HYDROGEN IMPLEMENTING AGREEMENT

IEA Hydrogen Implementing Agreement Secretariat

Management Support for Sustainable International Cooperation

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M.R.S. Enterprises, LLC
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This presentation does not contain any proprietary or confidential information

Project SAP2

Overview

IEA HIA Secretariat Function

Timeline

- US commitment long-standing
- Support ongoing
- M.R.S. engaged FY04

Budget

- FY04 - $103,000
- FY05 - $107,000
- Voluntary Contractor Cost-Share- $57,000/yr

Other Funding

R&D costs of 200 experts, 175 FTEs, "task-shared" by member countries.

Overview - Barriers

IEA HIA Secretariat Function

DOE Hydrogen Program Management and Operations 6.1

- Cites value to US in cooperative partnerships and coordinated international hydrogen activities
- Acknowledges DOE's leadership role in collaborative international activities via the IEA HIA
- Builds on sustainable HIA model with Secretarial initiative for an "International Partnership for a Hydrogen Economy"

Overview - Barriers

IEA HIA Secretariat and HIA R&D

- HIA's collaborative R&D, analysis and outreach portfolio contributes to removing full range of technical barriers in hydrogen
  - Production
  - Storage
  - Safety
  - System Analysis and Integration

- Secretariat management function essential to continued barrier reduction via HIA R&D

Overview- Barriers and Targets Examples

DOE Program Plan Areas and HIA Tasks

Task 15 Photobiological

Task 16 H_2 from Carbon Containing Materials

Task 17 Storage

Task 18 Integrated Systems Analysis

Task 19 Safety

Task 20 H_2 Waterphotolysis

Example Technical Barriers and/or Technical Targets

- 50% molar yield of carbon conversion to H_2
- $1.50/gge total H_2 distributed H_2 production
- Reversible H_2 storage medium recoverable with **5wt% H_2** at @ **80°C**
- Conflicts bet. domestic and int. codes & standards; lack of consistent modeling approaches; info and experience gap in tech validation
- Limited historical database; Proprietary data; Validation of historical data;
- Net solar to H_2 conversion efficiency of 10%

HIA Member Countries

Canada
Mr Nick Beck

European Commission
Dr Stathis Peteves

Japan
Dr Koji Nakui

Italy
Dr Agostino Iacobazzi

Iceland
Mr Agust Vatfells

Lithuania
Dr Jurgis Vilemas

The Netherlands
Dr Henk Barten

France
Dr Paul Lucchese

Australia
Dr John Wright

Norway
Mr Trygve Riis (Chairman)

Spain
Dr Antonio Garcia-Conde

Sweden
Dr Lars Vallander

Switzerland
Dr Gerhard Schriber

United Kingdom
Dr Ray Eaton

United States
Mr Patrick Davis

Denmark
Mr Jan Jensen

Finland
Dr Seppo Hannus

Partners

IEA HIA Fundamentals

International Energy Agency (IEA)

Autonomous body within the Organization of Economic Cooperation and Development (OECD), founded in 1974 to carry out energy cooperation among member countries

IEA Implementing Agreement (IA)

A collaborative research and development (R&D) program

Annex / Task

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

Hydrogen Implementing Agreement (HIA)

Created in 1977 on task-shared, "bottom-up" basis; US a founding member

US supports HIA Secretariat and participates in all tasks

HIA Annexes Since 1977

Past Tasks

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
1. Design and Optimization of Integrated Systems
2. Photoelectrolytic Production

Present Tasks

15. Photobiological Production
16. H_2 from Carbon-Containing Materials
17. Solid & Liquid State Storage Materials
18. Integrated Systems - II
19. Safety
20. Hydrogen from Waterphotolysis

Objectives

- Manage orderly and efficient conduct of HIA to support realization of HIA mission and DOE Hydrogen Program to advance hydrogen economy
- Support appropriate and effective expansion of the HIA R&D, analysis and outreach program
- Promote growth in HIA membership and industry participation
- Cooperate with other international hydrogen R,D&D ventures, notably the IPHE
- Enhance HIA leadership position in international hydrogen RD&D ventures
- Foster HIA's standing as a premier global resource for technical expertise in hydrogen R&D

Approach
In support of HIA mission & DOE Hydrogen Program Objectives
and under direction of HIA Executive Committee

