

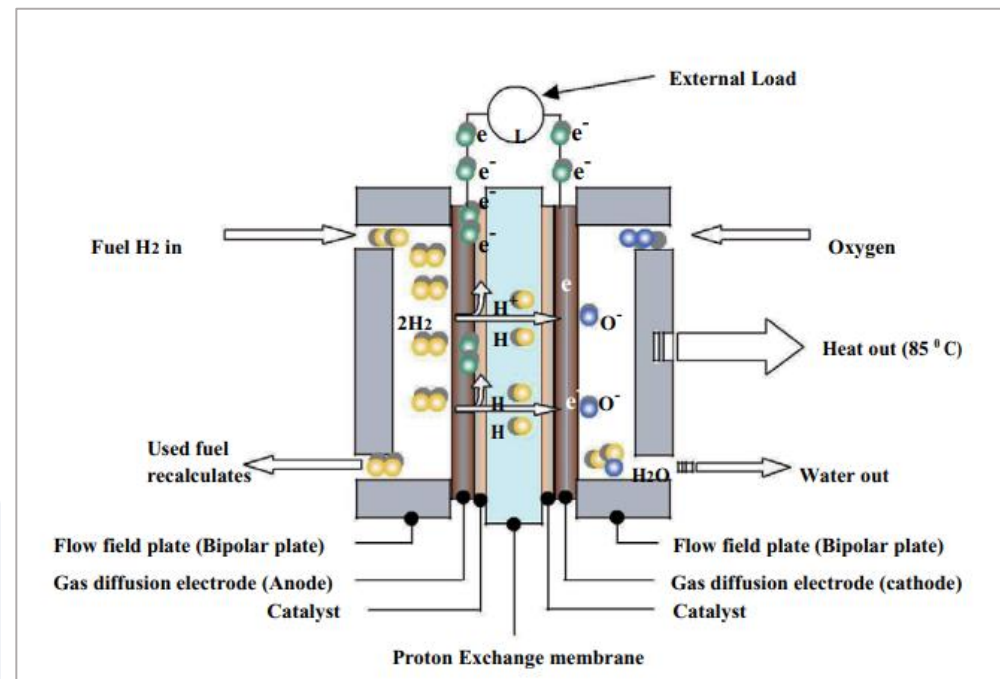
Dynamic performance of the 240-kW PEMFC HI-SEA power system

