

Final report

1.1 Project details

Project title	IEA Hydrogen Implementing Agreement 2015-16
Project identification (program abbrev. and file)	Journalnr.: 64014-0502
Name of the programme which has funded the project	EUDP 14-II
Project managing company/institution (name and address)	DGC Dr. Neergaards Vej 5B, 2970 Hørsholm
Project partners	-
CVR (central business register)	12105045
Date for submission	31 March 2017

1.2 Short description of project objective and results

The aim of the project is to participate in the IEA Hydrogen Implementing Agreement (HIA), in order to stimulate hydrogen R&D activities in Denmark and to co-ordinate Danish and international scientific work on hydrogen and related subjects. At the end of 2016, HIA had members from: 21 countries, 2 international organisations and 4 industrial sponsors. New-comers in 2016 are China and the sponsor Southern Company, the second largest utility in the US.

The work includes:

- DGC participation in HIA Executive Committee (Chair 2011-2014)
- Facilitate Danish participation from Industry and Academia in HIA Tasks (Working groups)
- Information activities on IEA HIA results via web, papers, workshops and conferences

Furthermore to coordinate the Danish HIA participation with the Danish Energy Agency (the formal Danish HIA representative).

Results during the period 2015-2016:

- Growth in HIA members
- Task Portfolio: 3 tasks approved during 2015-2016
- Steady and effective participation of ExCo Members and task experts
- Development of a new and updated HIA homepage
- Large participation at the HIA presentations at the WHEC2016 in Zaragoza
- HIA key presentations at ICSH2015 (Tokyo) and WHTC2015 (Sydney)
- HIA (and hydrogen) representation at UNFCCC COP 22 (Marrakech)
- Active part in the IEA ETP process
- The IEA HIA/TCP participates regularly in the IEA Transport Contact Group (TCG)

1.3 Executive summary

The main HIA activities and the strategic directions during 2015-2016 are given by the HIA Strategic Plan 2015-2020, based on:

Vision:

A hydrogen future based on a clean sustainable energy supply of global proportions that plays a key role in all sectors of the economy.

Mission:

To accelerate hydrogen implementation and widespread utilization to optimize environmental protection, improve energy security and promote economic development internationally while establishing the HIA as a premier global resource for expertise in hydrogen.

Strategy:

To facilitate, coordinate and maintain innovative research, development and demonstration activities through international cooperation and information exchange.

Themes

The main themes in the work programme are:

Collaborative RD&D

- Hydrogen production
- Hydrogen storage
- Integrated hydrogen systems
- Integration of hydrogen in existing infrastructure

Analysis

- Technical progress and optimization
- Market preparation and deployment
- Support in political decision-making

Understanding, Awareness and Acceptance

- Information dissemination
- Safety
- Outreach

Work programme overview

Collaborative task: Ongoing or recently completed

NR	TASK NAME	DURATION	STATUS
21	Bioinspired and Biological Hydrogen Production	2010–2014	completed
26	Advanced Materials for Waterphotolysis with H ₂	2008–2013	completed
28	Large-Scale Hydrogen Delivery Infrastructure	2010–2014	ongoing
29	Distributed and Community Hydrogen (DISCO H ₂)	2011–2014	ongoing
30	Global Hydrogen Analysis	2010–2014	ongoing
31	Hydrogen Safety Task	2010–2013	completed
32	H ₂ Based Energy Storage	2013–2016	ongoing
33	Local H ₂ Supply for Energy Applications	2013–2016	ongoing
34	BioH ₂ for Energy & Environment (Successor to Task 21)	2014–2017	ongoing
35	Renewable Hydrogen	2014–2017	ongoing
36	Life Cycle Sustainability Assessment (LCSA) (Successor Task 30)	2014–2017	ongoing
37	Hydrogen Safety (Successor to Task 31)	2015-2018	ongoing
38	Power-to-Gas	2015-2018	ongoing
39	Hydrogen in Marine Applications	2016-2018	approved

Danish Task participation by:

Task 28: Mikael Sloth, H2Logic

Task 30: Limited Danish participation via DGC

Task 32: Torben R. Jensen, iNANO and Tejs Vegge, DTU

Task 33: John Bøggild Hansen, Haldor Topsøe

Task 35: Limited DTU participation

Task 37: Frank Markert, DTU

Task 38: Henrik Iskov, DGC

Task 39: Several interested Danish participants as of 31 December 2016

Actual work programme by themes

Hydrogen production

Task 21 Bio-Inspired & BioHydrogen 2010-2014

- Hydrogen dark fermentations
- Photobiological H₂ production systems
- Bio-inspired systems
- Basic Studies of Light-Driven BioHydrogen Production
- Electrochemical Systems

Task 33: Local H₂ Supply (2013-2016)

