



SOCTESQA

Solid Oxide Cell and Stack Testing, Safety and Quality Assurance

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***Programme Review Days 2017
Brussels, 23-24 November***

PROJECT OVERVIEW



- Call year: 2013
- Call topic: SP1-JTI-FCH.2013.5.4: Development of industry wide uniform performance test schemes for SOFC/SOEC cells & stacks
- Project dates: 05/2014 - 04/2017
- % stage of implementation 01/11/2017: 100%
- Total project budget: 3.2 Mio €
- FCH JU max. contribution: 1.6 Mio €
- Other financial contribution: 0 €
- Partners: DLR, CEA, DTU, ENEA, JRC, EIFER, (NTU)

PROJECT OBJECTIVE

“Development of standardized, industry wide test modules and programs for SOFC and SOEC assembly units according to the different applications”



Solid Oxide Fuel Cell
(SOFC):
stationary / mobile

Combined SOFC/SOEC:
“Power-to-Gas-to-Power”

Solid Oxide Electrolysis
(SOEC):
“Power-to-Gas”



μ -CHP (Galileo 1000 N) from Hexis



Truck SOFC APU
(EU DESTAproject, J. Hagerskans)

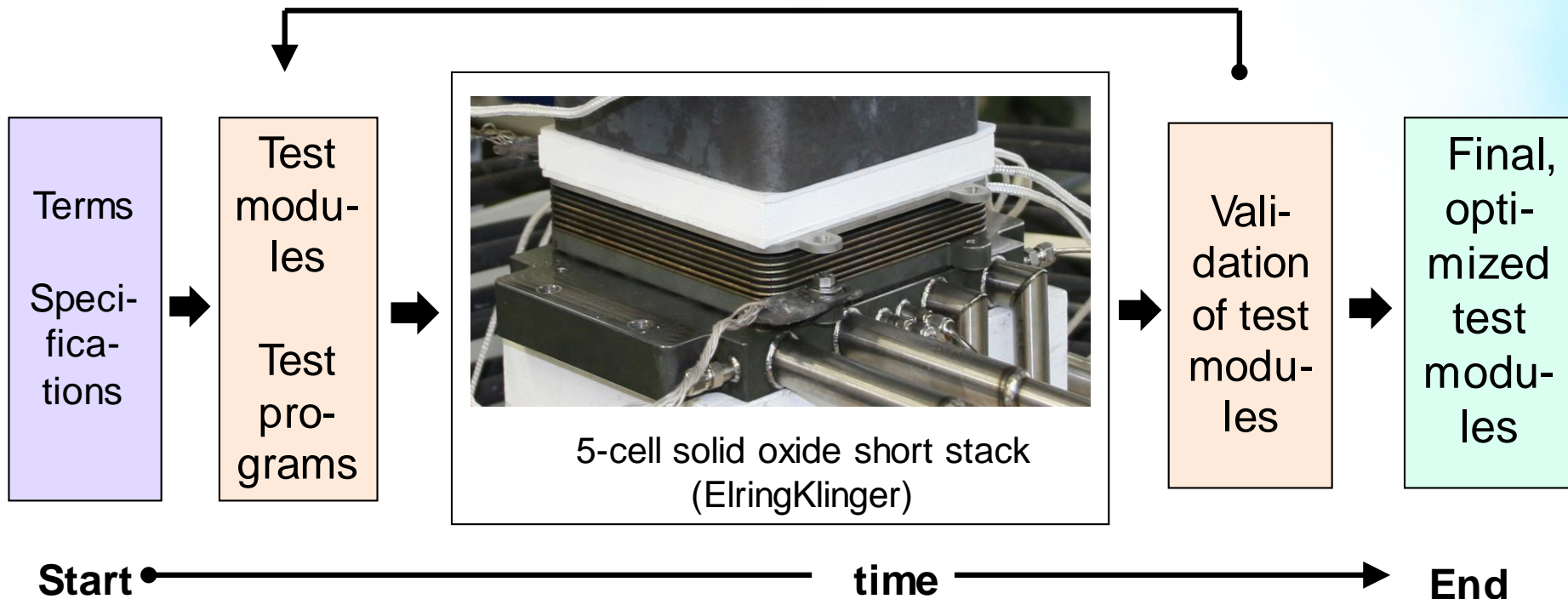


SOEC system (SYDNEY)
from CEA

PROJECT Workflow Concept

4 testing campaigns:

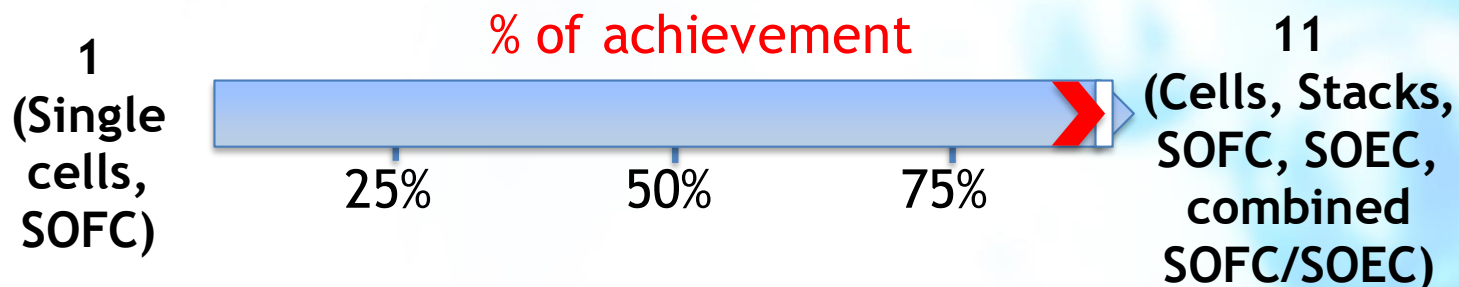
- Repeatability (several measurements)
- Reproducibility (different partners/methods)
- Sensitivity analysis (test input parameters)
- Calculation of derived quantities
-



PROJECT PROGRESS - Number of standardized Test Modules



Achievement to-date
% stage of implement.



Aspect addressed	Parameter (KPI)	SoA 2017	FCH JU Targets
			Call topic
Quality Assurance	Number of standardized test modules	<ul style="list-style-type: none">➤ 11 pre-normative test modules for cells and stacks in SOFC, SOEC and combined SOFC/SOEC operation➤ 5 application specific test programmes	Development of test procedures for SOFC/SOEC

Public test modules can be downloaded

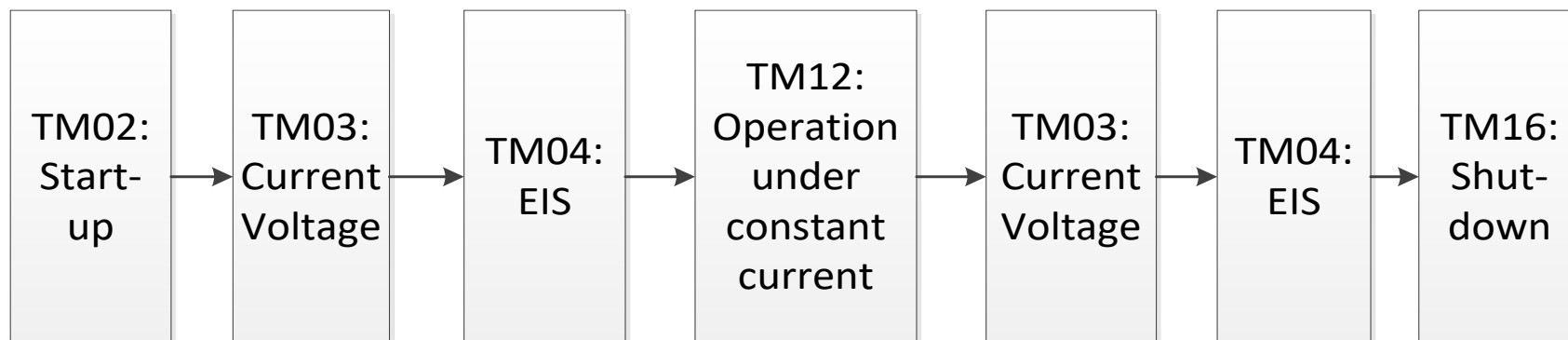
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Test modules for system application relevant testing