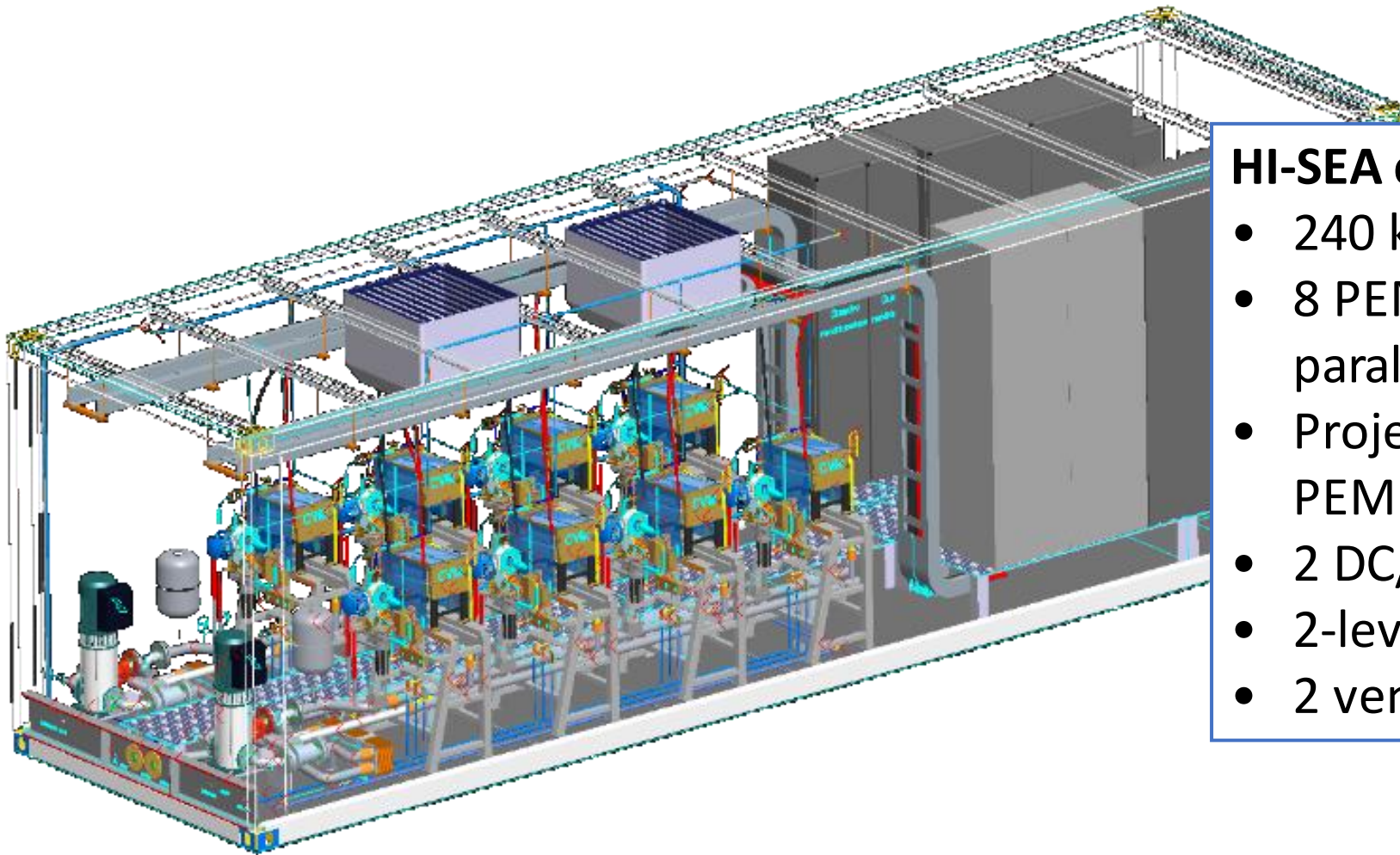
Low Emission Advanced Power – LEAP Workshop, 1-5th November 2021

Eng. Eleonora Gadducci, PhD candidate

