The International Energy Agency (IEA) Hydrogen mplementing Agreement (HIA): Activity and Progress in a Global Collaborative R&D Portfolio

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NHA 2008

April 1, 2008 Sacramento, CA

IEA HIA Presentation

- IEA HIA Fundamentals
- Overview of IEA HIA Portfolio
  - Science and Technology
  - Market Environment
  - Outreach Program
- IEA HIA Value Proposition

Hydrogen Implementing Agreement (HIA)

A collaborative research and development (R&D) program
Created in 1977 on a task-shared, "bottom-up" basis

Strategic Framework

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

Strategy

To facilitate, coordinate and maintain innovative research, development and demonstration (RD&D) activities through international cooperation and information exchange

Annex / Task

Basic unit of organization; Next level is sub-task;
Operating Agent manages Annex; Experts do work

IEA HIA Members

IEA HIA April 2008

Canada
Mr Nick Beck (Chairman)

European Commission
Dr Stathis Peteves

Japan
Dr Yoshiteru Sato

Italy
Dr Agostino Iacobazzi

Iceland
Dr Agusta Loftsdottir

Lithuania
Dr Jurgis Vilemas

The Netherlands
Mr Frank Denys

France
Dr Paul Lucchese

Australia
Dr John Wright

Germany
Mr J.-F. Hake

Greece
Dr Eli Varkaraki

Turkey
Dr Alper Sarioglan

Korea Mr Kijune Kim

New Zealand Dr Steven Pearce

Norway
Ms Line Amlund Hagen

Spain
Dr Antonio Garcia-Condé

Sweden
Dr Lars Vallander

Switzerland
Dr Andreas Gut

United Kingdom
Dr Ray Eaton

United States
Dr Carole Read

Denmark
Mr Jan Jensen

Finland
Dr Heikki Kotila

IEA HIA Goals

Science & Technology Goal

Advancement of Science via Pre-Commercial Collaborative RD&D

- **Hydrogen Production**
- **Hydrogen Storage**
- **Hydrogen Systems**

Market Environment Goal

Assessment of Market Environment, including Non-Energy Sector

- **Non-Energy and Industrial Processes**
- **Foundation for Codes & Standard**
- **Infrastructure**

Outreach Program Goal

Increasing Knowledge and Comfort with Hydrogen

- **Membership and Participation**
- **Information Dissemination**
- **Synchronization worldwide**

IEA HIA Annexes Since 1977

1. Thermochemical Production
2. High-Temperature Reactors
3. Potential Future Markets
4. Electrolytic Production
5. Solid Oxide Water Electrolysis
6. Photocatalytic Water Electrolysis
7. Storage, Conversion and Safety
8. Techno-Economic Assessment
9. Hydrogen Production
10. Photoproduction of Hydrogen
11. Integrated Systems
12. Metal-Hydride for H_2 Storage
13. Design and Optimization of Integrated Systems
14. Photoelectrolytic Production
15. Photobiological Production
16. H2 from Carbon-Containing Materials
17. Solid & Liquid State Storage Materials

Current Portfolio

18. Integrated Systems - II
19. Hydrogen Safety
20. Hydrogen from Waterphotolysis
21. BioHydrogen
22. Fundamental and Applied H2 Storage Materials Development
23. Small-Scale Reformers for On-Site H2 Supply (SSR for H2)
24. Wind Energy and H2 Integration
25. High Temperature Processes for H2 Production

Current Annexes

Science and Technology

Production

20. Hydrogen from Waterphotolysis
21. BioHydrogen
23. Small-Scale Reformers for On-Site H_2 Supply (SSR for H2)
24. Wind Energy and H2 Integration
25. High Temperature Processes for H_2 Production

Storage

17. Solid & Liquid State Storage Materials
22. Fundamental and Applied H2 Storage Materials Development
23.

Market Environment

Analysis, Safety and Economics

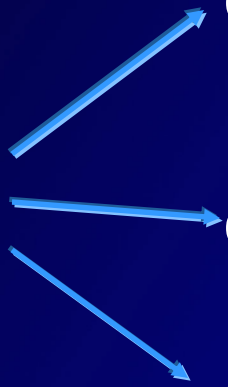
18. Integrated Systems
19. Safety

Science and Technology

HYDROGEN PRODUCTION

Hydrogen Production Pathways

Sustainable Pathways



- Renewable Sources
  (high or low temperature)

