IEA HIA R,D&D Portfolio and Fossil Fuels with a Hydrogen Future

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Ms. Mary-Rose de Valladares and Mr. Agostino Iacobazzi

S4FF
July 2009 Rome, Italy

IEA HIA Presentation

- **IEA HIA Fundamentals**
- **Introduction to IEA Portfolio**
- **Focus on Fossil Fuels**
- **Overview of IEA HIA Portfolio:**
  - **Collaborative R,D&D**
  - **Analysis that Positions Hydrogen**
  - **H2 Awareness, Understanding and Acceptance**

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 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 (RD&D) activities through international cooperation and information exchange

IEA HIA Members

June 2009

Canada
Mr Nick Beck

European Commission
Dr Marc Steen

Japan
Dr Yoshiteru Sato

Italy
Mr Agostino Iacobazzi

Iceland
Dr Agusta Loftsdottir

Lithuania
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Denmark
Mr Jan Jensen
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Finland
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Strategic Framework 2009 - 2014

2009 – 2014 Themes

Collaborative R, D & D
that advances hydrogen Science and Technology

- Hydrogen Production
- Hydrogen Storage
- Integrated Hydrogen Systems
- Hydrogen integration in existing infrastructure

Analysis that Positions Hydrogen
for

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

Hydrogen Understanding, Awareness and Acceptance
that foster technology diffusion and commercialization

- Information Dissemination
- Safety
- Outreach

IEA HIA Tasks 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 &Optimization Integ. Systems
14. Photoelectrolytic Production
15. Photobiological Production
16. H2 from Carbon-containing mat.
17. Solid & Liquid Storage Materials
20. Hydrogen from Waterphotolysis

Current Portfolio

18. **Integrated Systems - II**
19. **Hydrogen Safety -II**
21. **BioHydrogen - II**
22. **Fundamental & Applied H_2 Storage Materials Development**
23. **Small-Scale Reformers for On-Site H2 Supply (SSR for H_2)**
24. **Wind Energy and H2 Integration**
25. **High Temperature Processes for H_2 Production**
26. **Advanced Materials for H_2 from Waterphotolysis**
27. **Near-Market Routes to H2 by co-utilization of biomass with fossil fuel**

Current Tasks and Activities by Theme

Science and Technology

18. Integrated Systems Evaluation
21. Biogydrogen
22. Fundamental and Applied H2 Storage Materials Development
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
26. Advanced Materials for Waterphotolysis of Hydrogen
27. Near-Term Market Routes to H_2 via Co-Gasification with Biomass

--- *Large Scale Infrastructure and Mass Storage (in definition)*

Current Tasks and Activities by Theme

Analysis that Positions Hydrogen

--- *Analysis Task in (definition)*

H2 Awareness, Understanding and Acceptance

19. Safety

---- Information Dissemination and Outreach Portfolios

HYDROGEN IMPLEMENTING AGREEMENT

Theme:

Collaborative R,D&D

Fossil Fuels with an H_2 Future

Task 16: Hydrogen from Carbon Containing Materials

Task 16: H_2 from Carbon-Containing Materials

April 2002 – December 2005 (completed)

- **State of the Art Reports for all three subtasks:**
  - **Subtask A** – *Large Scale Integrated H_2 Production for Power Generation /Precombustion Decarbonization*
  - **Subtask B** – *Prospects for H_2 from Biomass*
  - **Subtask C** – *Small-Scale Reformers for Stationary H_2 with Minimum CO_2 Emissions*
- **Substantial industry participation – HIA Benchmark**
- **Two Successors tasks – Task 23 and Task 27**

OA: Elisabet Fjermestad-Hagen (Norsk Hydro, Norway)

Task 16 Recommendations for successor tasks

- A new task addressing small scale reformers should be formed
- A new task addressing hydrogen from biomass should be defined
- Focus on near marked opportunities at a small to medium scale
- Industrial players should be directly involved
- Co-gasification of biomass with coal should be included in the new hydrogen from biomass task

Task 23: Small-Scale Reformers for On-Site H_2 Supply

December 2006-December 2010

- **Development of reformer technologies and distributed on-site reformer based H_2 supply systems**
- **Three Subtasks:**