Agenda

- HI-SEA Laboratory
- Dynamic load tests
- Conclusions and discussion





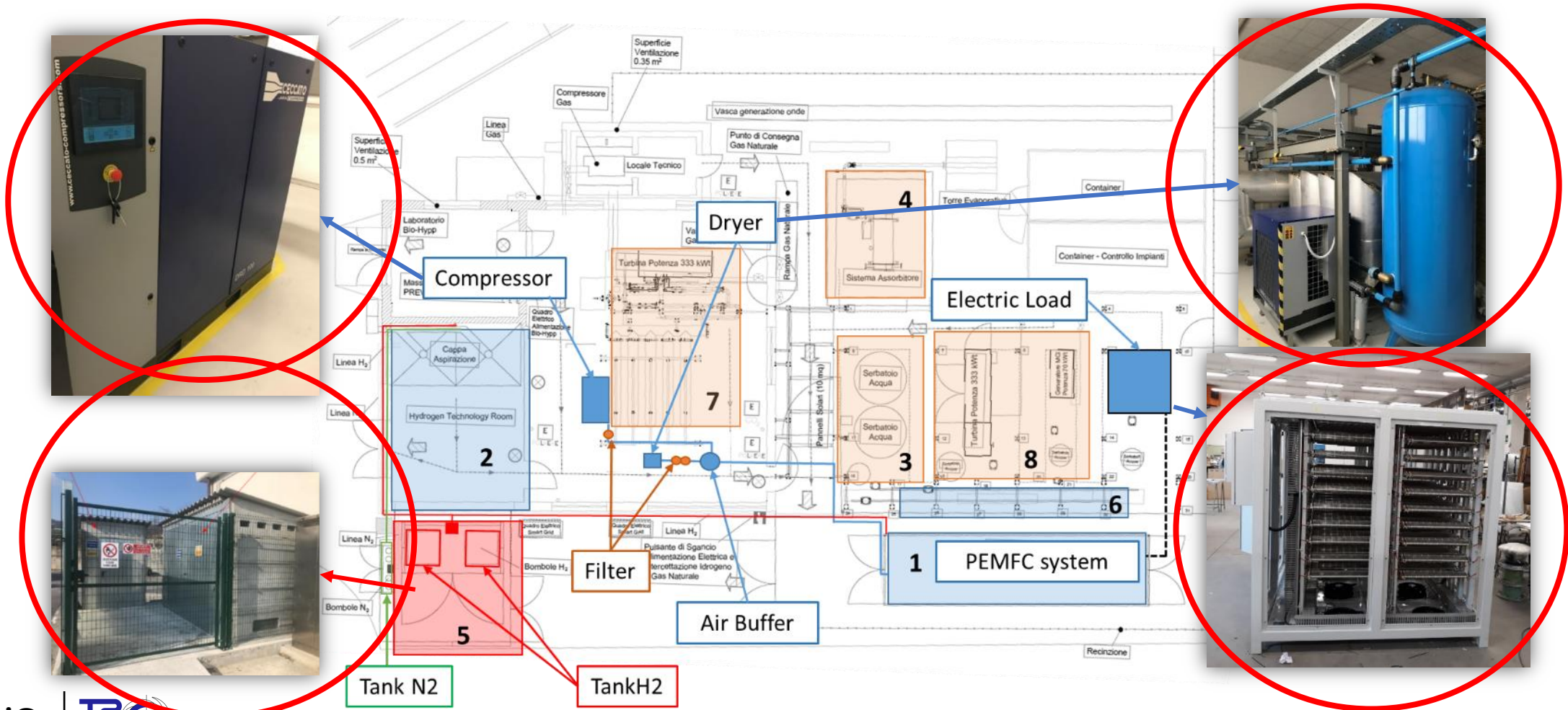
HI-SEA container (30 ft):