Test Module 00: General testing guideline

TM01	Leakage test	TM10	Pressure sensitivity
TM02	Start-up	TM11	Mechanical load sensitivity
TM03	Current-voltage characteristics	TM12	Operation under constant current
TM04	Electrochemical impedance spectroscopy	TM13	Operation under varying current
TM05	Current interruption	TM14	Thermal cycling
TM06	Cyclic voltammetry	TM15	Redox cycling
TM07	Reactant utilisation	TM16	Shut-down
TM08	Reactant gas composition	TM17	Vibration test
TM09	Temperature sensitivity	TM18	Emergency stop

Example of test program for stationary application



Simplified example of TM03 “Current-voltage characteristics”

Objective and Scope

To characterize the performance of an SOC cell/stack at different current densities either in fuel cell (SOFC) mode or in electrolysis (SOEC) mode.

Test Input Parameters (TIPs)

Static TIPs: f , T_{oven} , p ,

Variable TIP: I

Test Output Parameters (TOPs)

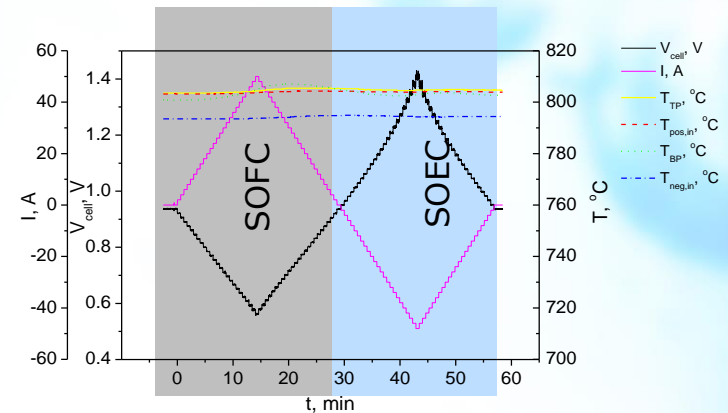
TOPs: V , T_{stack} , T_{cell} ,

Derived / Calculated Quantities

J , ASR, W_{el} , U_{gas}

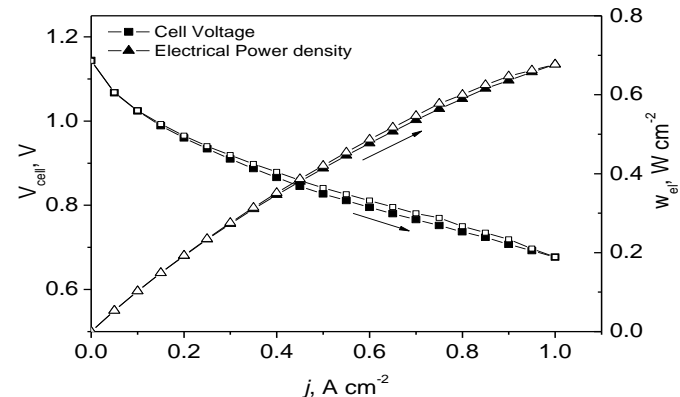
Test Procedure

- Test object setup....
- Setting the TIPs...
- Measuring the TOPs....
- Data acquisition...



