HYDROGEN IMPLEMENTING AGREEMENT

END-OF-TERM REPORT | 2004-2009
STRATEGIC PLAN | 2009-2014

MARCH 2009

Executive Summary
Part II Strategic Plan 2009-2014

The forecast for 2009-2014 is for continued HIA expansion, progress toward fulfillment of the HIA mission and enhancement of the HIA value proposition.

Strategic Framework
The Agreement's **vision** for hydrogen remains unchanged:

> *The HIA vision for a hydrogen future is one based on a clean, sustainable energy supply of global proportions that plays a key role in all sectors of the economy.*

The HIA has adopted a **mission** statement for 2009-2014 that contemplates both the advancement of hydrogen and the role of the Agreement in achieving its vision:

> *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.*

To fulfill its mission and achieve its vision, the HIA's will continue to employ its existing **strategy**:

> *Facilitate, coordinate and maintain innovative, research, development and demonstration activities through international cooperation and information exchange.*

For the period 2009-2014, the HIA has identified three major **themes** that stem from its mission and vision. These themes are at once goals and priorities. Each theme is associated with a set of **portfolios** that contain the tasks and activities. The themes and portfolios are listed below

- **Collaborative R,D&D** that advances hydrogen science and technology

  The four Collaborative R,D&D portfolios are:
  - Hydrogen Production
  - Hydrogen Storage
  - Integrated Hydrogen Systems
  - Hydrogen Integration in Existing Infrastructure

- **Analysis that Positions Hydrogen** for technical progress and optimization
  for market preparation and deployment
  for support in political decision-making

  The three Analysis portfolios are:
  - Technical
  - Market
  - Support for Political Decision-Making

- **Hydrogen Awareness, Understanding and Acceptance** that fosters technology diffusion and commercialization

  The three Hydrogen Awareness, Understanding and Acceptance portfolios are:
  - Information Dissemination
  - Safety
  - Outreach – inform and engage critical subset of HIA stakeholders and decision makers