- 240 kW system with auxiliaries
- 8 PEMFC stacks Nuvera on 2 parallel branches
- Project financed by Fincantieri: PEMFC applications for shipping
- 2 DC/DCs
- 2-level cooling system
- 2 ventilators

HI-SEA Laboratory

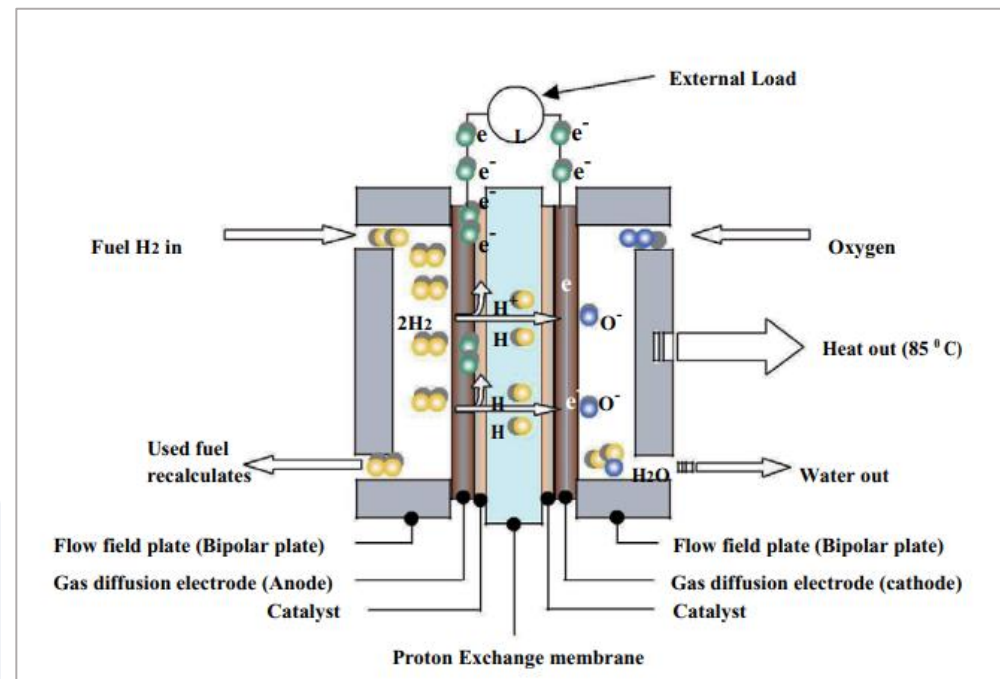
Other components:

- Air compressor with dryer and filters (12.3 Nm³/min)
- Resistive load (modular resistive banks, 300-500V @ 300A)
- 2 groups of 25 hydrogen tanks at 200 bar (max capacity 400 Nm³)

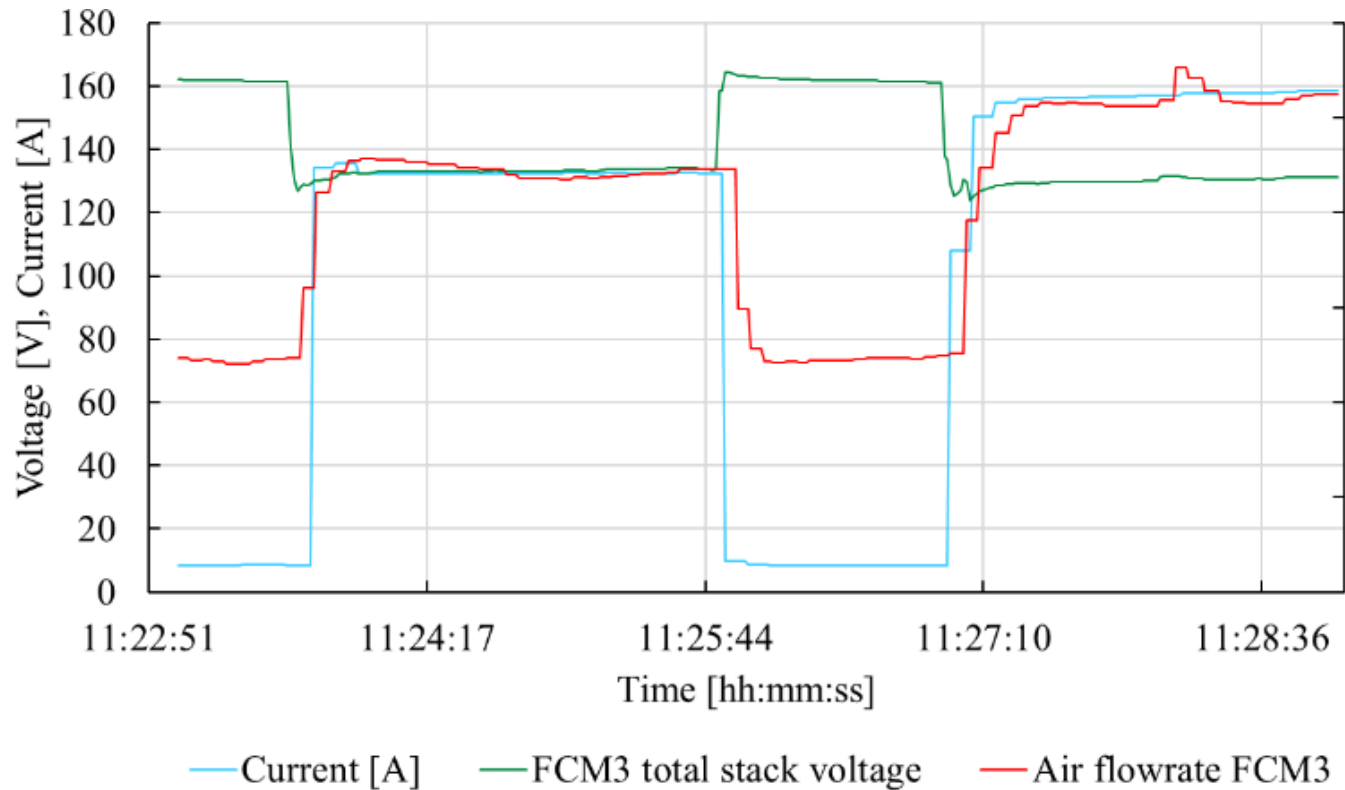


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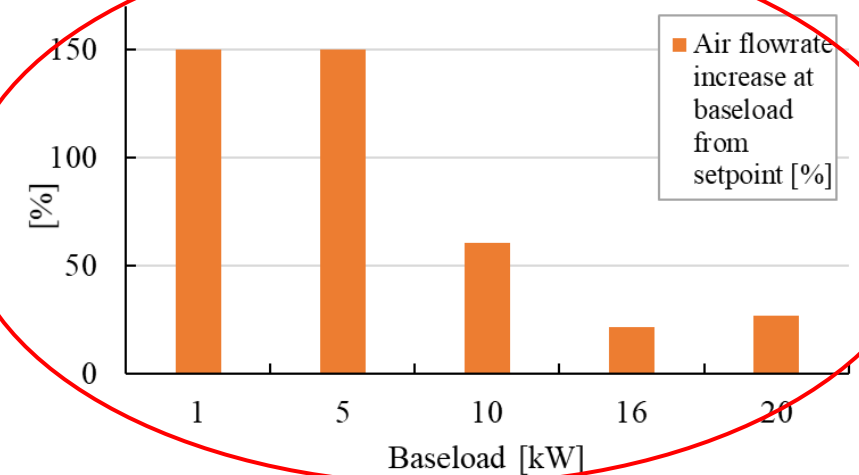
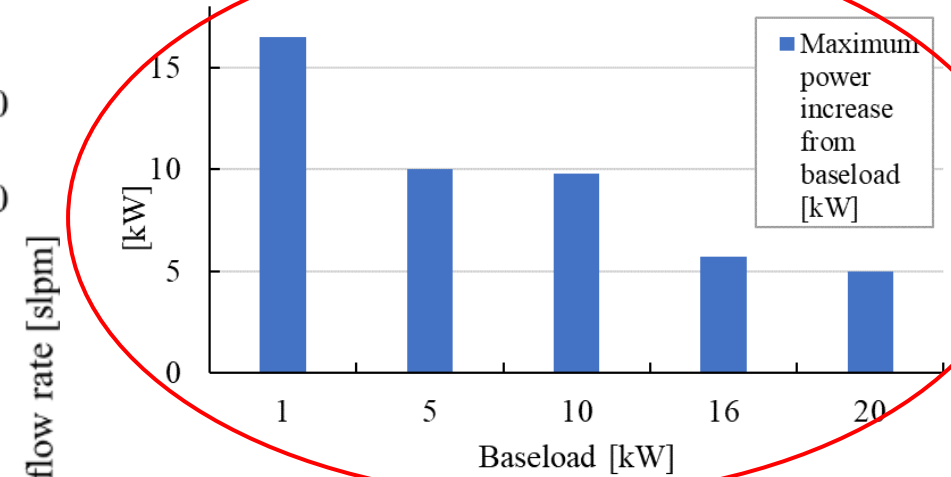
- HI-SEA Laboratory
- Experimental activities
- Conclusions and discussion