- **Manage HIA Operations**
  - Strategic planning for R&D, analysis and outreach portfolio
  - Finance and accounting
  - Administration
  - Conferences, meetings and event planning
- **Manage HIA Personnel**
  - Employees and consultants, both professional and administrative
- **Manage Communication and Outreach program**
  - Internal HIA communications and IEA liaison
  - External communications and cooperation (www.ieahia.org)
  - Media Engagement
  - Representation to relevant organizations and groups

HIA Secretariat Accomplishments-Progress-Results

Operations

- Membership recruiting - Current total 17 members:
  - 4 new members
  - 1 returning member
  - 8 potential country members in pipeline to join HIA
- Formal IEA approval for new five year term of operation 2004-2009 and Strategic Plan
  - Features plans for HIA growth and expanded collaboration
- Two Executive Committee meetings per year
- HIA R&D, Analysis and Outreach Portfolio and Work plan
  - 3 new tasks (18, 19, 20) approved
  - approval of 4th task imminent
  - 2 tasks in project definition phase and others in decision pipeline

HIA Secretariat Accomplishments-Progress-Results

Outreach and Communications

- Press conference held at the National Press Club in Washington, D.C. to launch the 25th Anniversary Report *In Pursuit of the Future: 25 years of IEA Research towards the realisation of Hydrogen Energy Systems*
- HIA featured speaker at 10 major international conferences
- 12 media articles on HIA
- 4 major presentations and 2 posters now planned
- New corporate identity (logo, etc) developed
- HIA website www.ieahia.org now under reconstruction
- Published HIA Annual Report

Personnel

- Managed Secretariat's administrative and professional resources

HIA's success acknowledged as a sustainable vehicle for collaborative R&D that offers a global model for international cooperation

HIA 25th Anniversary Report "In Pursuit of the Future"

Luzzi / Bonadio / McCann

released at the National Press Club, Washington DC, 7-Sep-04

1) provides an introduction to the complex, interconnected issues associated with the development of a hydrogen infrastructure and the adoption of hydrogen as the "future fuel"

2) conveys the attractive fundamentals of the hydrogen energy proposition

3) highlights important HIA contributions to the advancement of hydrogen science and technology

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

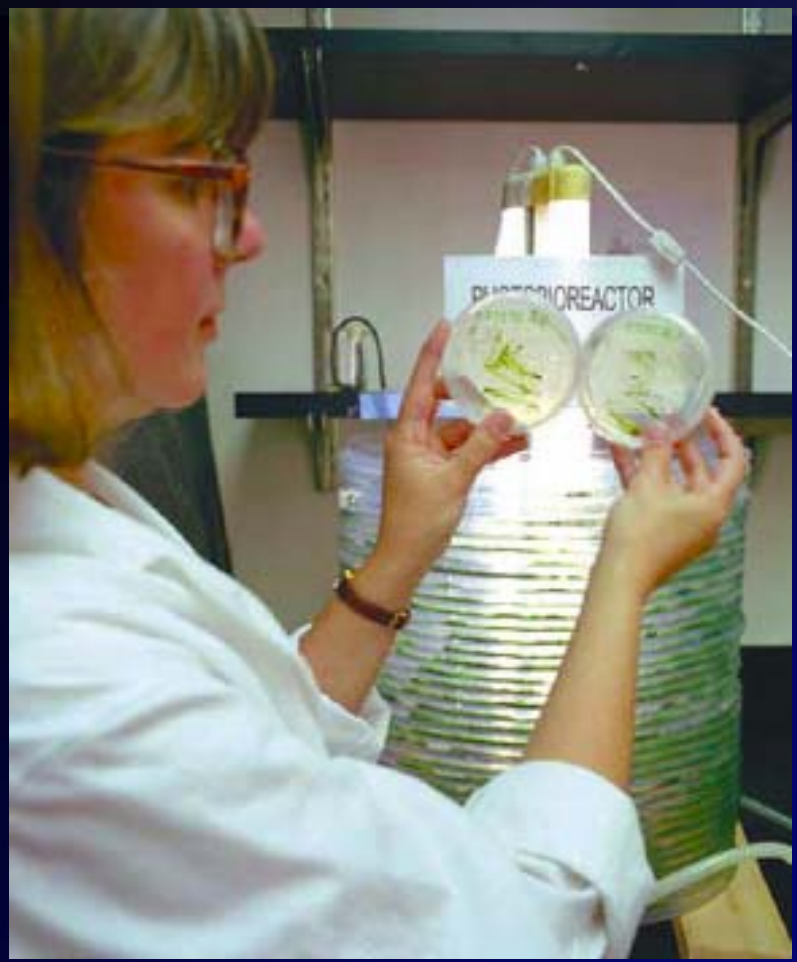
Task-15: Photobiological Hydrogen Production

