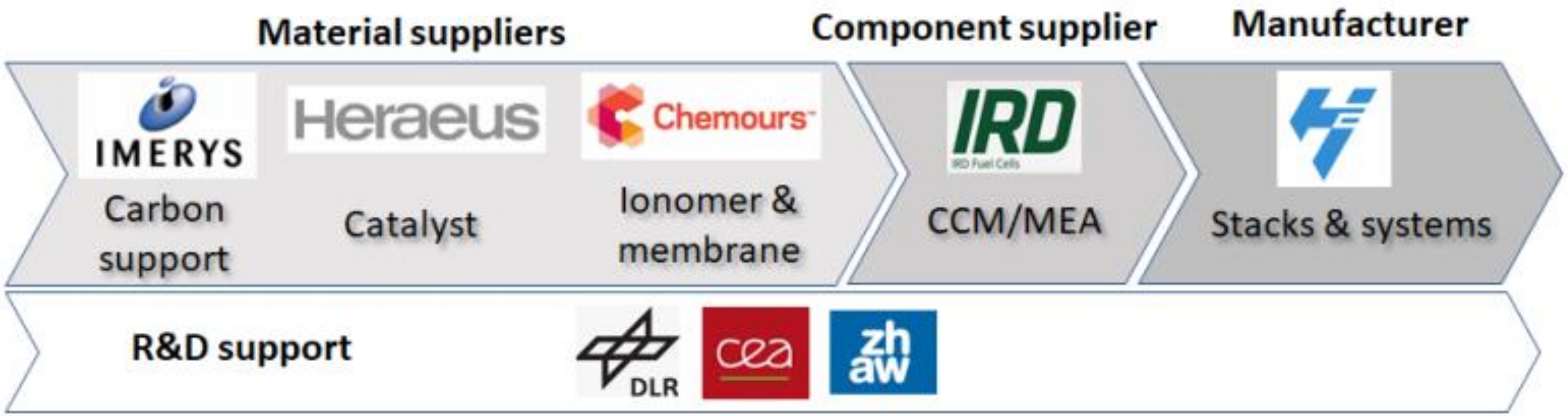
PEMTASTIC

Clean Hydrogen Partnership

Co-funded by the European Union

ROBUST PEMFC MEA DERIVED FROM MODEL-BASED UNDERSTANDING OF DURABILITY LIMITATIONS FOR HEAVY DUTY APPLICATIONS

- **Call topic:** HORIZON-JTI-CLEANH2-2022-03-02 (RIA)
- **Duration:** 01.02.2023 – 31.01.2026
- **CleanH2 Funding:** 2.749 k€
- **Total budget:** 3,685 k€



The project is supported by the Clean Hydrogen Partnership and its members Hydrogen Europe and Hydrogen Europe Research.

Concept

The R&D project PEMTASTIC aims to meet the key technical challenges to increase durability of membrane-electrode assembly (MEAs) for heavy-duty (HD) applications. These challenges are approached with a combination of model-based design and the development of a durable CCM using innovative materials tailored for heavy duty operation at high temperature (105°C).