Data Post Processing / Representation

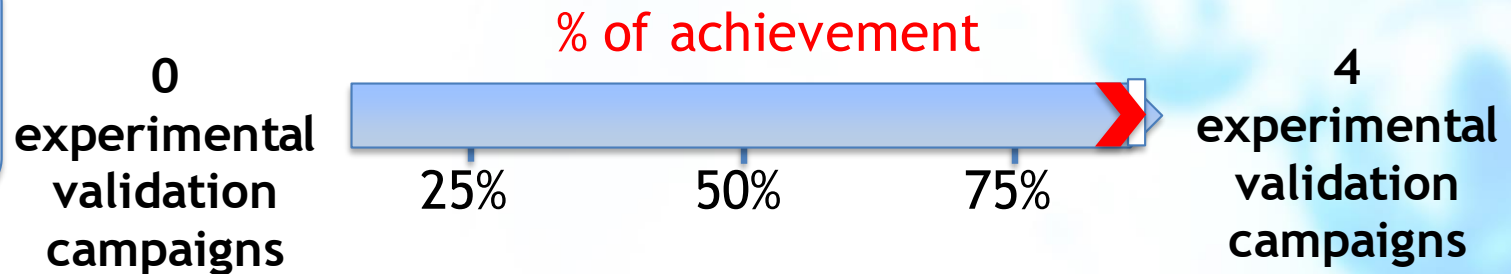
- Calculation of power density, ASR ...
- Data presentation using diagrams



PROJECT PROGRESS - Validation of Test Procedures



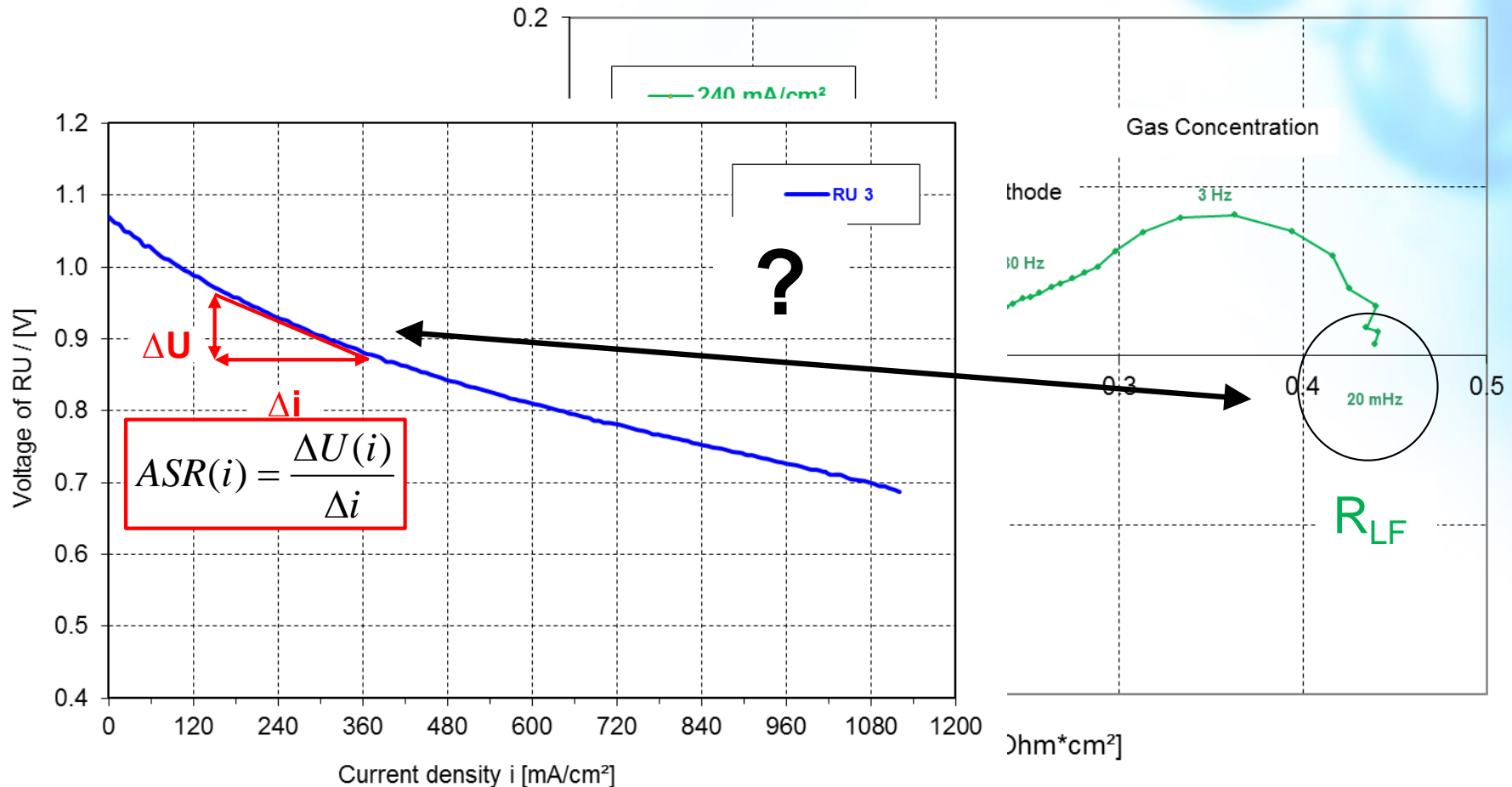
Achievement to-date
% stage of implement.



