

Final report

1.1 Project details

Project title	IEA Hydrogen Implementing Agreement – Dansk deltagelse 2013-14
Project identification (program abbrev. and file)	Journalnr.: 64012-0219
Name of the programme which has funded the project	EUDP-12-II
Project managing company/institution (name and address)	DGC Dr. Neergaards Vej 5A, 2970 Hørsholm
Project partners	-
CVR (central business register)	12101545
Date for submission	31. marts 2015

1.2 Short description of project objective and results

The aim of the project is to participate in 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 2014 HIA had members from: 20 countries, 2 international organisations and 3 industrial sponsors.

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 via web, papers and workshops

Furthermore to coordinate the Danish HIA participation with the Danish Energy Agency, who is the formal Danish HIA member.

Results during the period 2012-2014:

- Growth of industry participation – 80 participants
- Admission of Industry sponsor members (3 members in Executive Committee)
- Development of systems analysis expertise
- Cooperation established with IEA analysis
- Separate HIA track at the WHEC2014 in Korea
- HIA participation at IGRC2014 (Copenhagen) and ICSH2013 (Brussels's)
- Active part in the IEA Hydrogen Roadmap process
- Successful management of a large portfolio of tasks
- Task Portfolio (2009 – 2014): 11 completed – 5 ongoing – 5 recently approved
- Steady and effective participation of ExCo Members and experts
- Approval of End og Term report (2019-2014) and Strategic Plan (2015-2020) by IEA

1.3 Executive summary

The main HIA activities and the strategic directions during 2012-2014 were given by the HIA Strategic Plan 2009-2014, based on a

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 executed or ongoing or initiated during 2009-2014:

11 completed – 5 ongoing – 5 recently approved

NR	TASK NAME	DURATION	STATUS
18	Integrated Systems Evaluation	2004–2009	completed
19	Hydrogen Safety	2004–2010	completed
21	Biohydrogen	2005–2010	completed
21	Bioinspired and Biological Hydrogen Production	2010–2014	completed
22	Fundamental & Applied H ₂ Storage Materials Development	2006–2012	completed
23	Small-Scale Reformers for on-Site H ₂ Supply	2006–2011	completed
24	Wind Energy and Hydrogen Production (Electrolysis)	2006–2011	completed
25	High Temperature Production of Hydrogen	2007–2011	completed
26	Advanced Materials for Waterphotolysis with H ₂	2008–2013	completed
27	Near-Term Market Routes to H ₂ via Co-Gasification with Biomass	2009–2011	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	approved
35	Renewable Hydrogen	2014–2017	approved
36	Life Cycle Sustainability Assessment (LCSA) (Successor Task 30)	2014–2017	approved
37	Hydrogen Safety (Successor to Task 31)	2015-2018	approved
XX	Power-to-Gas	2015-2018	Ini. Approvel

Danish Task participation by:

Task 18: Henrik Iskov, DGC

Task 22: Torben R. Jensen, iNANO and Tejs Vegge, Risø

Task 23: John Bøghild Hansen, Haldor Topsøe

Task 24: Claus O.E. Jørgensen and Allan Schrøder Pedersen, Risø

Task 25: Sune Ebbesen, Risø

Task 28: Mikael Sloth, H2Logic og Henrik Iskov, DGC

Task 30: Begrænset DK deltagelse via DGC

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

Task 33: John, Bøghild Hansen, Haldor Topsøe

Task 34: Evt. DTU

Task 35: Evt. DTU

Task 37: Frank Markert, DTU

Task xx: Henrik Iskov and Jan Jensen, DGC

Work programme by themes:

Hydrogen Production: Electrolysis («Power-to-Gas »)

Task 24: Wind Energy and Hydrogen Production (Electrolysis)

- State of the art
- Needed improvements & system integration.
- Business concept development
- Applications: Emphasis on wind energy management

→ EU-Project JTI-FCH: Efficient Alkaline Electrolysers (ELYGRID)

Hydrogen Production

Task 21: BioHydrogen (2005-2010);

Task 21 bis: 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 25: High temperature production of hydrogen (2007-2011)

- Subtask 1 – State of art
- Subtask 2 – Processes evolution
- Subtask 3 – Deployment strategy