Technical Accomplishments-Progress-Results

May 1999 – June 2004

- Completed – will evolve into Task-21
- Various process-development-scale photo-bioreactor systems being tested
- Comprehensive global database established on hydrogen-producing microorganisms
- Hydrogen production from a green algae demonstrated
- Two breakthroughs
  - Accessory genes for photoproduction of H_2 in Chlamydomonas Reinhardtii identified
  - STA7 and starch metabolism play important roles in this process

Gen-Mutated Algae Cultures for Hydrogen Production



NREL

Task-16: H_2 from Carbon-Containing Materials

Technical Accomplishments-Progress-Results

April 2002 – December 2005

- Completed concept study of large-scale integrated hydrogen production project for power production with decarbonization
- Comprehensive status and R&D challenges report on hydrogen production from biomass complete; Resource, technology and market analysis for biomass feedstock underway
- Review of small-scale stationary reformers for hydrogen production from fossil fuels with CUTE update
- Three subtasks:
  - Osaka Gas won engineering excellence award from ENAA for reformer work under Subtask C

“Small-scale” Natural Gas Reformer

Mahler

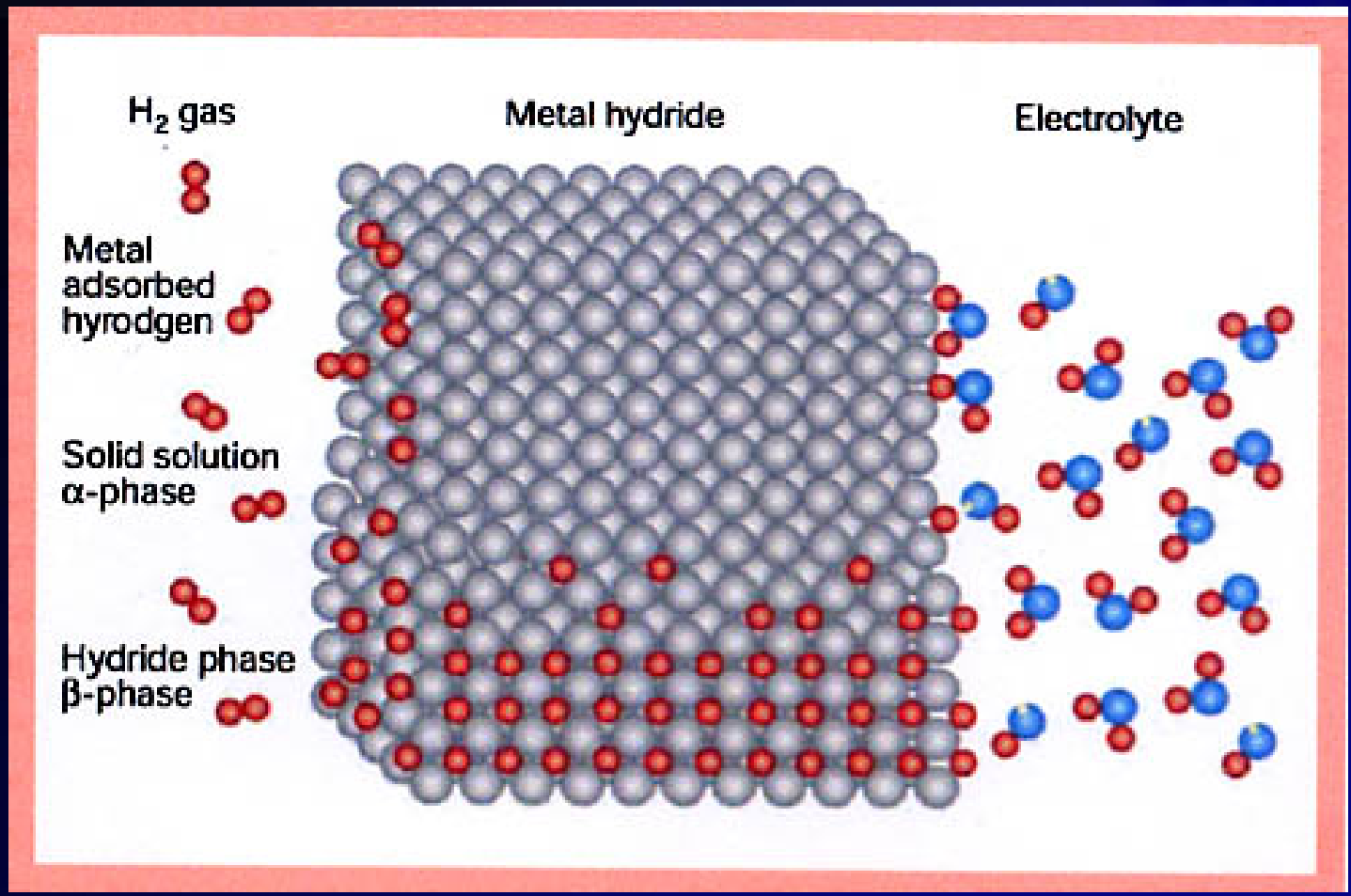
Task-17: Liquid & Solid Hydrogen Storage