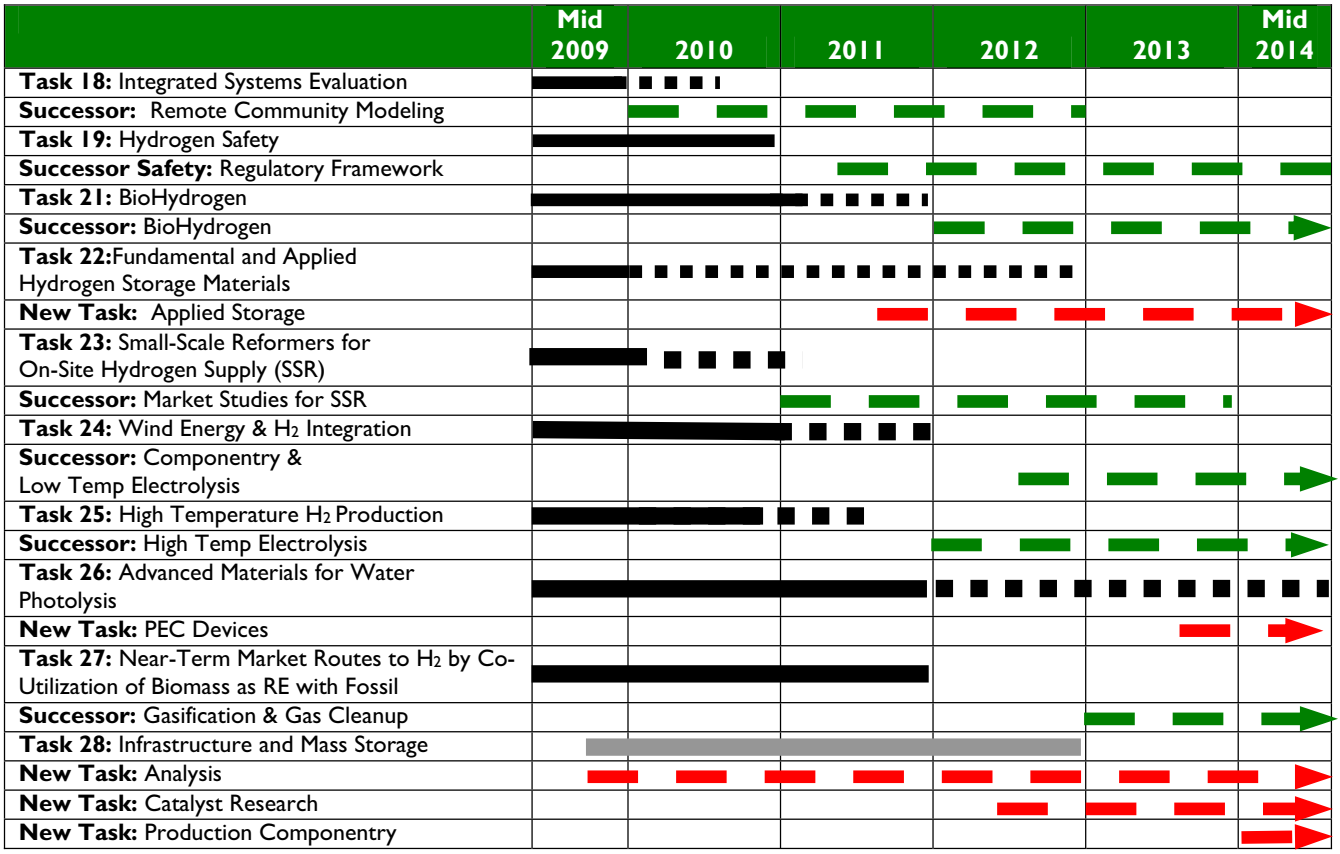
Potential Participants

As it looks forward to continued growth in membership, the HIA seeks to engage other IEA member and non-member countries The HIA is most especially interested in attracting members who are willing and able to commit to active participation in Agreement tasks and activities. It is also clear from the example of other Agreements that industry sponsors have the potential to make significant contributions to the advancement of hydrogen technology and the realization of the HIA mission. The HIA will consider parameters for sponsorship early in the new term. In tandem, the HIA will continue to encourage greater participation by industry experts at the task level. Each task will be asked to set a target for industry participation. Finally, the identification and training of potential experts, Operating Agents and Sub-task leaders will continue to be a priority activity.

Program of Work

In formulating the 2009-2014 Strategic Plan there was a clear sense in the Executive Committee that the Program of Work must contemplate the big picture needs of near, mid and long term hydrogen R,D&D. In addition, however, the Executive Committee stressed that the Program of Work must also address issues germane to the 2009-2014 timeframe, the term for this Strategic Plan. All nine tasks in place as of 2009 will continue in the new term. Another task, now in definition, is expected to launch just before or right after the new term begins. Six (6) of the existing tasks are expected to be extended during the term: Task 18, Task 19, Task 21, Task 22, Task 23 and Task 24. Some seven (7) tasks are expected to be formed as successors to current tasks: Remote Community Modeling (Task 18); Regulatory Framework (Task 19); new BioHydrogen (Task 21); Applied Storage (Task 22); Market Studies for SSR (Task 23); Componentry and Low Temperature Electrolysis (Task 24); and High Temperature Electrolysis (Task 25). Finally, five (5) other new tasks are forecast: PEC Devices; Gasification and Gas Clean-up; Production Componentry; Catalyst Research; and Analysis.

While HIA efforts in fundamental R,D&D will continue, there will be an increasing emphasis on applied R&D. In addition, this term will feature an "Analysis Imperative." The HIA understands that the ultimate success of the Analysis Imperative depends upon effective information dissemination. Therefore, both expansion in the HIA information products – resulting in significant part from the analysis efforts — and more frequent use of distribution channels are planned. In addition, new platforms for information dissemination such as webinars will also be adopted. New this term is a conference/meeting initiative that will allow the HIA to hold meetings/ conferences to discuss progress, activities and achievements. Activities in the Outreach Portfolio will focus not only on informing, but more importantly on engaging, a critical subset of HIA stakeholders and decision makers. See Table C below for a Timeline on the 2009-2014 Programme of Work.



Part I End-of-Term Report 2004 – 2009

1.0 Introduction

1.1 Background

The International Energy Agency (IEA) Agreement on Production and Utilization of Hydrogen, commonly known as the IEA Hydrogen Implementing Agreement (HIA), was created in 1977. Its current term (2004-2009) ends in June 2009. As planned, the HIA experienced substantial growth in its membership, activity level, accomplishments and Secretariat capacity during this five year period. The 2004-2009 term marked the beginning of the "Second Generation HIA," following 25+ years of productive R,D&D cooperation. The growth in the HIA portfolio, as measured in tasks, was accompanied by Agreement-wide growth in two critical areas, analysis and outreach. The HIA also marked a major organizational milestone by opening a fully dedicated office as called for in its 2004-2009 Strategic Plan. Interest in hydrogen technologies has heightened in the recent past, driven by the sharpening global focus on energy and the challenge of climate change. With its track record for collaboration, Strategic Plan and increased Secretariat capacity, the HIA was well-positioned to convert this resurgence of interest into effective collaboration on hydrogen R,D&D.