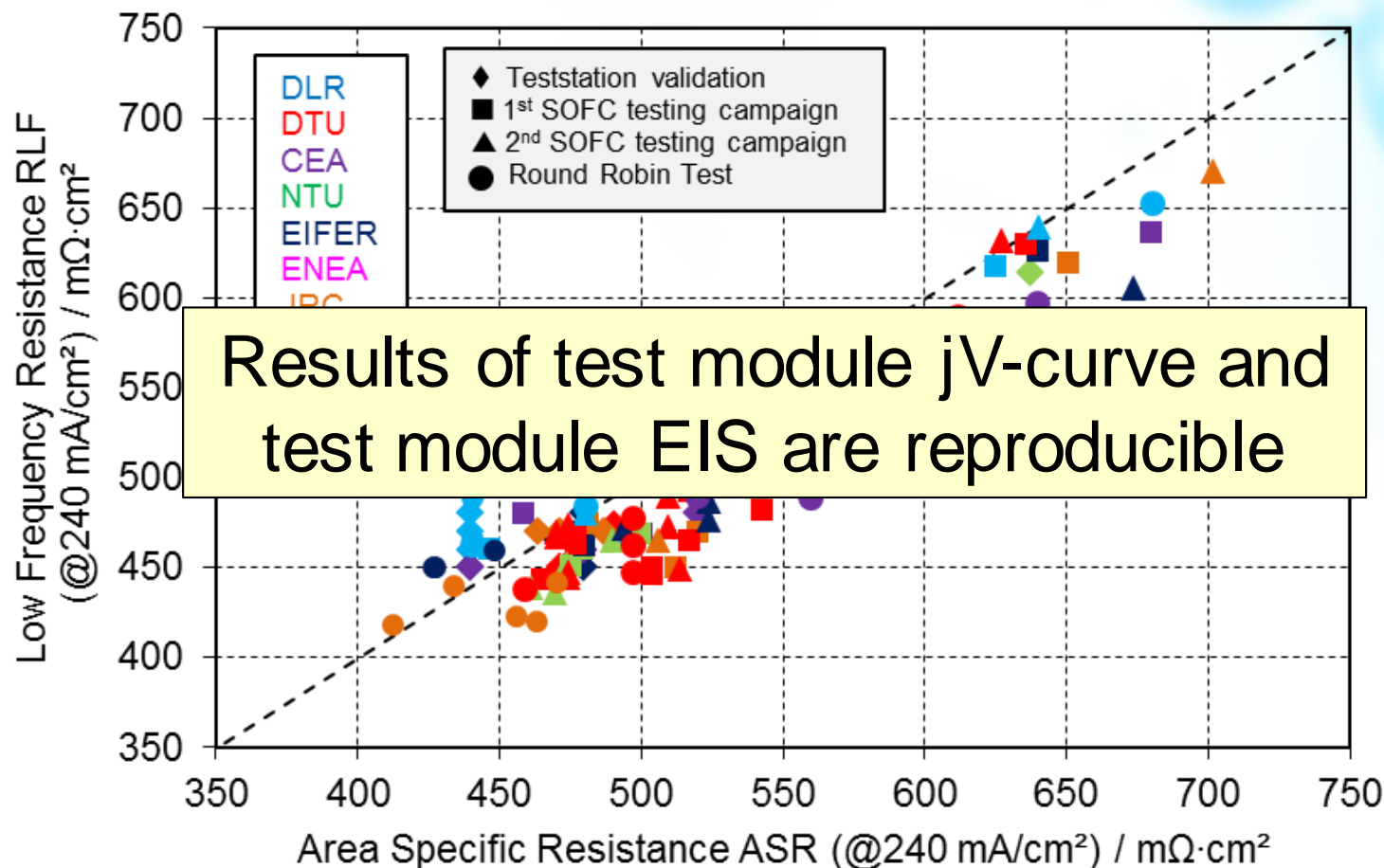
Aspect addressed	Parameter (KPI)	SoA 2017	FCH JU Targets
			Call topic
Quality Assurance	Number of validation campaigns	4 experimental validation campaigns have been performed in order to optimize the test procedures	Validation of test procedures for SOFC/SOEC