- Platform for evaluation and harmonization of various technologies for local H₂ supply for reduced costs and increased employment
- Expands research on supply to include electrolyzers as well as reformers

Task 34: BioH₂ for Energy & Environment (2014-2017)

- BioHydrogen production
 - Dark Fermentation and Bioelectrolysis
 - Light-driven BioHydrogen production
 - Enzymatic and Bio-inspired Molecular Systems
- Subtask 2 – Applied Research and Biohydrogen Production

Task 35 Renewable Hydrogen Production (2014-2017)

- Subtask 1 – Renewable Electrolysis
- Subtask 2 – Photoelectrochemical Solar Water-Splitting
- Subtask 3 – Solar High Temperature Thermochemical Cycles

Hydrogen Storage

Task 32: Hydrogen Based Energy Storage (2013-2015)

- Project based: Further research needed for new and improved compounds. Demonstration of solid storage systems for both stationary and mobile applications needed.
- Objectives: Develop reversible or regenerative H₂ storage materials fulfilling the technical targets for mobile and stationary applications; develop the fundamental and engineering understanding of H₂ storage; develop materials and systems that have the capacity to fulfil these targets.
- Develop materials and systems for H₂ based energy storage for use in stationary, mobile and portable applications, and electrochemical storage

Integration of hydrogen in existing energy systems

Task 28: Large-Scale H2 Delivery Infrastructure (2010-2014)

- Subtask A – FCEV & HRS scenarios
- Subtask B – HRS assessment
- Subtask C – Analysis H2 pathways
- Subtask D – Large-scale storage and greening of gas

Task 29: Distributed and Community H2 (2011-2014)

- Scope - H2 applications in energy communities integrating H2 with electricity and other energy and mobility networks and distributed systems
- Community Size – 1000; installed H2 capacity NTE 500 kW
- Community Types: Urban, Rural and Island; Distributed industrial applications

Task 38: Power to Hydrogen and Hydrogen-to-X. System analysis of the techno-economic, legal and regulatory conditions (2015-2018)

- Subtask 1 - Management and communication
- Subtask 2 – Mapping and analysis of existing demo projects
- Subtask 3 – Deliverables
- Subtask 4 – Specific case studies

Task 39: Hydrogen in Marine Applications

- Hydrogen and fuel cell suppliers
- Shipping companies
- Advisory and assurance institutions
- Research institutions

Analysis

Task 30: Global Hydrogen Analysis (2010-2013)

- Global resource study
- Hydrogen database on hydrogen production potentials
- Interaction with IEA analysis community types: Urban, Rural and Island; Distributed industrial applications

Task 36: Life Cycle Sustainability Assessment (LCSA) of H2 Energy Systems (2014-2017)

- Environmental challenges
- Economic analysis
- Social indicators and integrative approaches for LCSA

Hydrogen Safety

Task 37 Safety (2015-2018)

- Physical phenomena
- Storage/materials issues
- Early markets
- Knowledge analysis
- Dissemination and global relevance / Integrative approaches for LCSA

1.4 Project objectives (DGC)

The main objectives (for DGC) have been an active Danish participation in the relevant HIA tasks, contact to the HIA Secretariat and information dissemination and outreach.

Most of the DGC resources were spent on:

- Regular contact to the HIA secretariat
- Preparation of Executive Committee meetings
- Ensuring progress in the task work
- Recruitment of new HIA members
- Representing HIA at relevant workshops and conferences
- Collaboration with other Implementing Agreements on a national basis
- HIA involvement in the IEA activities relevant for hydrogen

1.5 Project results and dissemination of results

The results from each project (task) are summarized in an End of Task report, which is approved by the Executive Committee.

Results are also presented during the task period by the task members at workshops and scientific conferences and at internal IEA seminars (with other Implementing Agreements and IEA experts).

Furthermore, overview presentations and HIA newsletters are prepared by the HIA secretariat (USA).

For the period 2009-2014 (reported in the End of Term Report), the number of publications and presentations were:

Publications and articles

HIA summary publications	31
HIA expert publications	2609

Presentations

HIA overview – internal IEA	64
HIA overview – external IEA	114
HIA expert presentations	1558

DK presentations on the HIA activities and results during 2015-2016:

Marts 18th 2015: ½ day conference at Eigtveds Pakhus, Copenhagen

<http://www.dgc.dk/nyhed/2015/iea-temamoede-om-brint-og-braendsejceller>

November 10th 2016: Den danske brint- og brændselscelledag (posters), SDU, Odense

<http://www.hydrogennet.dk/1186/>

1.6 Utilization of project results

The Danish energy systems are facing large changes and challenges during the conversion from fossil fuels to a de-centralized energy system based on renewable energy

The Danish HIA participation offers a great opportunity for being at the forefront of the hydrogen energy research, which may be an advantage, because hydrogen is one of the tools for the implementation of the national energy policy.