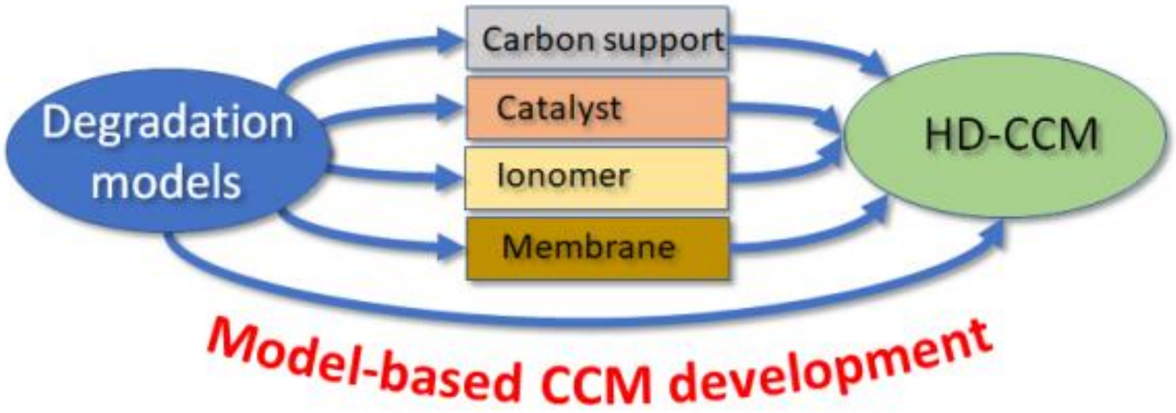


Table 1: SRIA KPIs and improvements targeted by PEMTASTIC

	Clean Hydrogen JU SRIA KPIs			
	SoA 2020[18]	Targets 2024	Targets 2030	PEMTASTIC targets
Durability / h	15,000	20,000	30,000	20,000
PGM loading / gkW^{-1}	0.4	<0,3	<0.25	0.3
Power density / Wcm^{-2}	1.0 @ 0.65V	>1,2@0,650V	>1,2@0,650V	1.2 @ 0.65V
Additional Project KPIs				
Operation temperature / °C	80-85			95-105 at low RH

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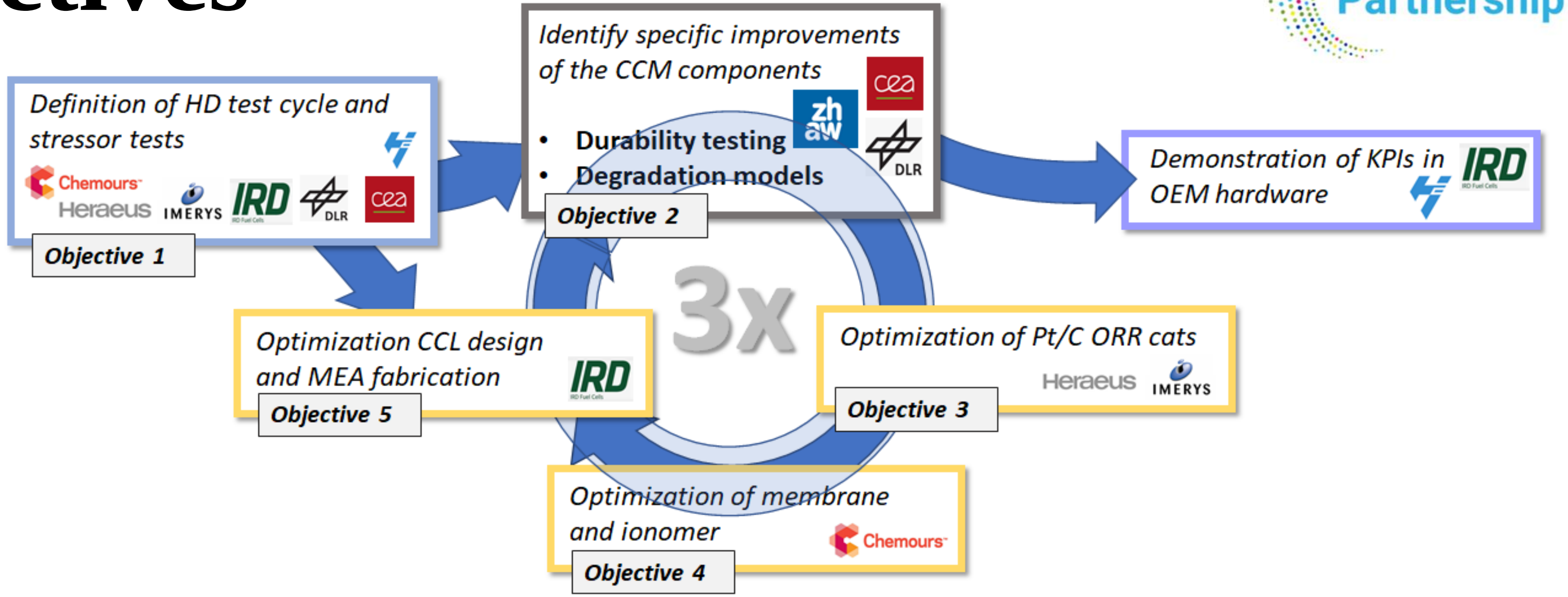
Objectives