Technical Accomplishments-Progress-Results

June 2001 – May 2006

- Global database created http://hydpark/ca.sandia.gov
- R&D on catalyzed sodium aluminum hydrides led to identification of hydride capable of 4 wt% reversible hydrogen @ 120°C
- Metal hydride storage material with 5 wt% @ 150°C confirmed
- Joint R&D on 14 metal hydride, 12 combined hydride/carbon and 6 carbon projects

Hydriding Mechanisms



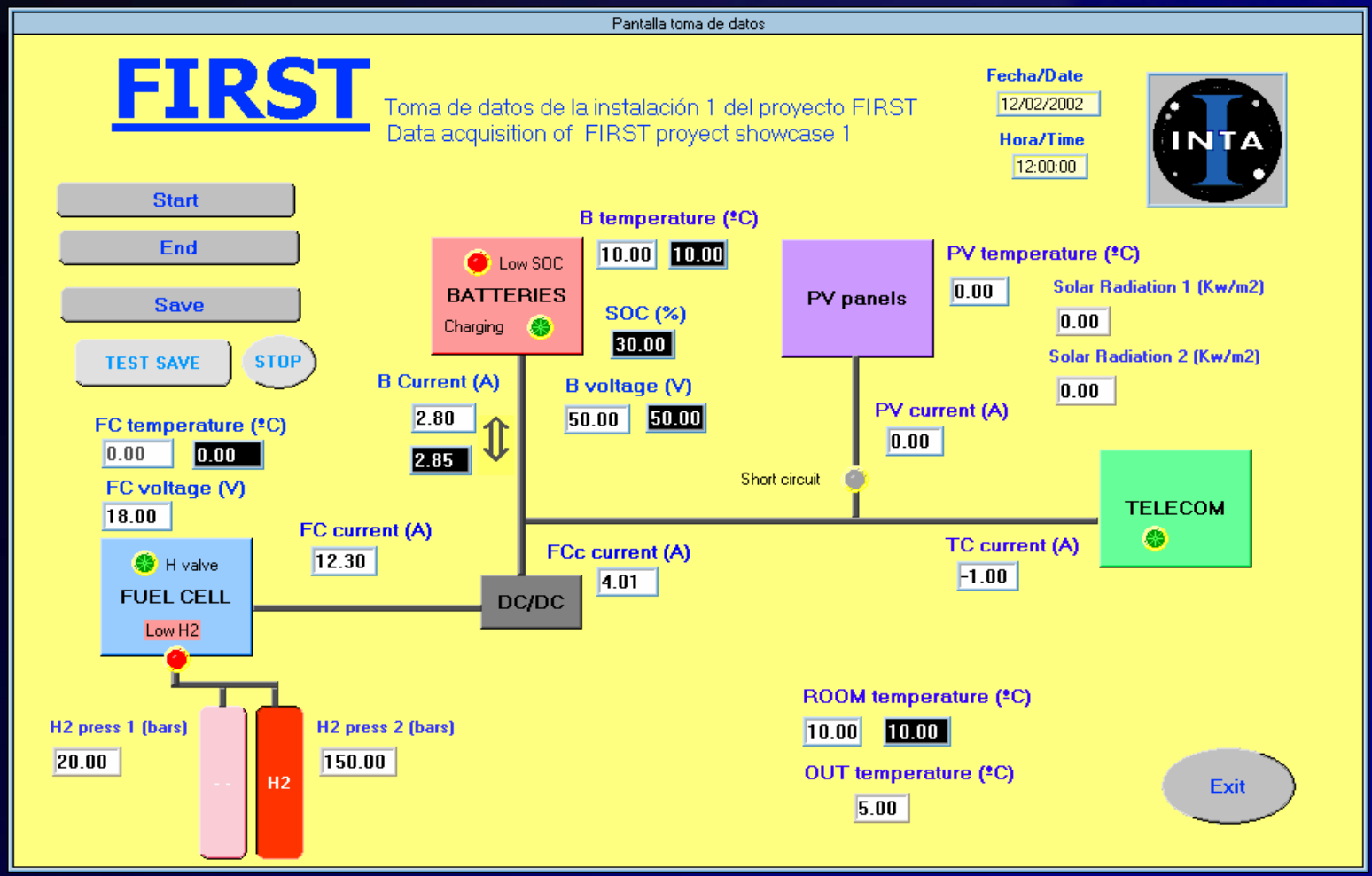
L. Schlapbach

Task-18: Integrated Hydrogen Systems
Technical Accomplishments-Progress-Results

January 2004 – January 2009

- Anticipates development of comprehensive information datasets and summary compilation of integrated hydrogen demonstration systems and development plans
- Utilizes Modeling and use of previously developed analysis tools to evaluate hydrogen demonstration projects
- Project selection and assessment: 8 demonstration projects selected; 2 evaluations complete; 6 underway
- "Hydrogen Resources Study" underway with broad participation
- New case study approach for other demonstration projects

Fuel Cell Innovative Remote System For Telecommunication



INTA

Task-19: Safety

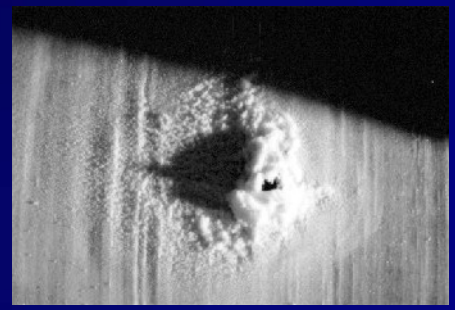
Technical Accomplishments-Progress-Results

October 2004 – October 2009

- Approved October 2004
- Subtask 1: Survey of Quantitative Risk Assessment (QRA) methodologies and testing methodologies underway
- Subtask 2: Establishment of testing equipment to evaluate the effects of equipment, product and/or system failures under a range of real-life scenarios, environments or mitigation measures
- Subtask 3: Development of targeted information packages for stakeholder groups