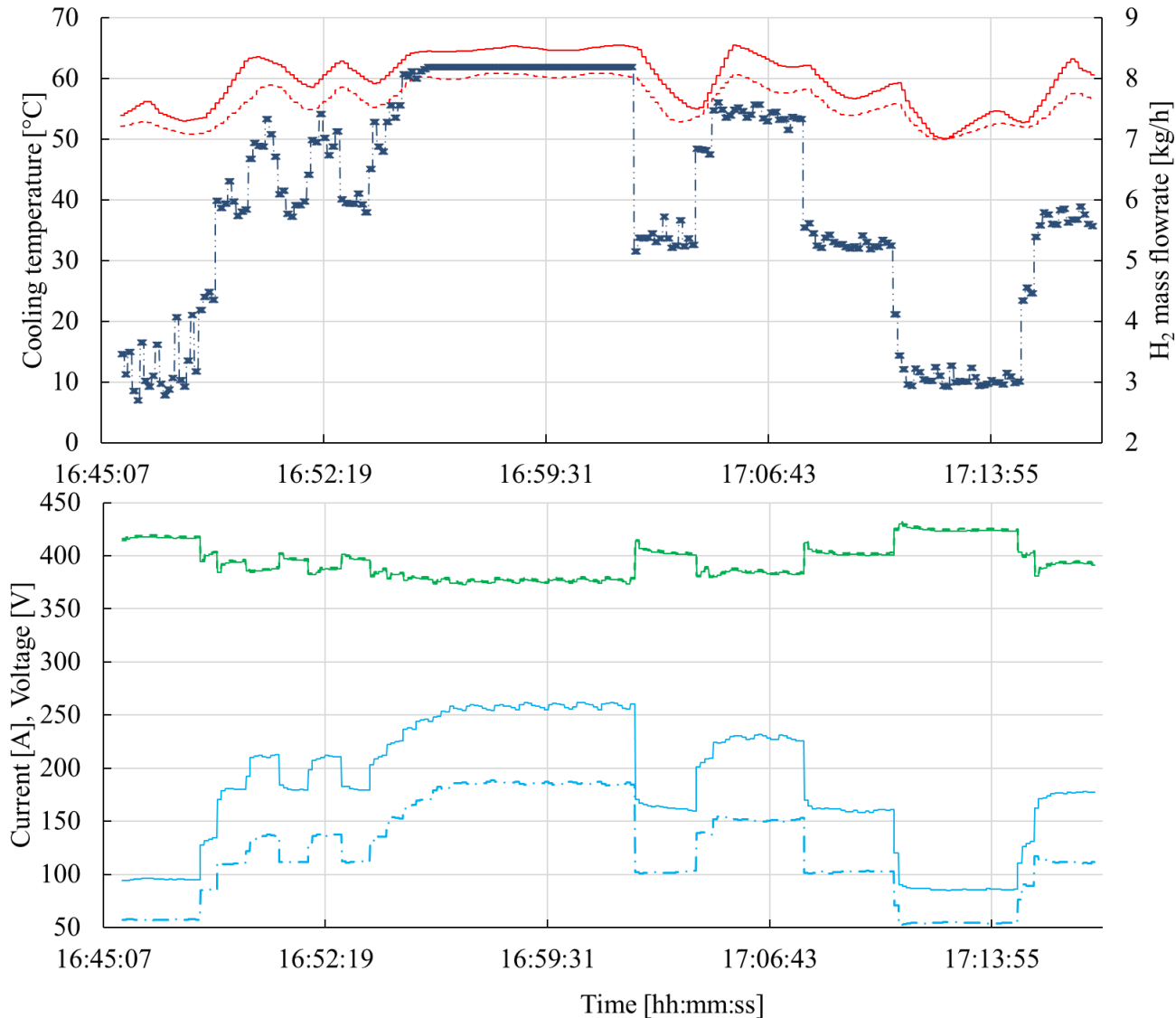
Experimental activities



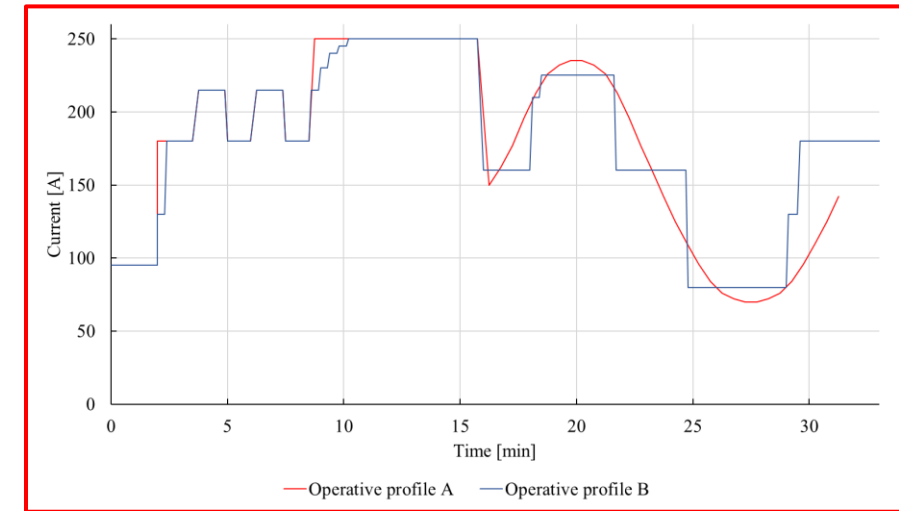
Dynamic load tests



Experimental activities



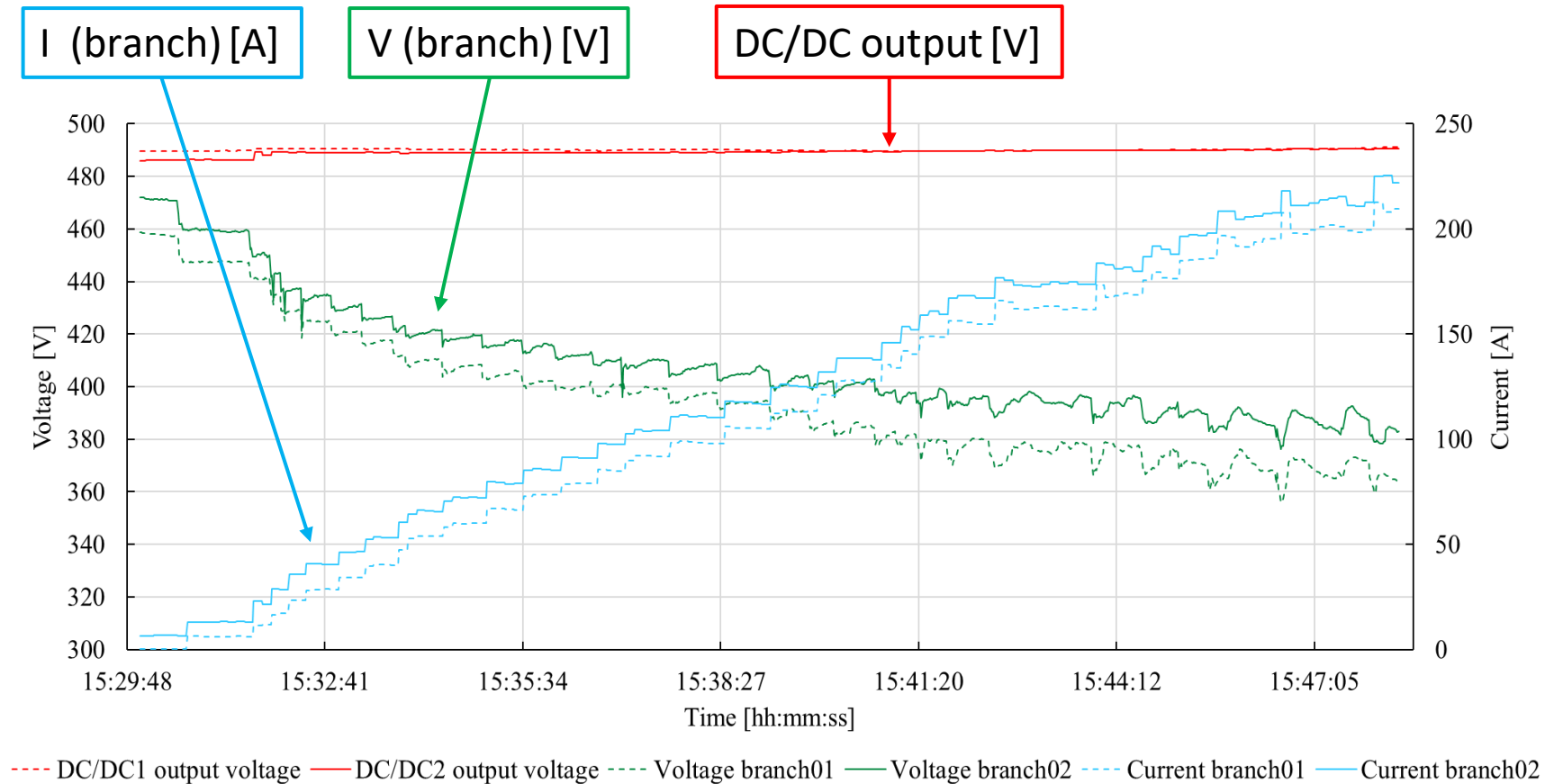
Operative profile tests



- Operative profile tested in line with ship operation requirements
 - Successful implementation
- Fault simulation: 3 stacks active on branch01, 4 stacks active on branch02
- Influence of compressor and anodic purges at const.load