Objective 1: Define FC operation protocols and cycling tests for HD application

Objective 2: Parameterisation of degradation models which aim to identify specific improvements of the CCM and its components

Objective 3: Development of robust catalyst support; Pt/C deposition process for ORR catalysts

Objective 4: Development of membrane and ionomer for operation at increased temperature

Objective 5: Catalyst layers and CCM with increased durability and state-of-the art performance tailored for HD operation

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Methodology

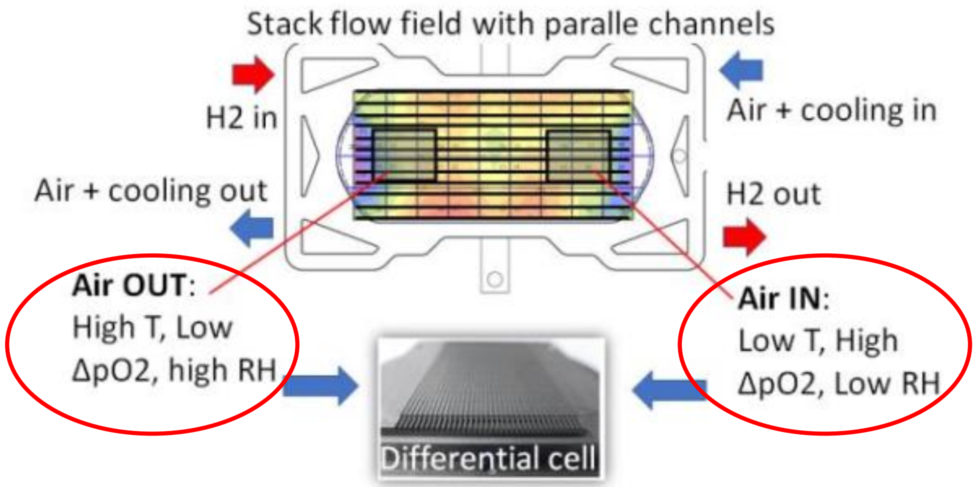

Figure 8: Definition of local operation conditions representative for certain areas of a large stack flow field.

Reference MEA and final MEA will be tested in short stack

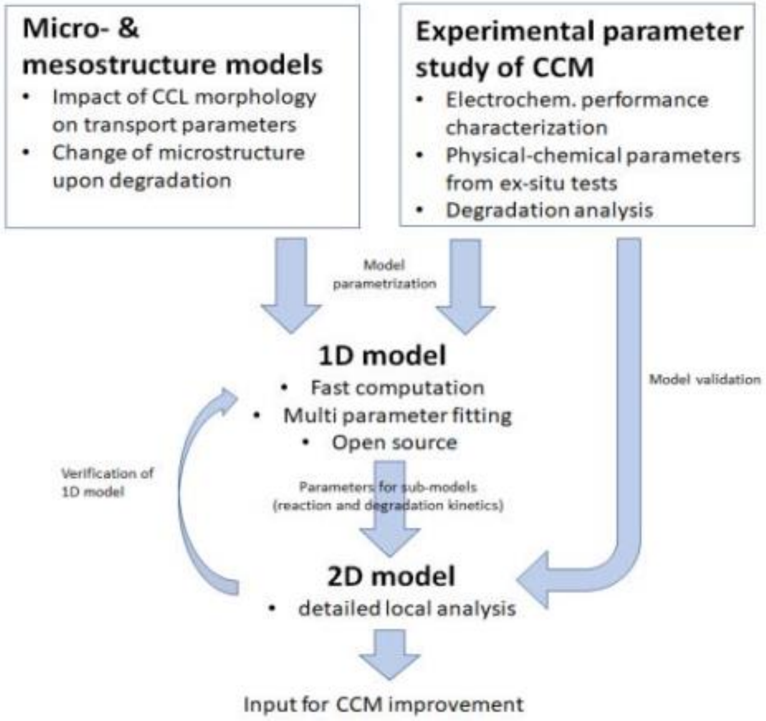

Figure 10: Link between 1D and 2D degradation models.