EIS and jV of RU3 of short stack in SOFC

(750°C, 240 mA/cm², 0,5H₂+0.5N₂+3%H₂O // 4 Air (SLPM/RU))



Correlation between EIS and jV of RUs of short stacks in SOFC
(750°C, 240 mA/cm², 0,5 H₂+0,5 N₂ // 4 Air (SLPM/RU))



PROJECT PROGRESS - Interaction with Standards developing Organisations (SDO)



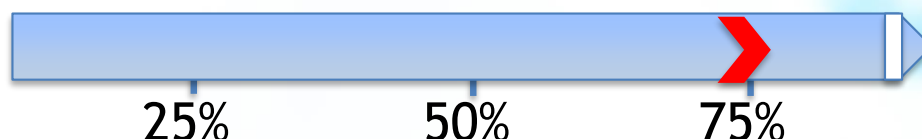
Achievement to-date



% stage of implement.

0
inter-
action

% of achievement



3
inter-
actions

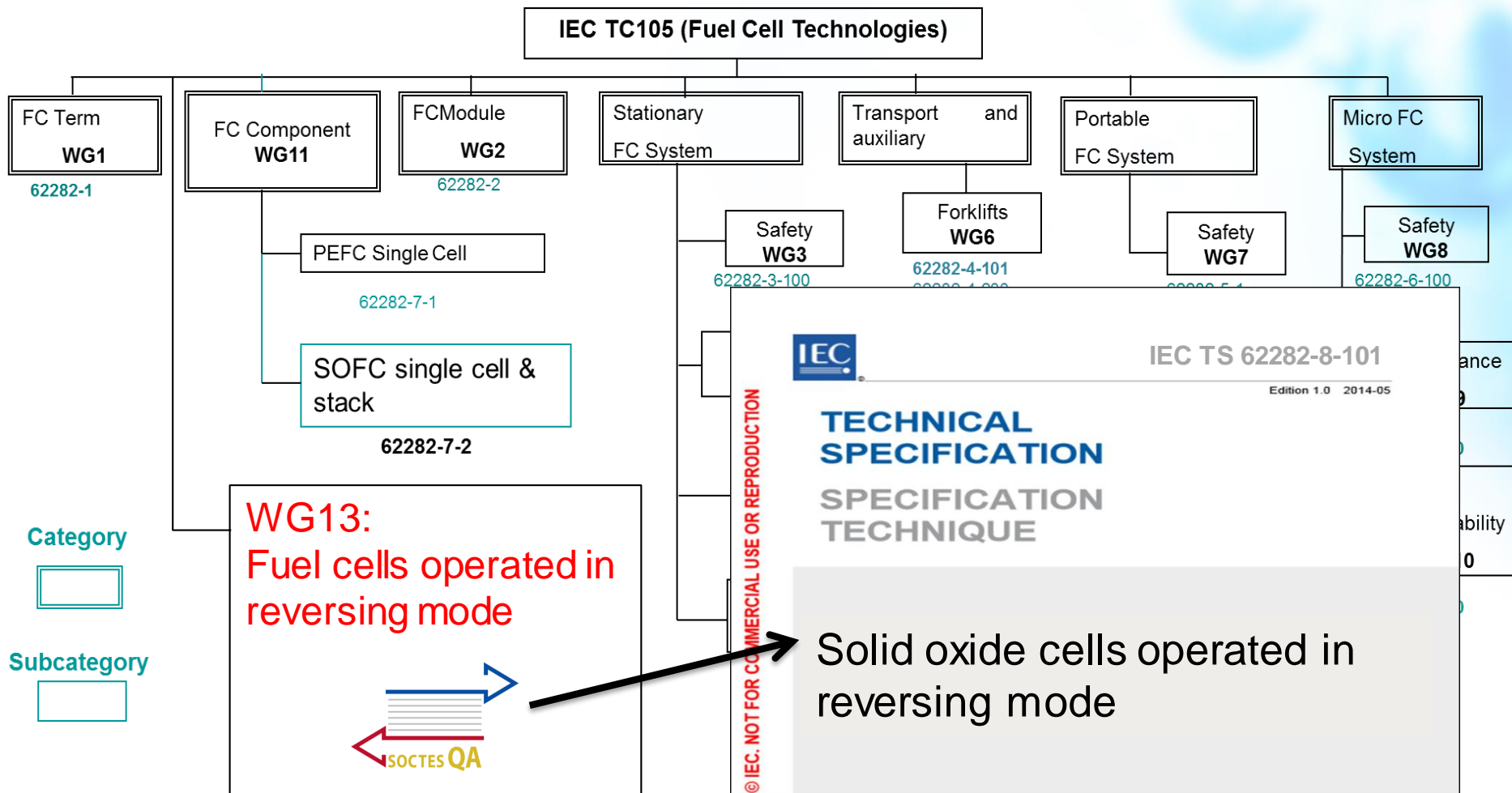


Aspect addressed	Parameter (KPI)	SoA 2017	FCH JU Targets
			Call topic
Regulations, Codes and Standards (RCS)	Number of inter-actions with SDO	Project results are currently being transferred to these main bodies working on regulations for hydrogen and fuel cell technology (ongoing process → 75%)	Interaction with standards developing organisations (SDOs)

PROJECT PROGRESS - Interaction with SDO



Interaction with International Electrotechnical Commission (IEC)



- **Interactions with projects funded under EU programmes**
 - STACKTEST: Harmonization the methodology for the development of the test matrix, test modules and test programmes
 - ENDURANCE, SOPHIA, ECo, NELLHI: Joint project meetings and workshops in order to transfer the test protocols