Experimental activities

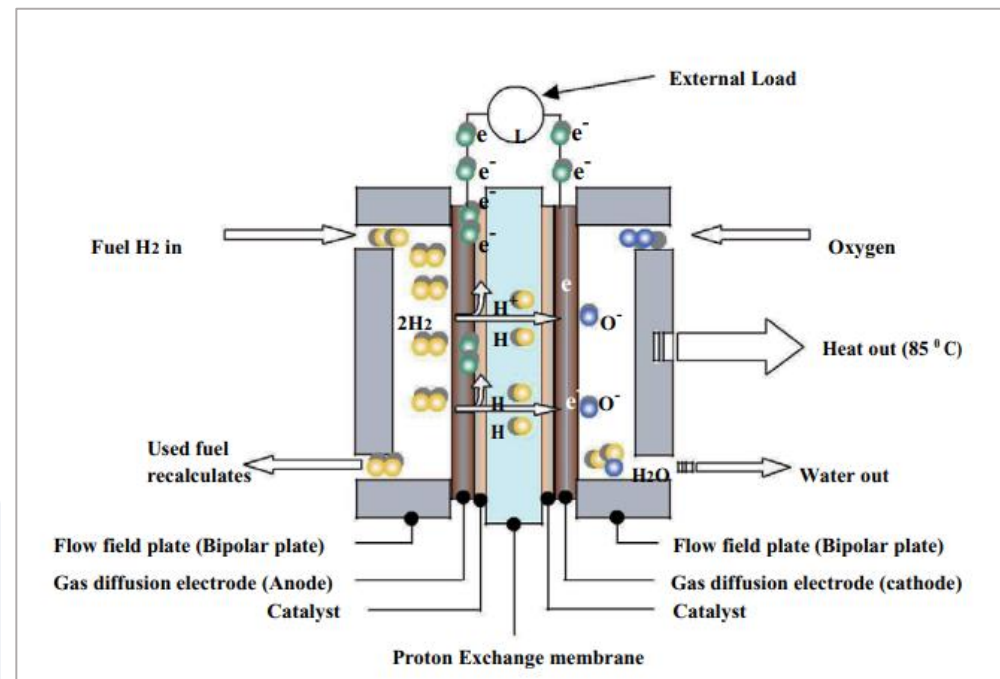
DC/DC output voltage control



- Voltage control crucial for system integration
 - 3 FC stacks active per branch
 - Current ramp implemented
- Different ageing of stacks results in different power output
- DC/DC output voltage correctly controlled

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Conclusions and discussion

HI-SEA system: real maritime application size, complete BoP simulating ship environment

- ✓ Different load profiles tested
- ✓ Successful operation
- ✓ Performance linked to BoP assembly
- ✓ “*Experimental campaign to assess the adequacy of a complete 240-kW PEMFC power system for maritime applications*” (Gadducci et al.) under review Int. J. of Hydrogen Energy



Discussion:

- What will be in the future the design of PEMFC systems for shipping? Which components to be employed?
- Crucial to define a load-dependent control strategy: reactants flowrate (if industrial compressor chosen), number of stacks ON in a mixed series/parallel design
- Considering the most detrimental operative conditions to PEMFC (partial and variable load, high load – see ID-FAST project), when is it feasible to have a FC system as a power generator?



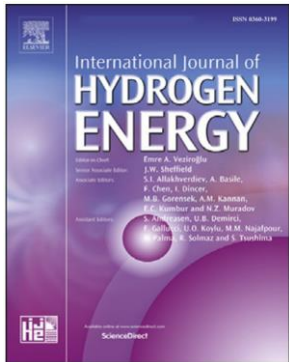
Thank you for the
attention!



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Publications



Publications:

- *“Experimental assessment of FCS for marine application”, “Recovery procedure for 30 kW PEM fuel cell stacks”, Proceedings of EFC2019*
- *“Analysis of consequences of cells rupture on PEMFC module performance”, “Assessment of PEMFC system performance for marine application”, Proceedings of EFCF 2019*
- *“Design and Development of a Laboratory for the Study of PEMFC System for Marine Applications”, E3S Web Conferences*
- *“BoP incidence on a 240 kW PEMFC system in a ship-like environment, employing a dedicated fuel cell stack model”, Int. J. of Hydrogen Energy, 2021*
- *“Experimental campaign to assess the adequacy of a complete 240-kW PEMFC power system for maritime applications”, under review Int. J. of Hydrogen Energy*