1.2 Guiding Principles

The members of the IEA HIA agree that energy related hydrogen technologies merit serious attention. The following are the guiding principles on which the scope of the Agreement is based[1]:

- Hydrogen—now mainly used as a feedstock for upgrading fossil-based energy carriers—will in the future increasingly become an energy carrier itself. It is necessary to carry out the analysis, studies, research, development and outreach that will facilitate a significant role for hydrogen in the future.
- Significant use of hydrogen will contribute to the reduction of energy-linked environmental impacts, including climate change due to anthropogenic carbon emissions, mobile source emissions such as CO, NOx, SOx, and NMHC (non-methane hydrocarbons), and particulate matter.
- Hydrogen has the potential for short, medium and long-term applications. The steps to realize the potential for applications in appropriate time frames must be understood and implemented.
- All sustainable energy sources require conversion from their original form. Conversion to electricity and/or hydrogen will constitute two prominent, complementary options in the future.
- Hydrogen can assist in the development of renewable and sustainable energy sources by providing an effective means of storage, distribution and conversion; moreover, hydrogen can broaden the role of renewables in the supply of clean fuels for transportation, heating, back-up power, portable power and combined heat and power (CHP) or cogeneration.
- Hydrogen is an energy carrier that can be produced as a storable, clean fuel from the world's sustainable non-fossil primary energy sources - solar energy, wind energy, hydropower, biomass, geothermal, nuclear, or tidal. Hydrogen also has the unique feature that it can upgrade biomass to common liquid and gaseous hydrocarbons, thus providing a flexible, sustainable fuel.

[1] The guiding principles on which the Agreement is based are incorporated in the *2002 Handbook of Policies and Procedures*. While the handbook is not a legal document, it serves as an all-purpose reference document for the HIA.

- Hydrogen can be used as a fuel for a wide variety of end-use applications including important uses in the transportation and utility sectors.
- All countries possess some form of sustainable primary energy sources; hence, hydrogen energy technologies offer an important potential alternative to fossil fuel energy supply (in many instances to imported fuels). Utilization of hydrogen technologies can contribute to energy security, diversity and flexibility.
- Barriers, both technical and non-technical, to the introduction of hydrogen are being reduced through advances in renewable energy technologies and hydrogen systems including progress in addressing hydrogen storage and safety codes & standards concerns.
- Hydrogen energy systems have potential value for locations where a conventional energy supply infrastructure does not exist. The development of hydrogen technologies in niche applications will result in improvements and cost reductions that will lead to broader application in the future.

The members of the Agreement recognize that a near, mid and long-term research, development and demonstration effort is required to realize the significant technological potential of hydrogen technologies. This effort can help to create competitive hydrogen energy production and end-use technologies, and to support development of the infrastructure required for its use. The HIA effort considers the entire technology system and the entire value chain. While its efforts consist largely of R,D&D, they also feature techno-economic analysis and outreach.

If the technological potential of hydrogen is realized, it will contribute to the sustainable growth of the world economy by facilitating a stable supply of energy and by helping to reduce future emissions of carbon dioxide. Cooperative efforts among nations can help speed effective progress towards these goals.

1.3 Contribution to IEA Shared Goals

In 1993 IEA Ministers adopted a policy framework whose shared goals were intended, among other objectives, to "create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment.[2]" The HIA is pleased to report that, during the 2004-2009 term, its members have sought to strengthen their respective policy frameworks in keeping with the spirit and letter of the Shared Goals.

Because hydrogen can be made from highly diverse sources, HIA member country efforts in this field stand to contribute to future energy supply diversity. In terms of environmental sustainability, hydrogen is a winner: When made from renewable and nuclear sources, hydrogen has very low emissions taking into account the full value chain. When made from carbon sources, emissions can be managed with carbon capture and sequestration. Member commitments to the IEA collaboration, in addition to their own national efforts, make critical contributions to R,D&D and deployment of hydrogen.

All HIA members have discrete national hydrogen programs or significant hydrogen activities. Their participation in the HIA reflects their interest and commitment to hydrogen. It also reflects their national priorities and concerns, which contribute directly to formation of the HIA portfolio of tasks and activities.

[2] Shared Goals, http://www.iea.org/about/sharedgoals.htm

1.4 Trends

Beyond the borders of hydrogen R&D, the energy market is in transition. The future has never been brighter for the wind industry. Markets are opening to photovoltaics and biomass. The nuclear industry is on the verge of a comeback in some places. The coal industry is fighting for competitive advantage in a low carbon market even as it enjoys phenomenal growth in emerging countries.