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Methodology

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Table 2: Material properties to be improved based on model recommendations and material characterisation, i.e. all listed properties will be captured by models and will be quantified by experiments.

Component	Property	Expected improvement	Impact on final MEA operation
Carbon support	Degree of crystallinity	Better resistance to corrosion/oxidation	Higher stability during start-up shut down, at higher temperature, and higher RH
	Pore size distribution	Increase fraction of mesopores; Less platinum poisoning by the ionomer	Higher stability due to less Pt mobility; higher performance
	Specific surface	Higher Pt utilization	Higher performance at lower Pt loading
	Hydrophobicity	Improved water management	Stable operation in broad range of operation conditions
Pt/C	Pt size distribution	less Ostwald ripening	Higher ECSA and performance stability
	Pt-C interaction	less particle mobility	
Membrane	Thickness	Increased mechanical stability and ionic conductivity	Performance, durability and extended operation temperature
	Additive concentration	Durability	
	EW	Trade-off between conductivity, expansion and water management	
Ionomer	EW	Trade-off between conductivity, expansion and water management	
CCL	Membrane properties are listed above as well, mixing with the CCL properties. During CCL manufacturing, mainly the **ionomer: carbon** ratio will be modified using a fixed coating technique		

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Schedule and Work Packages

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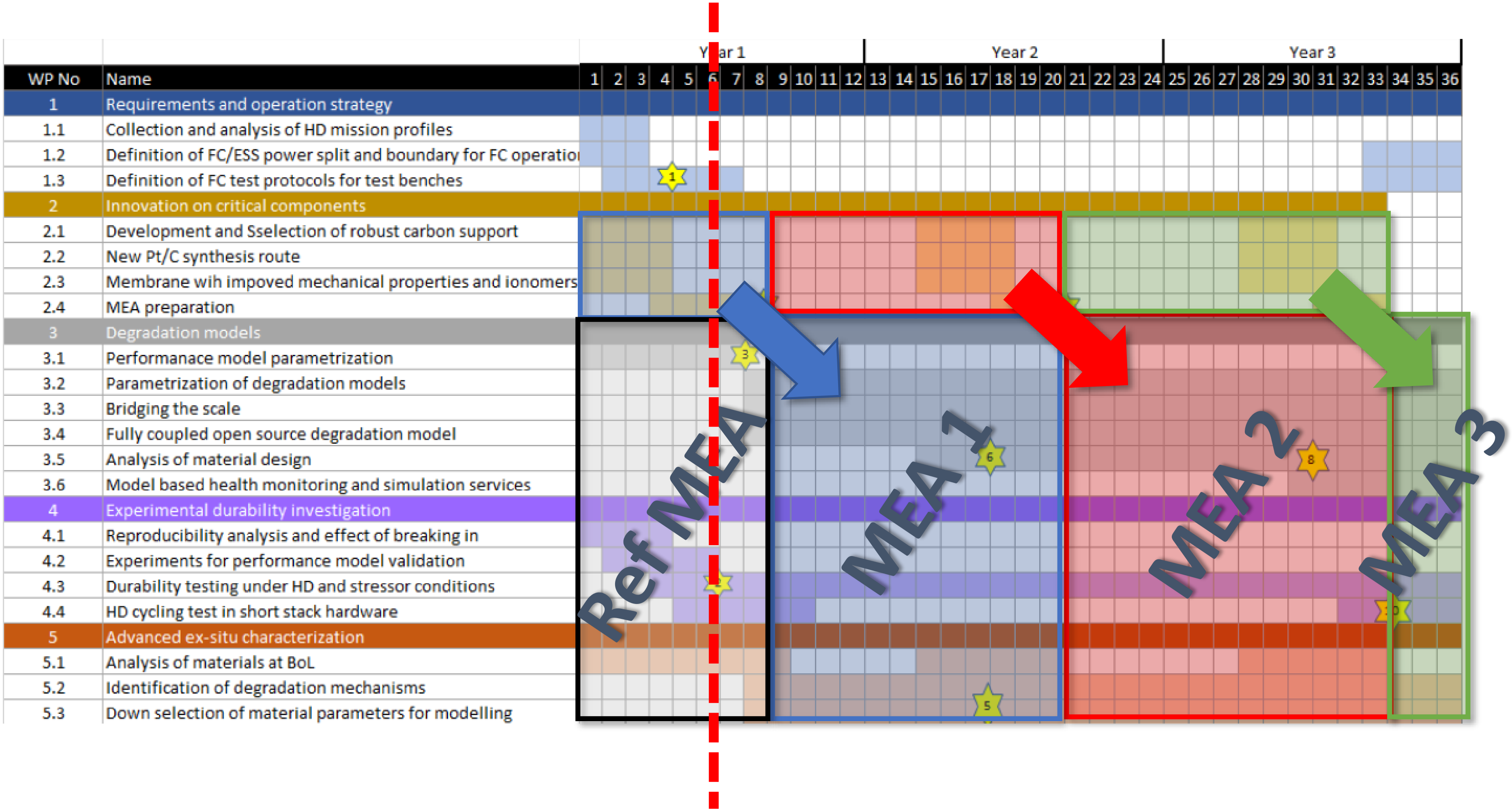