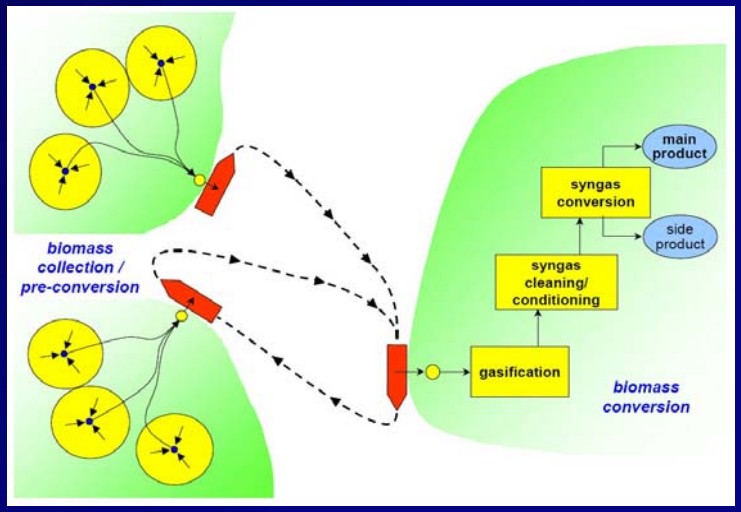
1) Harmonized Industrialization
2) Sustainability and Renewable Sources
3) Market Studies

OA: Dr. Ingrid Schjølberg of Sintef

Task 27: Near-Market Routes to H2 by Co-Utilization of Biomass as a Renewable Energy Source with Fossil Fuel

2008 – 2011

- **Co-gasification of biomass with fossil fuels**
- **Hydrogen market facilitation** based on distributed processing of biomass to new **tradable intermediates**
- **Near term stand-alone** biomass gasification
- **Roadmap –** development and verification



Source: Shell

OAs: Dr Jan-Erik Hanssen and Ms. Elif Caglayan

HYDROGEN IMPLEMENTING AGREEMENT

Theme:

Collaborative R,D&D

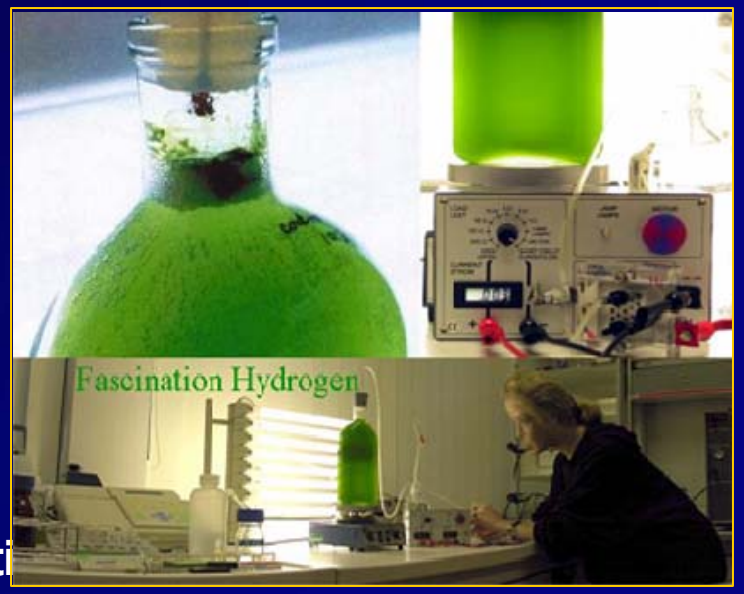
Portfolio:

HYDROGEN PRODUCTION

Task 21: BioHydrogen

October 2005-October 2010

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



OA: Dr. Jun Miyake

Task 24: Wind Energy and H_2 Integration

December 2006-December 2009

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

OAs: Dr. Luis Correas and Mr. Fernando Carpintero

Task 25: High Temperature Processes for H_2 Production

May 2007 – May 2010

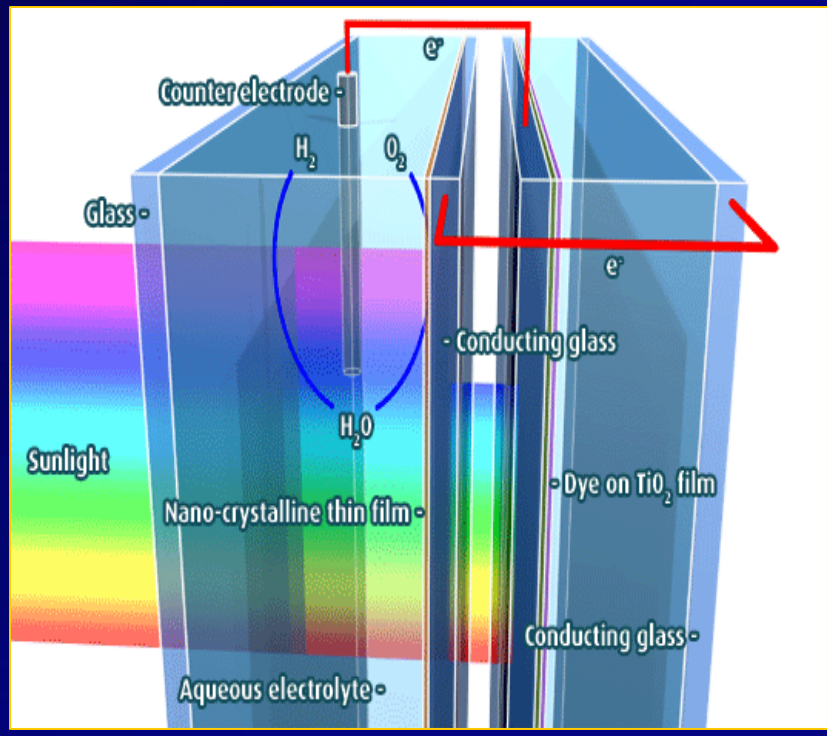
- Will Support production of massive quantities of zero-emission H_2 through use of high temperature processes (> 500 ° C) coupled with nuclear and solar heat sources
- **Three process families**: thermochemical cycles, steam electrolysis and innovative water splitting
- **Four Subtasks**
  - **Subtask 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

Task 26: Advanced Materials for Waterphotolysis of H_2

May 2008 – May 2011

- **Continuation and expansion of Task 20, Hydrogen from Waterphotolysis – Final Report available May 2009.**
- **Aim: Photoelectrochemical (PEC) materials that enable net solar-to-hydrogen conversion efficiency of 10% in PEC water-splitting**
- **4 Subtasks:**
  1) **Materials "Theory" R&D**
  2) **Materials "Synthesis" R&D**
  3) **Materials "Characterization" R&D**
  4) **"Information Coordination/ Database" Development**



OA: Dr Eric Miller of Hawaii Natural Energy Institute, University of Hawaii, Manoa

HYDROGEN IMPLEMENTING AGREEMENT

Theme:

Collaborative R,D&D

Portfolio:

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
- **20 HIA countries, 53 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 of IET

HYDROGEN IMPLEMENTING AGREEMENT

Theme:

Collaborative R,D&D

Portfolio:

INTEGRATED SYSTEMS

Task 18: Integrated Systems Evaluation

January 2004 – January 2009

- **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 23: Small-Scale Reformers for On-Site H_2 Supply

December 2006-December 2010

- **Development of reformer technologies and distributed on-site reformer based H_2 supply systems**
- **Three Subtasks:**

1) Harmonized Industrialization
2) Sustainability and Renewable Sources
3) Market Studies

OA: Dr. Ingrid Schjølberg of Sintef

HYDROGEN IMPLEMENTING AGREEMENT

Theme:

Collaborative R,D&D

Portfolio:

H_2 INFRASTRUCTURE & MASS STORAGE

Task 23: Small-Scale Reformers for On-Site H_2 Supply

December 2006-December 2010

- **Development of reformer technologies and distributed on-site reformer based H_2 supply systems**
- **Three Subtasks:**

1) Harmonized Industrialization
2) Sustainability and Renewable Sources
3) Market Studies

OA: Dr. Ingrid Schjølberg of Sintef

Task in Definition

Large Scale Hydrogen Infrastructure and Mass Storage

Task in definition

Approval expected at ExCo meeting Oct. 2009

HYDROGEN IMPLEMENTING AGREEMENT

Theme:

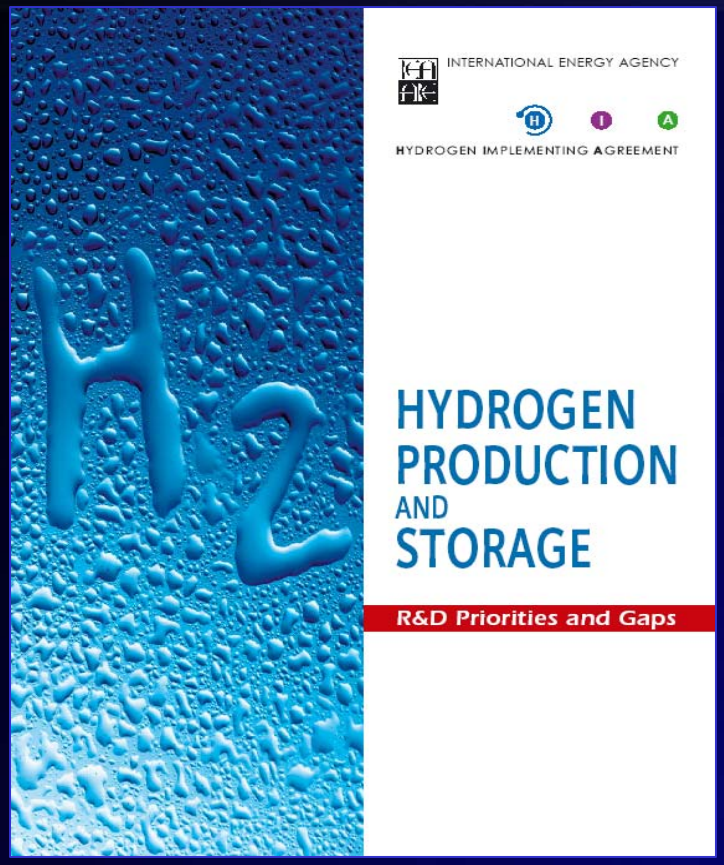
Analysis that Positions Hydrogen

Portfolio:

TECHNICAL, MARKET AND SUPPORT FOR POLITICAL DECISION-MAKING

S4FE, Rome, ITALY JULY 2009

Past Technical Analysis



Near Term

Medium Term

Long Term

R&D Priorities and Gaps

in H_2 Production and Storage

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

HYDROGEN IMPLEMENTING AGREEMENT

Theme:

Hydrogen Awareness, Understanding and Acceptance

Portfolio:

INFORMATION DISSEMINATION

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***

End-Of-Term Report 2004-2009 & Strategic Plan 2009-2014

2007 Annual Report

S4FE, Rome, ITALY JULY 2009

HYDROGEN IMPLEMENTING AGREEMENT

Theme:

Hydrogen Awareness, Understanding and Acceptance

Portfolio:

SAFETY

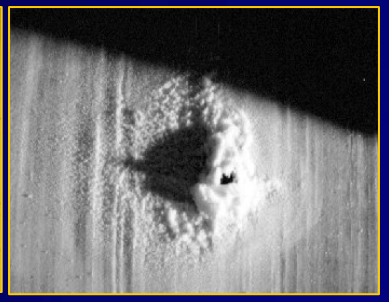
Task 19: Safety

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)

HYDROGEN IMPLEMENTING AGREEMENT

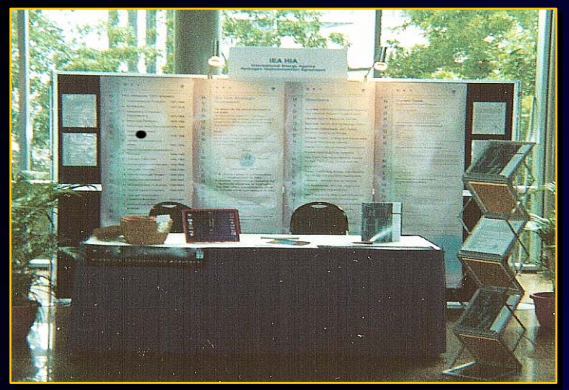
Theme:

Hydrogen Awareness, Understanding and Acceptance

Portfolio:

OUTREACH

Outreach



Conference/Meeting/Event Strategy

- 12 internal IEA presentations
- 40 external ExCo presentations
- 8 Conference Exhibits
- >1,015 task presentations
- >1,153 task publications
- 33 patents

Public Relations

- Creation and inaugural award of **HIA Individual Prize** for technical excellence in H2 R&D and harmony in international cooperation; **Project Prize** in 2009

Dr. Gary Sandrock

IEA HIA Chair Trygve Riis

Media Engagement

- Released 25th Anniversary Report at **National Press Club** in Washington, D.C.
- 12 Press Releases
- Letters to the Editor

IEA Value 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
- Membership growing

International Energy Agency Hydrogen Implementing Agreement . . .

www.ieahia.org

. . . A premier global resource for technical expertise in Hydrogen RD&D