The feedback from HIA participants is that HIA offers an excellent opportunity for international collaboration, creation of project consortia and exchange of scientific results.

Main Danish interests are: Conversion of electricity to hydrogen (electrolysis, Power-to-Gas issues, energy storage); roll out of hydrogen infrastructure; hydrogen re-fuelling stations and hydrogen vehicles and hydrogen regulatory conditions (legal and safety).

1.7 Project conclusion and perspective

During the last 2 years, there has been an increasing global interest for hydrogen as a highly flexible energy vector. Driven by a greener energy supply by biomass and wind there is a need for:

- Hydrogen from renewable energy resources
- Energy conversion via hydrogen
- Energy storage via hydrogen
- Hydrogen as a CO₂ free energy carrier

The HIA participation by both countries and sponsors is increasing and so is the expert task participation, indicating the importance of the HIA work and the great opportunity offered for international collaboration on the challenges on the future energy systems.

More than 200 hydrogen experts participate in the HIA tasks making the IEA HIA network a unique platform for hydrogen knowledge.

The HIA core businesses, such as hydrogen production, hydrogen storage, hydrogen infrastructure systems and hydrogen safety, are all issues of great importance for the future energy systems, and therefore they are the main issues in the new Strategic Plan, formally approved by IEA in February 2015.

Overarching Objectives for the period 2015–2020:

- To broaden the perspective on the transformative role of H₂ by articulating and communicating its functions and value as a highly flexible energy vector in an integrated future multi-sector energy system.
- To strengthen analysis activities with a special focus on IEA analysis & publications and the competitive global energy technology environment.
- To focus on the development and implementation of the H₂ infrastructure, highlighting storage, safety and cost reduction.
- To raise the profile of the IEA HIA
- To formulate messages from IEA HIA technical and analytic activities in order to guide and inform IEA's policy making activities.
- To foster productivity and progress through growth in membership, closer relationships and cooperation with other H₂ organizations as well as a broader business orientation.
- To cultivate and deepen industry participation at task and ExCo levels.

Links

HIA homepage

<http://ieahia.org/>

HIA Strategic Plan (2015-2020) and HIA End of Term report (2009-2014)

http://ieahia.org/pdfs/IEAHIA_SP_2015_2020.aspx

http://ieahia.org/RESEARCH-PORTFOLIO/Tasks/IEAHIA_EOT_2009_2015.aspx

HIA Annual report 2015

http://ieahia.org/pdfs/2015-Annual-Report_WEB.aspx

HIA Summary (2 pager)

<http://ieahia.org/News/Brochures/IEA-HIA-Executive-Summary-June-2015.aspx>

HIA newsletter winter 2016/2017

<http://ieahia.org/News/Newsletters/Winter-2015-2016-Newsletter.aspx>

HIA summary presentation at WHEC, June 2016, Zaragoza

<http://ieahia.org/pdfs/IEA-HIA-RD-D-Cultivating-Sustainability-in-the.aspx>

Links to DGC news on IEA and IEA Hydrogen during 2015-2016

2016

November: <http://www.dgc.dk/nyhed/2016/nyhedsbrev-fra-iea-hydrogen>

October: <http://www.dgc.dk/nyhed/2016/world-energy-outlook-2016-i-danmark>

September: <http://www.dgc.dk/nyhed/2016/brint-i-gasnettet>

July: <http://www.dgc.dk/nyhed/2016/nyt-fra-iea-brintsamarbejde>

Marts: <http://www.dgc.dk/nyhed/2016/hydrogen-til-marineapplikationer>

2015

December: <http://www.dgc.dk/nyhed/2015/nyt-fra-ieas-brintsamarbejde>

December: <http://www.dgc.dk/nyhed/2015/indtryk-fra-world-hydrogen-technology-convention>

November: <http://www.dgc.dk/nyhed/2015/world-energy-outlook-2015-i-danmark>

June: <http://www.dgc.dk/nyhed/2015/webinar-om-hydrogen-og-braendselsceller>

June: <http://www.dgc.dk/nyhed/2015/ieas-gas-market-report-praesenteres-paa-wgc-i-paris>

April: <http://www.dgc.dk/nyhed/2015/power-gas-vinder-frem-i-tyskland>

Marts: <http://www.dgc.dk/nyhed/2015/presentationer-fra-temamoede-brint-og-braendselsceller>

February: <http://www.dgc.dk/nyhed/2015/stort-potentiale-i-power-gas>

January: <http://www.dgc.dk/nyhed/2015/iea-temamoede-om-brint-og-braendselsceller>

January: <http://www.dgc.dk/nyhed/2015/international-fokus-paa-hydrogen>

DGC, Hørsholm

31st December 2016