTIONS - Environmental assessment



Status at month 20 of a 48 months project at date 01/11/2017

40 MWh produced with H2-FC APU

	GWP 100a [kg CO ₂ eq.]	GWP 100a (share)
Full life cycle	79810	100.0 %
Containers	13820	17.3 %
Fuel cell system	12090	15.1 %
H ₂ production and transportation	11880	14.9 %
H ₂ storage system	42030	52.7 %
Use stage	0	0.0 %

40 MWh produced with the marine diesel oil engines

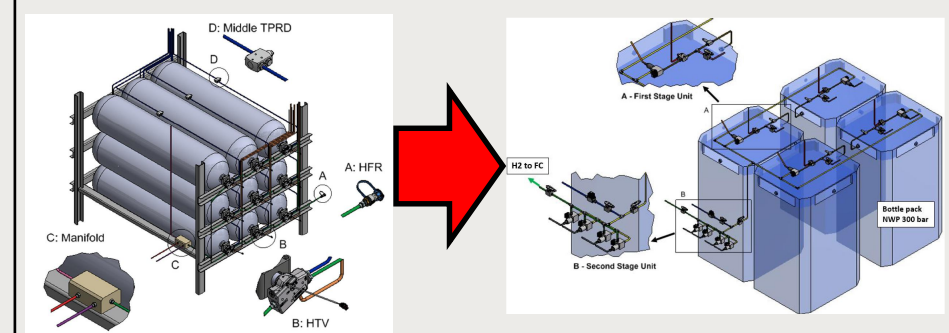
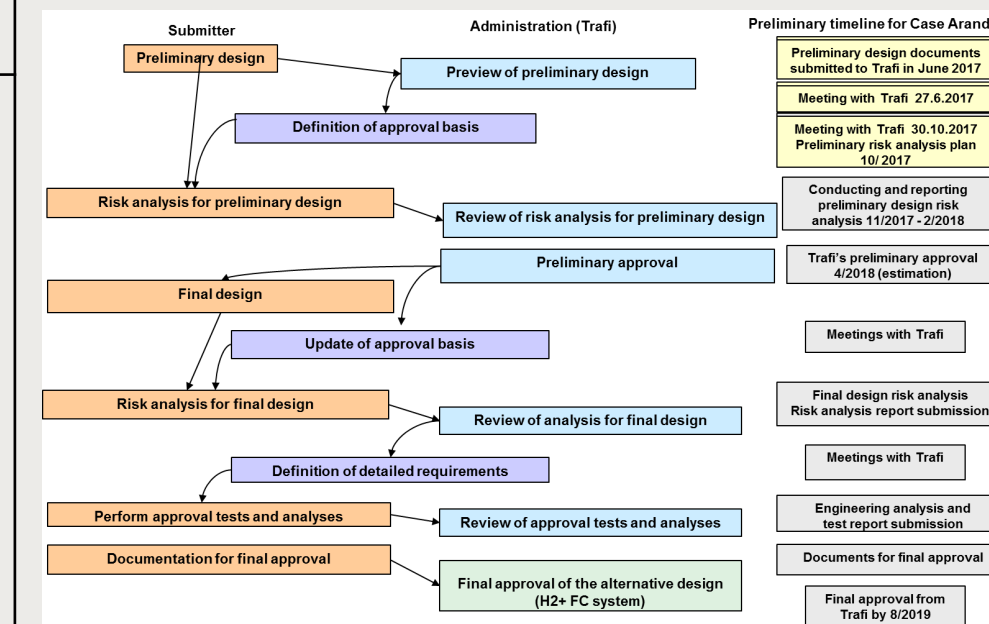
	GWP 100a [kg CO ₂ eq.]	GWP 100a (share)
Full life cycle	38340	100 %
Use stage	33280	86.8 %
Fuel production	5065	13.2 %

- For very low total use hours (lifetime 30 x 8 h = 240 h) global CO₂ emissions are larger than with conventional diesel engines and fuel.
- When total use hours are low FC system and H₂ storage dominate in LCA calculations.
- For by-product hydrogen the choice of allocation method (energy, economical value, mass) has a large impact.

Risks and Challenges



Description of risk	Risk-mitigation measures	Comments
A delay in the development of PEMFC system for marine use.	Monthly TC meetings keeping the project status updated. Mapping optional suppliers for main components.	Unexpected major delay of stack component delivery. Factory acceptance testing (FAT) of the first fuel cell system delayed.
Both FCS and hydrogen storage containers need to be realised so that class approval could be possible (DNV GL-classed)	Resources are transferred from other tasks and work packages if needed.	Unexpected risk (not in DoA)
Road transport of the closed sea container with full hydrogen bottles is not possible.	A change of the hydrogen storage container to TPED certified composite bottle bundles.	Unexpected risk (not in DoA)



Communications Activities



During the first 18 months the project has communicated the possibilities of hydrogen fuel cells in marine applications.

The main event was NaviGate 2018, international fair for marine professionals, organised at the Turku 16.-17.5. 2018. MARANDA project was presented in it's own booth.

