Final report

1.1 Project details

Project title	Deltagelse I IEA og FCH-JU
Project identification (program abbrev. and file)	IEA - j.nr. 64013-0573
Name of the programme which has funded the project	EUDP
Project managing company/institution (name and address)	Danish Power Systems (DPS) Egeskovvej 6C 3490 Kvistgaard
Project partners	Danish Power Systems
CVR (central business register)	17913301
Date for submission	17.February 2017

1.2 Short description of project objective and results

1.3 Executive summary

Annex 31 is a research and development oriented Annex with the objective to contribute to the identification and development of techniques and materials to reduce the cost and improve the performance and durability of polymer electrolyte fuel cells (PEFCs), direct fuel polymer electrolyte fuel cells (DF-PEFCs), and corresponding fuel cell systems. Major applications are in the automotive, portable power, auxiliary power (APUs), stationary power (residential, commercial), and combined heat-and-power (CHP) sectors.
The Annex was renamed Annex 31 about a year ago, but originally it was Annex 22.
The R&D activities in Annex 31 cover all aspects of PEFCs and DF-PEFCs, from individual component materials to whole stacks and systems. These activities are divided into three major subtasks: 1) new stack materials, 2) system, component, and balance-of-plant, and 3) DF-PEFCs.
Research in the new stack materials aims to develop improved, durable, lower-cost polymer electrolyte membranes, electrode catalysts and structures, catalyst supports, membrane-electrode assemblies, bipolar plates, and other stack materials and designs for PEFCs.
The second subtask addresses stack, system, and balance-of-plant issues in PEFC systems. It includes systems analysis, stack/system hardware designs and prototypes, and modelling and engineering. This subtask also engages in testing, characterization, and standardization of test procedures related to end-user aspects, such as the effects of contaminants on durability, water and heat management, operating environments and duty cycles, and freeze-thaw cycles. The development of fuel processors for PEFCs for CHP and APUs applications is also addressed in this subtask.
The third subtask focuses on the research and development of DF-PEFC technology, including systems using direct methanol fuel cells, direct ethanol fuel cell, and direct borohydride fuel cells. It involves development of the cell materials, investigation of relationship between cell performance and operating conditions, stack and system design and analysis, and investigation of fuel-specific issues for these direct-fuel polymer electrolyte fuel cell systems.

The work has further been in the Scientific Committee of the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) in Brussels. The work has been to advise the Project Office on the evolution and R&D of HFC technologies.

1.4 Project objectives

På dansk:

Formålet med det internationale samarbejde i IEA Annex 31 er at identificere og udvikle teknologier for at nedbringe produktionsomkostningerne og at forbedre effektivitet og levetid af brændselsceller og brændselscellesystemer. Endvidere har arbejdet omfattet deltagelse i Scientific Committee i Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) i Brussels. Arbejdet her omfatter rådgivning af Project Office om forskning og udvikling indenfor brint og brændselsceller.

In English:

Objective: To contribute to the identification and development of techniques to reduce the cost and improve the performance and durability of PEFCs and PEFC systems. The work has further been in the Scientific Committee of the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) in Brussels.

Subtask 1: Stack Materials
-Membrane materials (new functional groups, cheaper membranes, composite membranes, high-temperature membranes, low-humidity proton conductors)
-Electrode catalysts (lower Pt loadings, CO tolerance, lower-cost higher-performance structures, non-Pt materials)
-Bipolar plates (new materials, improved manufacturability, lower costs)
-Cells and stack assemblies (higher power density, low degradation, light-weight, lower cost, continuous fabrication techniques, >100ºC operating temp.)

Subtask 2: System, Component, and Balance-of-Plant Issues End-user aspects (contaminants, humidification and thermal management, operating environments and duty cycles, rapid-start, durability, freeze-thaw cycling, and characterization of materials and components). System-level issues (systems analysis, stack/system hardware designs, fuel processing, and prototypes)

Subtask 3: Direct Fuel Polymer Electrolyte Fuel Cells
(e.g., Direct Methanol, Direct Ethanol, Direct Borohydride FC)
Cell materials (anode and cathode catalysts, reduced precious metal loadings, MEA designs and processes for reduced fuel crossover, fuel impermeable membranes, anion-conducting membranes). Operating conditions (pressure, temperature, vapor versus liquid feed, fuel concentration, etc.). Stack and system designs and analyses (modeling, high-temperature operation, high power densities, high efficiencies, performance over duty cycles, etc.)

The work has further been in the Scientific Committee of the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) in Brussels. The work has been to advise the Project Office on the evolution of HFC technologies.

1.5 Project results and dissemination of results

The participating countries are Austria, Canada (partly), China, Denmark, Finland, France, Germany, Italy, Israel, Japan, Korea, Mexico, Sweden and United States.

Several meetings have been held. In Japan, Mexico, China, Italy, Germany and Mexico. A booklet about the activities and partners are underway based on a concept and a template created by DPS in Denmark.

The technical work from the members have been presented at the half year meetings. Further, the Annex 33 activities has been presented at a public seminar in Copenhagen organized by EUDP.

For the FCH-JU there has been activities related to the Program Review Days and the evaluation of the whole programme.

Finally, information has frequently been provided to the Danish Partnership for Hydrogen and Fuel Cells – also from the FCH-JU.

1.6 Utilization of project results

The work in the Annex facilitates benchmarking and sharing of information between the members. This is also reflected by significant collaboration in formal and informal projects. E.g. DPS has increased its collaboration with FZ Jülich and Fraunhofer ICT in Germany – some of the largest fuel cell research centres in the world.
It has also opened up for more dialogue with KAIST in Korea – on top of already existing collaboration with KIST and KIER. KAIST is DTU's preferred partner in Korea.
Italian and Mexican institutes are also planning to take up research on HTPEM fuel cells, which is the special competence of DPS.
The work in Annex 31 has also resulted in commercial sale to a Japanese company.

1.7 Project conclusion and perspective

The work in Annex 31 has been very successful in creating more international attention and also new collaboration projects and possibilities. The work in FCH-JU has been helpful for making the whole program more aligned with the R&D needs in Europe.

The work in IEA will continue in the coming years, since EUDP has decided to fund the next period, which is gratefully acknowledged.

Annex

Report: Annex 31: Polymer Electrolyte Fuel Cells (PEFC), 2014.

Lecture: Resultater og erfaringer fra IEA Annex31 (22) – PEM fuel cells, Informationsmøde, 18. Marts 2015, EUDP.

(can be send on request)

Relevant links