- **Interactions with national and international-level projects and initiatives**
 - Smart 2: Application of the test modules in order to ensure high quality and reproducibility of the test results
 - European Energy Research Alliance (EERA): Participation at workshops in order to disseminate project results
 - ongoing standardisation activities are now lead by JRC

DISSEMINATION ACTIVITIES



Public deliverables

8 Deliverables and 11 Test modules:

- D 3.1 Test matrix document
- D 3.6 Final document of test protocols (includes all TMs)
- D 7.3 Final report on liaison and dissemination activities

Conferences/Workshops

- 3 workshops organised (midterm workshop, joint workshop with other EU projects, final workshop with booth at Hannover Fair)
- 17 presentations at workshops and conferences, e.g. European SOFC & SOEC Forum, Int. Symposium on SOFC

Publications: 7 (+3 journal publications in progress)

- M. Lang et al., Quality Assurance of Solid Oxide Fuel Cell (SOFC) and Electrolyser (SOEC) Stacks, DOI 10.1149/07801.2077ecst, ECS Transactions 2017 78(1), 2077 - 2086
- C. Auer et al., Solid Oxide Cell and Stack Testing, Safety and Quality Assurance (SOCTESQA), DOI 10.1149/06801.1897ecst, ECS Transactions 2015 68(1), 1897 - 1905

Thank You!

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