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Definition of FC testing protocols for heavy duty application

J. Sanchez-Monreal (DLR-TT)

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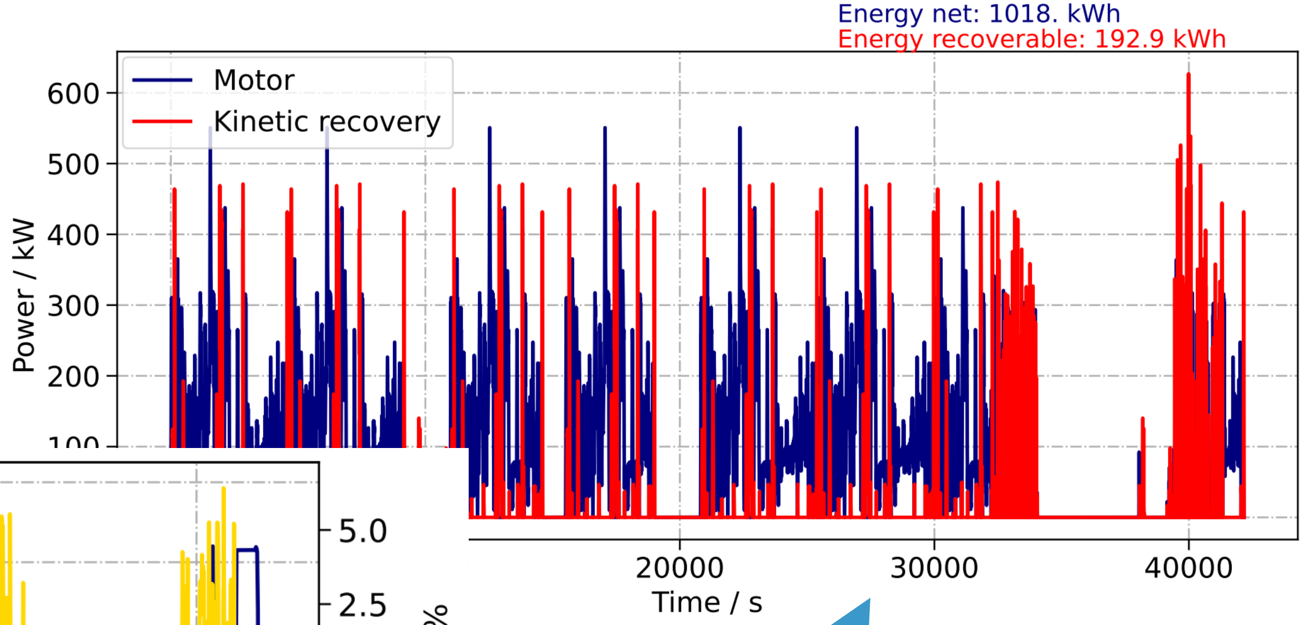
