

Final report

1.1 Project details

Project title	EUDP 2016 - Participation in IEA Annex 31: Polymer Electrolyte Fuel Cells
Project identification (program abbrev. and file)	(Journalnr.: 64016-0012)
Name of the programme which has funded the project	EUDP
Project managing company/institution (name and address)	Danish Power Systems ApS Egeskovvej 6C 3490 Kvistgård Denmark
Project partners	Danish Power Systems ApS
CVR (central business register)	17913301
Date for submission	20. Feb. 2019

1.2 Short description of project objective and results

Participation in the Annex 31 of the International Energy Agency assures influence on the international R&D programs for hydrogen and fuel cells with focus on PEM. In the Annex relevant organizations from North America, Europe, Korea and Japan take part. The network collaboration has resulted in many new constellations for project work, new customers and new employees during the last four years. The purpose of the international collaboration is to identify and develop new technologies in order to reduce the cost of production and to improve the efficiency and lifetime of fuel cells and fuel cell systems. Originally Hans Aage Hjuler was asked by EUDP to become a member of the Annex.

Deltagelse i IEA Annex 31 sikrer indflydelse på de internationale programmer for brint og brændselsceller med fokus på PEM. I Annexet deltager der relevante organisationer fra Europa, Nordamerika, Korea og Japan. Netværksarbejdet har resulteret i mange nye samarbejdsrelationer i de seneste fire år. Formålet med det internationale samarbejde er at identificere og udvikle teknologier for at nedbringe produktionsomkostningerne og at forbedre effektivitet og levetid af brændselsceller og brændselscellesystemer. Hans Aage Hjuler blev oprindeligt bedt af EUDP om at blive medlem af annexet.

1.3 Executive summary

Participation in the Annex 31 of the International Energy Agency assures influence on the international R&D programs for hydrogen and fuel cells with focus on PEM. In the Annex relevant organizations from North America, Europe, Korea and Japan take part. The network collaboration has resulted in many new constellations for project work, new customers and new employees during the last four years. The purpose of the international collaboration is to identify and develop new technologies in order to reduce the cost of production and to improve the efficiency and lifetime of fuel cells and fuel cell systems. Originally Hans Aage Hjuler was asked by EUDP to become a member of the Annex.

1.4 Project objectives

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.

Operating Agent: D. J. Liu, U. S. Department of Energy, Argonne National Laboratory

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, >100°C 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.)

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 (PEFC), direct fuel polymer electrolyte fuel cells (DF-PEFC), and corresponding fuel cell systems. Major applications are in the automotive, portable power, auxiliary power units (APU),

stationary power (residential, commercial), and combined heat-and-power (CHP) sectors.

The R&D activities in Annex 31 cover all aspects of PEFC and DF-PEFC, 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-PEFC.

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 PEFC.

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 PEFC for CHP and APU 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.

Participating countries:

Austria

Denmark

China

Finland

France

Germany

Italy

Israel

Japan

Korea

Mexico

Sweden

United States

In more detail:

Participants list

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1.5 Project results and dissemination of results

- Meetings every half year
- Combined with conferences (Danish suggestion)
- All participants give lectures on their R&D activities
- Exchange of experiences
- Visit at the world's biggest MCFC power plant in Korea
- Company visit at Hyundai and test run of fuel cell car
- Attempt to expand the group to include more countries (Danish suggestion):
 - Turkey, Spain and Switzerland
 - Difficult due to lack of resources
- Dissemination activities
- A brochure with descriptions of technologies and partners has been made after initiative from Danish Power Systems
- Collaboration with IIE, Mexico about HTPEM
- Delivery of materials to Japanese customer
- Recruitment of international employees

It would not have been possible without the membership of IEA and the funding from EUDP.

1.6 Utilization of project results

The utilization of the project results has especially been concerned with the writing of a book (see link in the Annex on page 6) with descriptions of technologies and partners have been made after initiative from Danish Power Systems.

We have also delivered materials to Japanese customer. We have further been able to expand our collaboration with partners in Germany, i.e. Forschungszentrum Jülich and Fraunhofer.

The project has been presented at the DBBD in Odense, Denmark and at a seminar in Copenhagen.

Further, we have successfully recruited international employees.

1.7 Project conclusion and perspective

IEA provides an important network within hydrogen and fuel cells. The participation has provided new contacts, new employees and new customers. The funding from EUDP for HAH's participation in Annex 31 ended by the end of 2018.

Annex

Relevant links:

The link to the IEA organization:

<https://www.ieafuelcell.com/>

The link to the book that we have published:

https://www.ieafuelcell.com/documents/annex%2031_2017.pdf