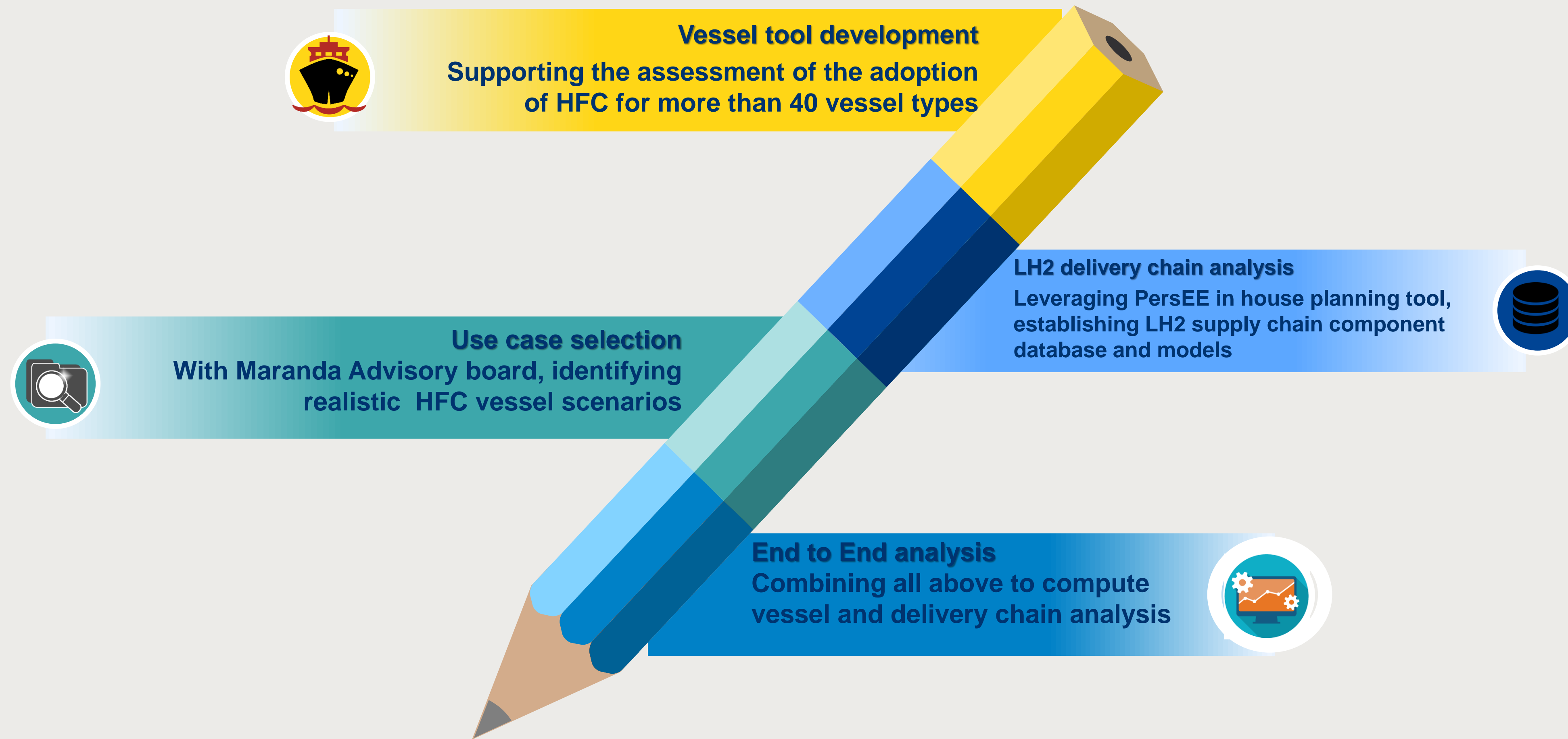
MARANDA project has organised 3 workshops and has participated in 8 other conferences or workshops.

The results of MARANDA project will be communicated by participation in conferences/workshops and in one more major marine event. A summer campaign to take place last summer, which will target the public using any ferry connection to a European island.



MARANDA stand at NaviGate 2018 trade fair (Turku, Finland).

Horizontal Activities - A business analysis tool and marine advisory board (MAB) work



HFC GoTo Marine market strategy
To be delivered during second half of the project



EXPLOITATION PLAN/EXPECTED IMPACT



Exploitation (result)

Direct exploitation of the project results will be done by the project partners:

VTT: Ejector model and experimental characterisation in ejector test-bench.

OMB: Design, manufacturing and testing hydrogen storage at system level.

PersEE: HFC Vessel analysis tool

PCS: Stack durability test results

ABB: HES880 drive operating at 690 V(AC)

SH: Cost reduction of fuel cell system

Impact (Exploitation plan)

VTT: Research services for fuel cell companies

OMB: a wider and more complex range of products.

PersEE: The vessel tool is expected to be used by all project partners during dissemination events.

PCS: Enables application of PowerCell S3 stack in more heavy-duty applications demanding long lifetime

ABB: New markets and applications for HES880

SH: Enlarge the market for Swiss Hydrogen



Acknowledgements



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This project has received funding from SERI, State Secretariat for Education, Research and Innovation (in Switzerland).