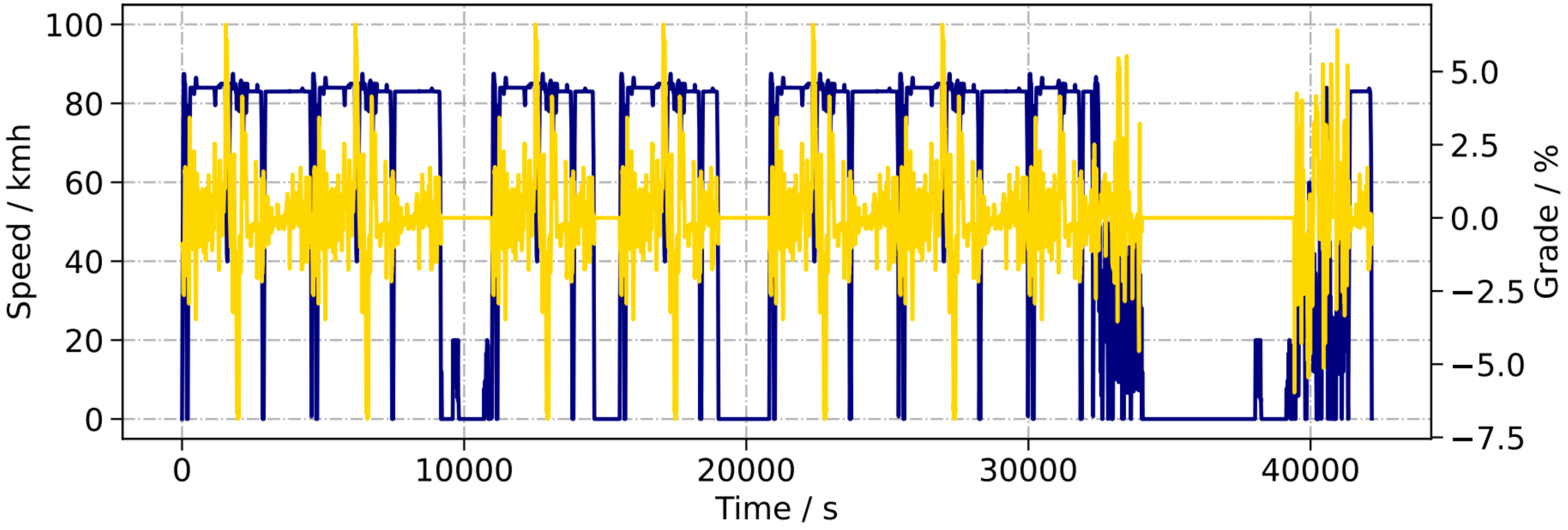
GVW	35029 kg
Vehicle	15729 kg
Load	19300 kg
$A \times C_d$	5.3 m^2
C_r	0.006





Mechanical simulation

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Definition of FC testing protocols for heavy duty application