E.g.: High-Pressure Hydrogen Gas Tank Testing

Bonfire test



Gunfire test

Grenade test

Drop test

Hydraulic burst test

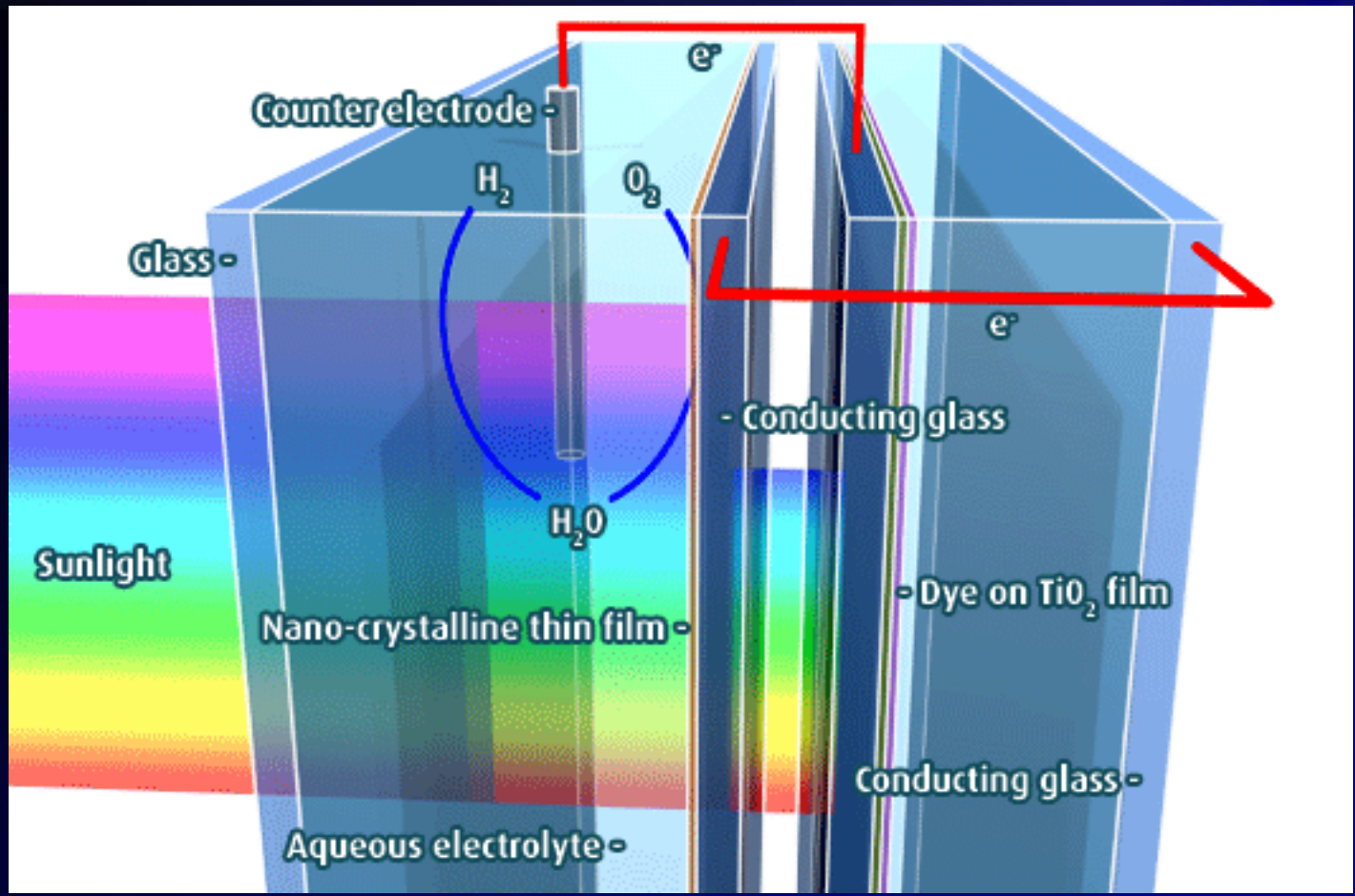
Task-20: Hydrogen from Waterphotolysis

Technical Accomplishments-Progress-Results

October 2004 – June 2008

- Launched October 2004: countries, 35 research groups, experts
- Continuation and expansion of Task-14 (up to 14 countries and 35 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

Photoelectrochemical (PEC) Tandem Cell



Hydrogen Solar LLC (UK)

The Future: HIA 5-Year Plan (2004 - 2009)

collaborative
RD&D

independent
Analyses

participation
Industry

country
Membership

with hydrogen
Confidence

The Future
HIA Goals 2004-2009

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**

Future Plans for Annexes & Activities

- Internal IEA cooperation – e.g. with Advanced Fuel Cells IA
- External collaboration – e.g. with IPHE
- High-temperature processes: Electrolysis, thermochemistry
- Low-temperature processes: Including electrolysis and wind
- Compressed gas assessment
- Hydrogen storage (focus on liquid & advanced solid state storage concepts)
- Industrial uses of hydrogen with non-energy focus
- Infrastructure for stationary applications
- Hydrogen economics
- Expanded outreach with newsletter on revamped website

Publications and Presentations

Secretariat Supported and/or Delivered

Publications

- **25th Anniversary Report: *In Pursuit of the Future***