or

- Nuclear Energy

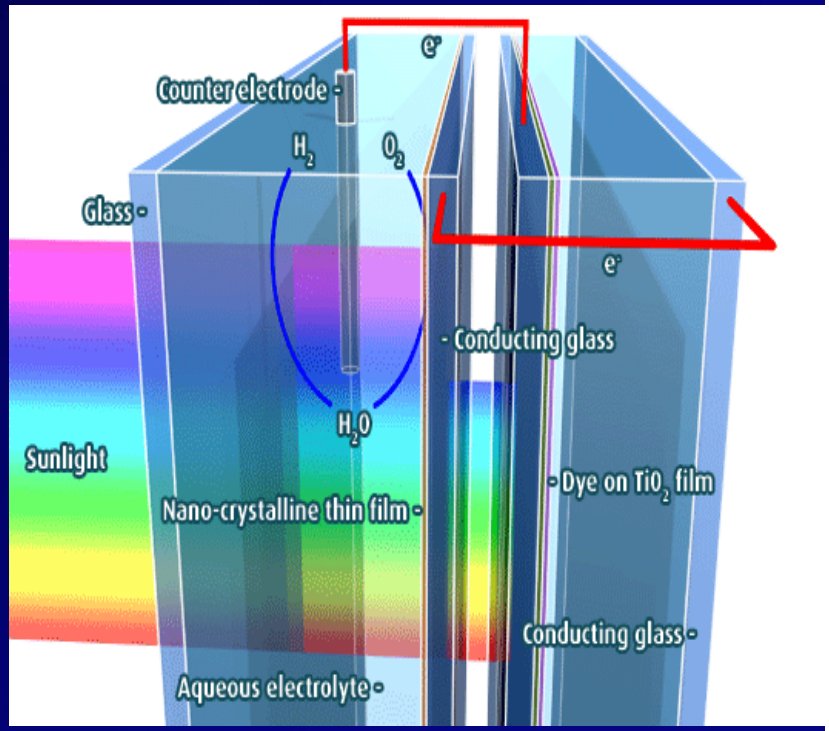
or

- CO_2 Handling of Carbon Containing Materials

Task 20: Hydrogen from Waterphotolysis

October 2004 – June 2008 (closing)

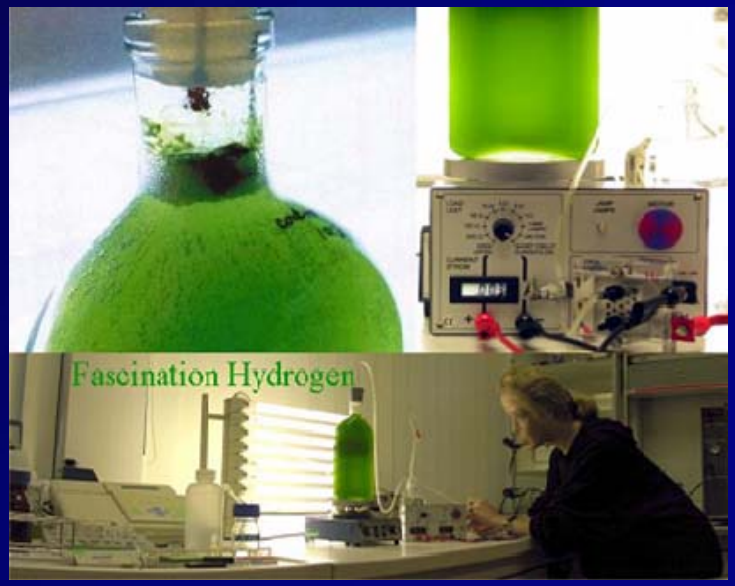
- **Continuation and expansion of Task-14 (up to 14 countries and 37 research groups)**
- **Aim: Net solar-to-hydrogen conversion efficiency of 10%**
- **Objectives: Intensification of international collaboration, advancement of PEC materials science, development of engineering solutions, demonstration of leading concepts, promotion of photolysis of water**



OA: Dr Andreas Luzzi (University of Applied Sciences Rapperswil, Switzerland)

Task 21: BioHydrogen

October 2005-October 2008



- **Evolved from Task 15**
- **Includes four areas of investigation:**
  - **Hydrogen dark fermentations**
  - **Photobiological hydrogen production systems**
  - **Bio-inspired systems**
  - **Overall analysis**