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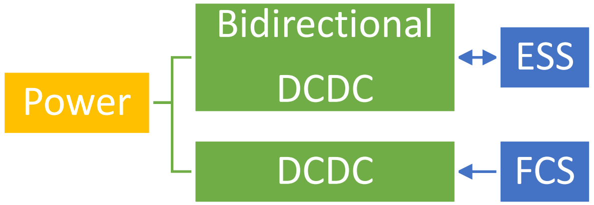
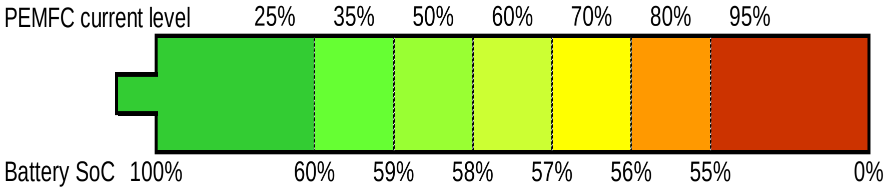
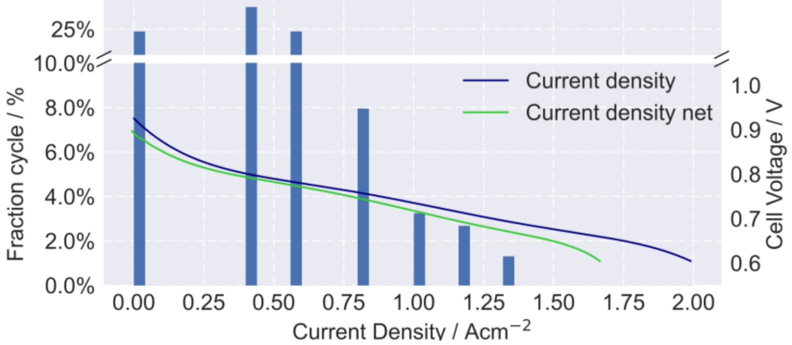
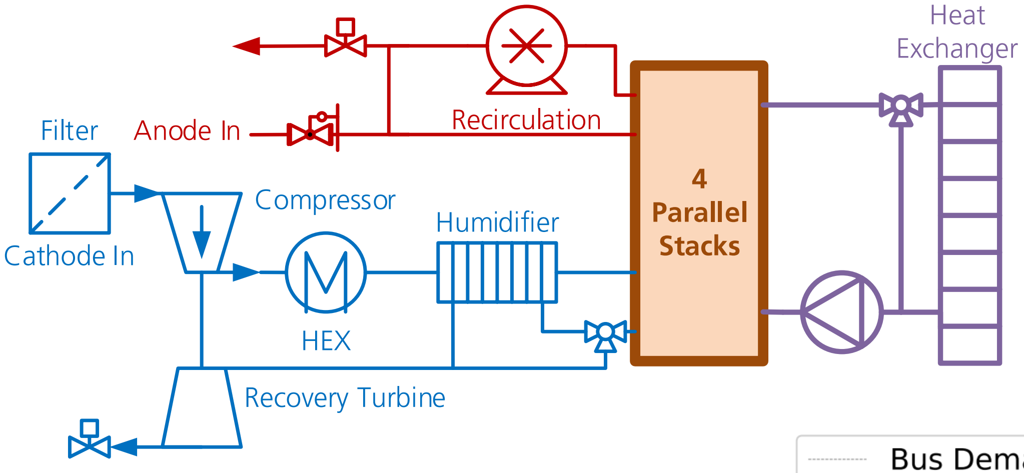
Hybrid Architecture