Vigorous debate about carbon policy has also taken center stage, resulting in the 2006 award of the Nobel Peace Prize to the Intergovernmental Panel on Climate Change (IPCC) and former U.S. Vice-President Albert Gore "for their efforts to build up and disseminate great knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change."[3] Growing demand, constrained conventional supply and uncertain costs have spurred sobering discussions among government policy makers about the full range of alternatives, their level of technology maturity, their safety and their emissions implications. These alternatives include nuclear and coal, as well as renewable energy, a modest but growing contributor to the world energy supply. They also include hydrogen. Hydrogen may well be considered the energy solution for environmental protection, offering significant CO_2 reduction possibilities. It can also contribute to energy security and economic development.

Over the past five years many nations have begun or deepened investigation of hydrogen for energy applications. These investigations have often included hydrogen roadmaps. Some 400 significant hydrogen and fuel cell technology demonstration and deployment projects have been funded and constructed around the world (North America, Europe and Japan) in both stationary and transport sectors. A similar number of demonstrations have taken place in the distributed power sector.[4] Several nations have established hydrogen highways in some part of their territory, often in cooperation with their states and provinces. These include Canada, the European Union, Japan, Norway and the U.S.

In 2003, the International Partnership for a Hydrogen Economy (IPHE) was established as an international institution to accelerate the transition to a hydrogen economy (refer to 5.2.2). Its large (16 countries and the EC) membership attests to increased global interest in hydrogen and the benefits it can bring.

Today, hydrogen is primarily used as a chemical feedstock in the refining, petrochemical, food, electronics, and metallurgical processing industries, but it is rapidly emerging as a major component of clean sustainable energy systems. Fuel cells, an important energy conversion device, operate on hydrogen, so access to hydrogen is key to development of that business. Hydrogen is relevant to all of the energy sectors - transportation, buildings, utilities, and industry. It can be produced in both centralized and distributed generation systems. Hydrogen is found in carbon containing materials (fossil energy and biomass). A diverse array of primary sources (renewables, nuclear and solar) can be used for watersplitting. The global diversity of production options enhances hydrogen's appeal for energy security.

Hydrogen can be used to provide back-up power, portable power and combined heat and power. For these applications, fuel cells may often be the energy conversion technology of choice.

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[3] R K Pachauri, Chairman, IPCC, "Acceptance Speech for the Nobel Peace Prize Awarded to the Intergovernmental Panel on Climate Change (IPCC)," Oslo, 10 December 2007.

[4] http://www.netinform.net/h2/H2Stations/Default.aspx

Hydrogen can also provide bulk energy storage options for intermittent renewable technologies such as solar and wind, and when combined with emerging decarbonization technologies, it can reduce the climate impacts of continued fossil fuel utilization.

1.5 Technology Status

In 2004, at the request of the IEA Secretariat in satisfaction of Mr. Claude Mandil's directive to the Hydrogen Coordinating Group (HCG), the HIA undertook a thorough and in-depth examination of near, mid and long-term gaps and priorities in hydrogen production and storage, the two key challenges to widespread, large scale use of hydrogen. The results were captured in two papers.[5] The IEA then published the HIA's findings and conclusions in ***Hydrogen Production and Storage: R&D Priorities and Gaps.***[6] This effort served to inform the HIA's work during this term and also facilitated strategic planning for upcoming 2010-2014 period. Key findings and conclusions from this report are included in the 2010-2014 Strategic Plan discussion of important research areas. A few comments about the status of hydrogen production and storage technology follow.

The development of a clean, sustainable hydrogen supply propels the HIA's investigation of hydrogen production from renewable energy sources such as wind and biomass, and from nuclear energy. Wind is mature technology. Biomass gasification is well understood technically but still in the demonstration/pilot phase. Photo-electrochemical and photo-biological processes, as well as hydrogen from nuclear processes, require extensive fundamental and applied research and development. Much of both fundamental and applied research and development is materials related. Because production of hydrogen from fossil fuels offers a likely approach for early adoptors of hydrogen technologies, the HIA is exploring R&D in reformation of low emission natural gas and coal that has been decarbonized and subject to carbon capture and sequestration.

Hydrogen storage has been referred to as the "Grand Challenge[7]." The challenge pertains most directly to the transportation applications, where storage capacity, energetics, form factor and performance requirements have yet to be satisfied technically and economically. There has been steady progress, however, and the focus is clearly on solid materials as the preferred storage medium to enable greater driving range for transportation applications. As liquid and gas storage options are limited in their potential to meet longer term goals, new materials and solutions are needed to meet this challenge.