OA: Dr. Jun Miyake

Task 23: Small-Scale Reformers for On-Site H2 Supply

December 2006-December 2009

- **Development of reformer technologies and distributed on-site reformer based H2 supply systems**
- **Three Subtasks:**
  - **1)** Harmonized Industrialization
  - 2) Sustainability and Renewable Sources
  - 3) Market Studies

OA: Dr. Ingrid Schjølberg of Sintef

Task 24: Wind Energy and H2 Integration

December 2006-December 2009

- **Mid-term R&D for entire wind to hydrogen production chain**
- **Subtask A –** State of the Art
- **Subtask B –** Needed Improvements and System Integration
- **Subtask C -** Business Concept Development
- **Subtask D -** Applications with Emphasis on wind energy management

OAs: Dr. Luis Correas and Mr. Fernando Carpintero

Task 25: High Temperature Processes for H2 Productio

May 2007

- Will Support production of massive quantities of zero-emission H2 through use of high temperature processes (> 500 ° C) coupled with nuclear and solar heat sources
- **Three process families**: thermochemical cycles: steam electrolysis: and innovative water splitting
- **Four Subtasks**:
  - **Subtask A** – State of the Art
  - **Subtask B** – Methodology approach of HTPs
  - **Subtask C** – HTP R&D and future industrial development
  - **Subtask D** – Information Dissemination

OA: Mr. Gilles Rodriquez of CEA

Science and Technology

HYDROGEN STORAGE

Task 22: Fundamental and Applied Hydrogen Storage Materials Development

December 2006-December 2009

- **3 Targets:**
  - Reversible or regenerative storage media
  - Fundamental & engineering understanding
  - Storage materials for stationary apps
- **17 HIA countries, 50 projects**
- **Project types**: experimental, engineering, theoretical, safety
- **Classes of Materials:** reversible metal hydrides
  regenerative hydrogen storage materials
  chemical hydrides
  nanoporous materials
  rechargeable organic liquids and solids

OA: Dr. Bjørn C. Hauback

Market Environment

ANALYSIS, SAFETY AND ECONOMICS

Task 18: Integrated Systems Evaluation

January 2004 – January 2009 **(recently extended)**

- **Subtask A - Comprehensive information datasets** and **summary compilation** of **integrated hydrogen demonstration systems and development plans** - www.port-h2.com/IEA-Annex-18/
- **Subtask B - Modeling and existing analysis tools** used to **evaluate hydrogen demonstration projects.**
- Case Studies (http://www.ieahia.org/case_studies.html)

Phase 1 had **two Subtasks, A and B**. **Phase 2 will include:**

- **Subtask C – Synthesis and Learning** to bridge Subtask A and B experience and provide lessons learned, benchmark assessments and trend analysis

OA: Dr Susan Schoenung (Longitude 122 West, Inc, USA

Task 18 Demonstration Sites – Phase 1 and 2

CANADA	Pacific Spirit Station (H2 filling station)
DENMARK	Island Power
FRANCE	Review lessons learned from fuel cell evaluation **(EPACOP)**
GERMANY	Hydrogen Filling Station
GREECE	RES2H2
ICELAND	Hydrogen bus/refueling project **(ECTOS)**
ITALY	**BEAM** project: System efficiency; Control strategy
JAPAN	Regenerative PEM FC-power system (grid)
NEW ZEALAND	Renewable hydrogen at remote site
SPAIN	The Fuel Cell Innovative Remote Systems for Telecommunications (**FIRST**) project
SWEDEN	Malmö filling station and hythane-fueled buses
UK	Hydrogen and Renewables Integration **(HARI)** Project
USA	Las Vegas Energy Station
USA	Hydrogen Power Park

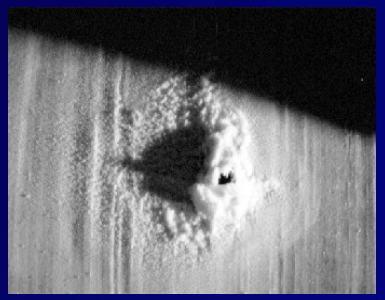
Task 19: Safety

October 2004 – January 2008 recently extended

Bonfire test

Grenade test

Hydraulic burst test



Gunfire test

Drop test

- Survey of Quantitative Risk Assessment (**QRA**) methodologies and testing methodologies
- **Testing and Experimental Program:** will evaluate the effects of equipment, product and/or system failures under a range of real-life scenarios, environments or mitigation measures
- **Targeted information packages for stakeholder groups such as:** permitting officials, insurance providers, system developers, manufacturers, early adoptors

