HEALTH-CODE

Real operation PEM fuel cells HEALTH-state monitoring and diagnosis based on dc-dc COnverter embeddeD Eis

PANEL 4
Research activities for stationary applications

ACRONYM	HEALTH-CODE
CALL TOPIC	FCH-02.3-2014: Stationary fuel cell system diagnostics: development of online monitoring and diagnostics systems for reliable and durable fuel cell system operation
START DATE	1/09/2015
END DATE	31/08/2018
PROJECT TOTAL COST	€2,3 million
FCH JU MAXIMUM CONTRIBUTION	€2,3 million
WEBSITE	http://pemfc.health-code.eu/

PARTNERSHIP/CONSORTIUM LIST

UNIVERSITA DEGLI STUDI DI SALERNO, AALBORG UNIVERSITET, DANTHERM POWER A/S, EIFER EUROPAISCHES INSTITUT FUR ENERGIEFORSCHUNG EDF KIT EWIV, ELECTRO POWER SYSTEMS MANUFACTURINGSRL, TORINO E-DISTRICT CONSORZIO, UNIVERSITE DE FRANCHE-COMTE, ABSISKEY CP

MAIN OBJECTIVES OF THE PROJECT

1) Implementation of monitoring & diagnostic tool based on Electrochemical Impedance Spectroscopy (EIS) for µ-CHP & O2-fed backup PEMFC.
2) Development of a tool for state-of-health assessment, fault detection & isolation as well as degradation level analysis for lifetime extrapolation. Determine the current status for the detection of 5 faults: i) change in fuel composition; ii) air and iii) fuel starvation; iv) sulphur poisoning; v) flooding and dehydration. Infer on the residual useful lifetime.
3) Reduce experiments, time & costs through scaling-up methodology.

PROGRESS/RESULTS TO-DATE

- Thorough state-of-art study on the most relevant PEMFC faults & on relevant diagnostic strategies.
- Test protocols developed for both µ-CHP and backup stacks, with respect to normal & faulty operation testing.
- All stacks have been installed on test benches at three laboratories.
- EIS board and power electronics under design process to meet measurements targets for monitoring & diagnostic purposes.
- Several diagnostic algorithms under development; preliminary analysis performed based on data from previous projects.

FUTURE STEPS

- Expecting a 1st set of EIS measurements for stacks characterization to be released in June 2016.
- Release of the 1st scaling-up algorithm to model stack behaviour from single cell EIS data.
- 2nd generation of the EIS board, improved with respet to the one developed in D-CODE project, will be released for first tests.
- Interfacing the EIS board and the converters to perform EIS during FC system operations.
- Integration of both hardware and algorithms for testing on FC systems.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Main activities are still ongoing and conclusions can't be drawn yet.
- Transfer EIS measurements from lab. to on-board applications to improve diagnostics + support advanced lifetime analysis.
- It is expected the implementation of a low cost board driving the DC/DC converter to perform the EIS, while the system is running on field.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAWP 2014-2020
Monitoring and diagnostic algorithm for improved PEMFC system efficiency, reliability & availability.	Increase electrical efficiency and durability of the different FCs used for power production	Several diagnostic algorithms (i.e. model- and signal-based) under design	100 %	From D-CODE project results, diagnostic algorithms have been successfully applied on PEMFC systems.	Activities are on time; preliminary results based on available data. Algorithms will tested on data acquired during project experiments.
EIS board cost <3% of the overall system manufacturing cost.	Reduce total cost ownership (TCO in €/kWh)	EIS board design based on components improvement for cost reduction.	100 %	From D-CODE project: overall cost of EIS board (with the provided accuracy) within 3% of the tested PEMFC system	EIS board cost under analysis vs the considered components for the the 2 systems (µ-CHP and backup).
Backup system designed to be coupled with electrolyser for an independent power production system	Improve grid stability through applications of stationary FCs + energy storage	Investigation of pure O2 feed instead of air considered for backup system	100 %	Negligible activity in literature on EIS applications & diagnostic analysis combined with O2-fed systems.	Test bench organized to perform tests on this system under normal & faulty conditions.
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:					AWP 2014
Demo of fault diagnosis on 2 stacks for µ-CHP and Backup	Demo of detection of major stack/system failure modes in lab tests with min. 2 different platforms	Stack installed on test benches and experimental activity at early stages	100 %	Not available for FC systems, few data available on stacks	Some delay due to change from air- to O2-fed system. However, overall progress is still on time, no further problem
5 faults considered: i) change in fuel composition; ii) air starvation; iii) fuel starvation; iv) sulphur poisoning; v) flooding and dehydration	5 failure modes detectable	Testing protocol defined; diagnostic algorithms under design	100 %	From D-CODE project, only 3 faults (flooding, dehydration & air starvation) were considered	Preliminary results obtained. Refinement on diagnostic algorithms with data from experimental activity to be done
Lab tests & field operation emulated on 2 PEMFC systems (µ-CHP and backup) to validate monitoring & diagnostic algorithms	Lab or field- demo of the monitoring/diagnostics approach integrated into2 FC systems	Lab tests at early stages	100 %	From D-CODE: only lab tests on backup system	Field operation planned after the 1st mid-term
EIS to estimate electrochemical info at cell level to monitor/follow time evolution of several metrics	A methodology for state-of-health monitoring incl. degradation measurement & remaining lifetime prediction	Methodologies under investigation for lifetime evaluation from EIS data	100 %	Only few works available on this topic, mostly for lab application	No preliminary results yet; most work performed on literature data.