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 Production: Local H₂ supply

Task 23: Small-Scale Reformers (2006-2011)

- Harmonized Industrialization
- Sustainability and renewable sources
- Market Studies
- Results: A basis for harmonized capacities of on-site reformer units

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

Hydrogen Storage: Solid state storage focus

Task 22: H₂ Storage Materials (2006-2012)

- Final report available under <http://ieahia.org/new.htm>
- Appendix A – Reports from 59 experts with scientific achievements
- Appendix B – Publication list (260 pages)

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 fulfill these targets
- Develop materials and systems for H₂ based energy storage for use in stationary, mobile and portable applications, and electrochemical storage

Integrated H₂ Systems/ Integration in Existing Energy systems

Task 18: Integrated Systems Evaluation (2004-2009)

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

- Scope - H2 applications in energy communities integrating H2 with electricity & 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 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

Analysis

Task 30: Global Hydrogen Analysis (2010-2013)

- Global resource study
- Hydrogen data base 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 19: Hydrogen Safety (2004-2010)

- Fundamental Data, Modeling, Component Testing, Mitigation effects, Databases

Task 31: Safety (2010-2014) – Task 37 Safety (2015-2018)

- Physical Phenomena
- Storage/Materials Issues
- Early Markets
- Knowledge Analysis
- Dissemination and Global Relevance / Integrative approaches for LCSA

Manpower

The total support to HIA by the task experts is app. 685 person years during 2009-2014.

1.4 Project objectives (DGC)

The main objectives (for DGC) have been an active Danish participation in the relevant HIA tasks and indeed the day to day management of the HIA Executive Committee and the HIA Secretariat.

Most of the DGC resources have been spend on:

- Weekly teleconference with secretariat
- Preparation and chairing of Executive Committee meetings
- Ensure progress in the task work
- Recruitment of new HIA members
- Regular contact and reporting to the IEA administration

- Preparation of End of Term report 2009-2014
- Preparation of Strategic Plan 2015-2020
- Represent HIA at relevant workshops and conferences
- Collaboration with other Implementing Agreements' and other relevant international organisations
- HIA involvement in the IEA Hydrogen Road Map process

Regular meetings between the Danish Energy Agency and DGC are held in order to ensure progress in the Danish participation and contribution to the HIA.

1.5 Project results and dissemination of results

The results from each project (task) are summarized in an End of Task report, which are 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 (Link: 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

1.6 Utilization of project results

The Danish energy systems are facing large changes and challenges during the conversion from fossil fuels to renewables and from a centralized system to de-centralized systems. The Danish HIA participation offers a great opportunity for being at the forefront at the hydrogen energy research, which may be an advance, because hydrogen is one of tools for the implementation of the national energy policy.

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

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

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 are increasing and so are 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.

The HIA core business on Hydrogen production, Hydrogen storage, Hydrogen infrastructure systems and hydrogen safety are all issues of great importance for the future energy systems, why they also are the main issues in the new Strategic Plan, formally approved by IEA in February 2015.

Overarching Objectives for the period 2015–2020:

- 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.
- Strengthen analysis activities with a special focus on IEA analysis & publications and the competitive global energy technology environment.
- Focus on the development and implementation of the H2 infrastructure, highlighting storage, safety and cost reduction.
- Raise the profile of the IEA HIA
- Formulate messages from IEA HIA technical and analytic activities in order to guide and inform IEA's policy making activities.
- Foster productivity and progress through growth in membership, closer relationships and cooperation with other H2 organizations, and a broader business orientation.
- Cultivate and deepen industry participation at the task and ExCo levels

Links

End of Term report (2009-2014)

http://ieahia.org/IEAHIA_SP_2015_2020.pdf

Strategic Plan (2015-2020)

http://ieahia.org/IEAHIA_SP_2015_2020.pdf

HIA Summary (2 pager)

http://ieahia.org/OnePagerSummerSept3_2014MR.pdf

Overview HIA presentation (Eigtveds Pakhus d. 18.03.2015)

<http://www.ens.dk/ny-teknologi/teknologi-strategier/brint-braendselsceller/praesentationer-temamoede-brint>

HIA homepage

<http://ieahia.org/>