OA: William Hoagland (W. Hoagland & Associates, USA)

Tasks in Definition

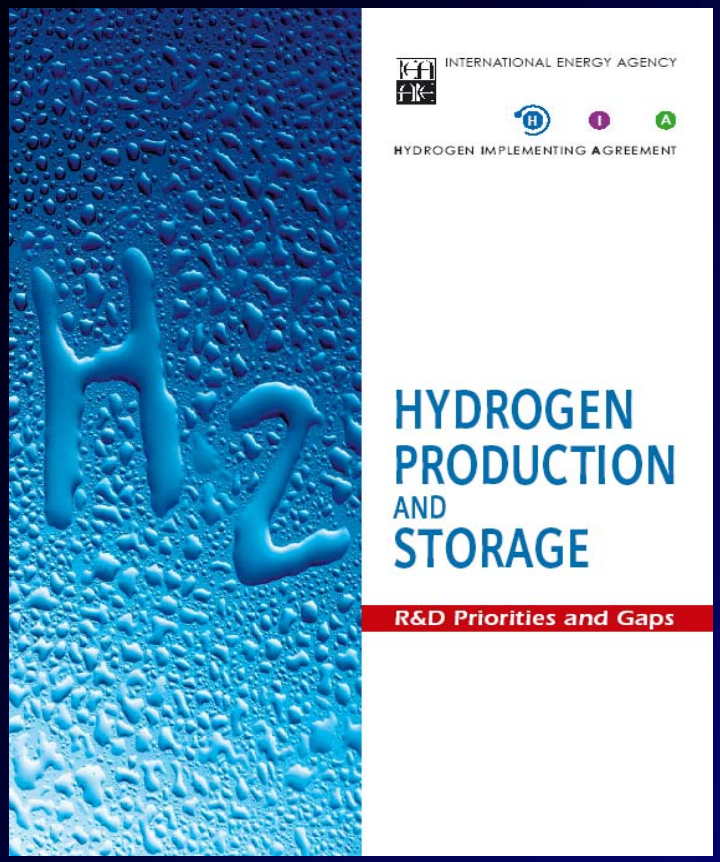
Science and Technology Goal Related : **PRODUCTION**

- Near Term Market Routes to Hydrogen by Co Utilization of Biomass as a Renewable Source with Fossil Fuels
- Advanced Materials for Waterphotolysis (successor to Task 20)

Both Science & Technology and Market Analysis Goals Related : **STORAGE AND ANALYSIS**