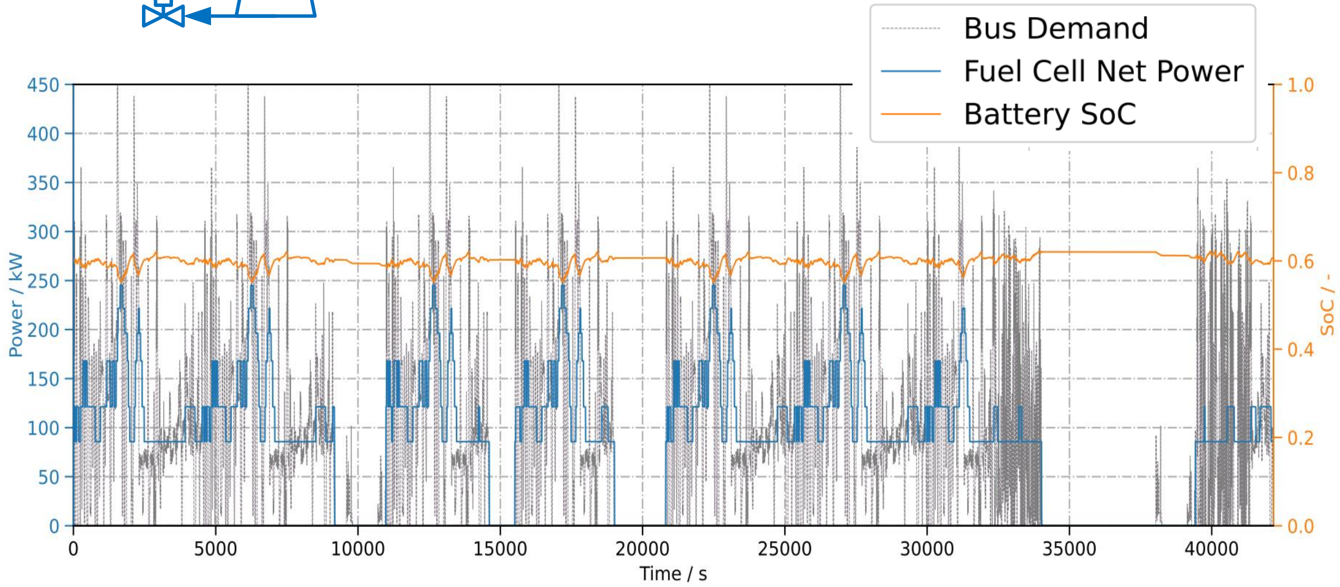


Hybridization Strategy









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Definition of FC testing protocols for heavy duty application

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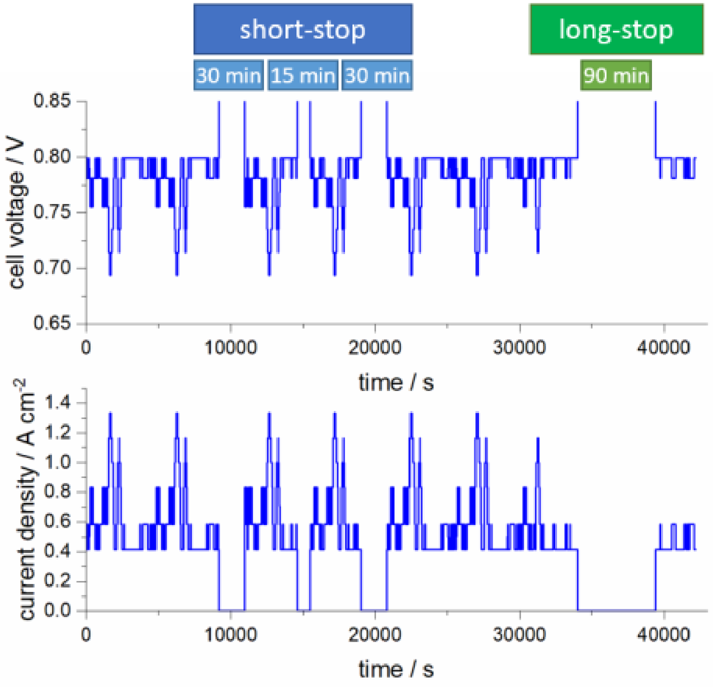
Deliverable 1.3: Public report on definition of FC test protocols

- Leak Test
- Break-in
- Shut-Down and Start-Up
- Polarization Curve
- Cyclic and Linear Sweep Voltammetry
- Electrochemical Impedance Spectroscopy
- Limiting Current Analysis
- HD Load Cycling Durability

Proposed by	PEMTASTIC HD condtions	
Source	At air inlet	At air outlet
Comment		(calc by CEA)
Differential Cell		
Cell temperature [°C]	90	105
Gas composition	H2/air	H2/(N2+9%O2)
Outlet pressure anode / cathode [bar_{abs}]	2.5/2.5	2.6/2.2
Gas inlet temperature anode/cathode [°C]	Cell temperature + 5 °C	
RH anode / cathode [%]	80/50	35/60
H2 and O2 stoichiometry for 4 cm channel length [-]	10/10	
Fixed gas flow according to current density [A/cm^2]	3.0	
Stack / technical single cell		
Coolant inlet temperature [°C]	90	
Gas composition	H2/air	
Inlet pressure anode / cathode [bar_{abs}]	2.6/2.5	
Gas inlet temperature anode/cathode [°C]	95	
RH anode / cathode [%]	50/35	
Stoichiometry integral cell / stack [-]	1.2/1.8	
Fixed gas flow according to current density [A/cm^2]	0.2	

Single cell

Stack



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https://www.linkedin.com/showcase/pemtastic

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