- **End of Term Report and Five-Year Plan**
- **HIA Annual Reports**
- **Final management Report Task 14**
- **200 expert publications**
- **Opportunities Assessment Report: Gaps & Priorities in Hydrogen R&D**
- **Papers for inclusion in conference proceedings**
- **Press releases on HIA news**
- **Member only publications – Semi-Annual Reports and presentations**
- **Secretariat and media articles**

Presentations

FY2004

- German Hydrogen Energy Conference
- U.S. National Hydrogen Association Conference
- Windsor Workshop Panel Discussion
- World Hydrogen Energy Conference 15 – Presentation and poster
- Task 16 Subtask C presentation
- World Renewable Energy Conference (WREC)

FY2005

- Fuel Cell Seminar
- Gaps and Priorities in Hydrogen R&D to IEA Hydrogen Coordinating Group
- Renewable Hydrogen at IEA REWP Meeting
- IPHE Storage Conference (Co-sponsor)
- International Hydrogen Energy Congress & Exhibition
- World Hydrogen Technologies Conference
- European Hydrogen Energy Conference/Exhibition

HIA Secretariat:
Enhances HIA Investment Value for DOE

Provides a neutral international profile

- Knowledgeable, reliable, unbiased
- Global reach (government, academia, industry)

Leverages resources through task-sharing

- Focus includes science & technology, market analyses and outreach
- Portfolio includes shorter term and long-term, pre-competitive activities

Offers sustainable model for management of international R&D cooperation