- Large Scale Hydrogen Infrastructure and Mass Storage

Analysis Related to Market Environment and Outreach Goals



Near Term

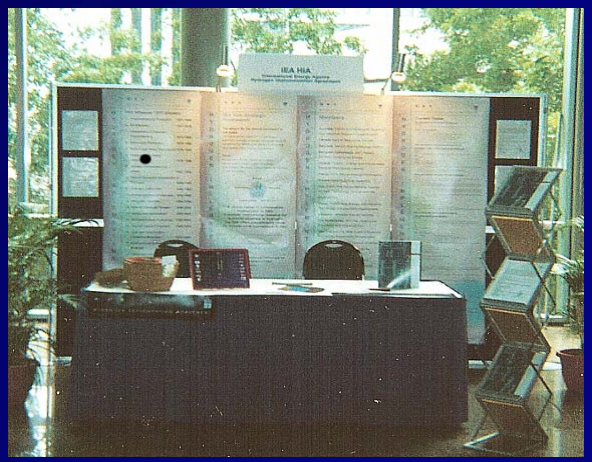
Medium Term

Long Term

R&D Priorities and Gaps in H2 Production and Storage

Available for downloading at http://www.ieahia.org/iea_publications.html

Outreach and Collaboration



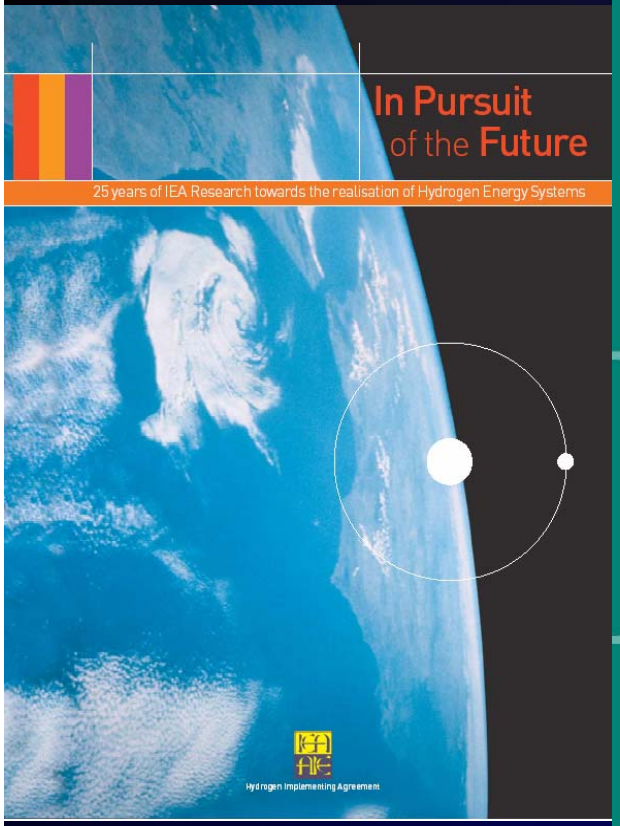
Objectives

1) Increasing Membership and Participation
2) Information Dissemination
3) Synchronization Worldwide

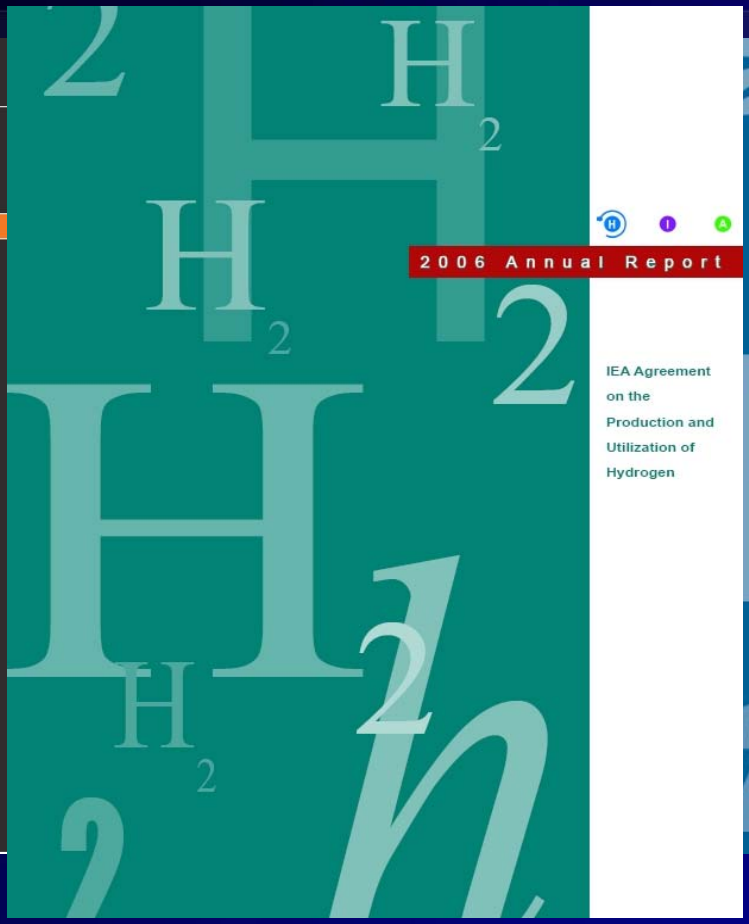
Collaboration: *Means and End*

Information Dissemination:

Download free at www.ieahia.org



25th Anniversary Report: In Pursuit of the Future
Luzzi / Bonadio / McCann
Released at the National Press Club, Washington DC, 7-Sep-04



2006 Annual Report

Task 14 Final Report Photoelectrolytic Production of Hydrgoen

National Hydrogen Association (NHA) Conference Sacramento, CA 2008

IEA HIA Value: a Sustainable Proposition

Provides a neutral international profile

- Knowledgeable, reliable, unbiased
- Access to technical experts
- Global reach (government, academia, industry)

Leverages resources

- Focus includes science & technology, market analyses and outreach
- Portfolio includes shorter term and long-term, pre-competitive activities
- Careful intellectual property (IP) treatment
- Established network of researchers

Offers assurance based on track record

- Collaborative research tasks completed over 30 years
- Growing Membership

International Energy Agency Hydrogen Implementing Agreement . . .

www.ieahia.org

. . . An R,D&D Collaboration pursuing hydrogen sustainability