2.0 HIA Framework

Coming into the 2004-2009 five year period, the HIA adopted a Strategic Plan reflecting its 26 year history of collaborative international RD&D hydrogen programs as well as the opportunities and challenges associated with the first five years of the "**Second Generation HIA."** This Five Year Strategic Plan included focal points, mission, vision, strategy, goals and scope. The Strategic Plan also retained the generic objectives and actions set forth in the HIA Handbook of Policies and Procedures and listed above in Section 1.2 Guiding Principles.[8] Finally, the Agreement's strategic framework for the completed term 2004-2009 was organized

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[5] The hydrogen production analysis was prepared by Trygve Riis and Elisabet Fjermestad-Hagen. Dr. Gary Sandrock was primarily responsible for the storage analysis. The corresponding authors of the papers were Preben S.J. Vie and Øystein Ulleberg.

[6] http://www.ieahia.org/pdfs/Hydrogen_Gaps_and_Priorities.pdf

[7] http://www1.eere.energy.gov/hydrogenandfuelcells/storage/national_proj.html

[8] Adapted from Handbook of Policies and Procedures for the IEA Hydrogen Program, August 2002, p. 17.

to support realization of the IEA's Shared Goals.

2.1 Focal Points

As it embarked on the "Second Generation HIA", the Implementing Agreement strove to advance its leadership role in the advancement and communication of hydrogen science and technology by identifying five focal points. These focal points are listed below and also illustrated in Figure 1:

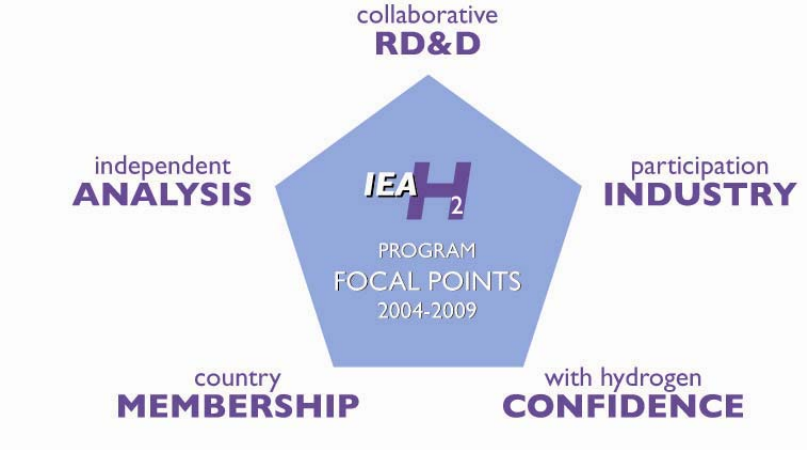

Figure 1: Focal Points

- Designing and conducting **collaborative RD&D** programs that address pre-commercial and basic needs;
- Undertaking **independent analyses** of hydrogen science, technology systems and economics that support RD&D and outreach programs;
- Increasing **membership participation**
- Involving a broad range of **industry partners**; and
- Raising the level of **hydrogen awareness, understanding, knowledge and support** throughout all sectors of the economy

2.2 HIA Vision, Mission, Strategy

The HIA **Vision** for a hydrogen future is based on a clean, sustainable energy supply of global proportions that plays a key role in all sectors of the economy.

The overarching HIA **Mission** is to accelerate hydrogen implementation and widespread utilization.

The **five year (2004-2009) specific Mission** of the HIA was to advance the adoption of a hydrogen economy through strategic implementation of collaborative RD&D and outreach programs that addressed key issues and barriers.

2.3 5 Year Goals

The HIA embraced three principal goals for the 5 year period 2004-2009:

- **Advancement of science and technology** via pre-commercial collaborative RD&D programs
- **Assessment of market environment**, including the non-energy sector
- **Implementation of outreach program**, aiming at community acceptance and support.

2.4 Scopes

Each goal has specific focus areas called scopes. The scopes are listed below under their goal.

Advancement of Science and Technology

- Hydrogen Production
- Hydrogen Storage
- Hydrogen Systems

Assessment of Market Environment

- Codes & Standards
- Non-Energy Processes
- Infrastructure Options

Implementation of Outreach Program

- Membership and Participation
- Information Dissemination
- Synchronisation Worldwide

3.0 Participation of Countries and Industry

3.1 Current Membership

Nearing the end of the 2004-2009 term, membership in the HIA had increased ~60%, from 14 to 22 members. With each new member, the HIA's capabilities have grown. All members are Contracting Parties (21 countries and the European Commission) as the HIA presently has no sponsors. There were no industrial participants among the Contracting Parties. A list of member countries and their Contracting Parties appears below in Table 1, categorized according to status (government, research institutes and other).

Table 1: Member Country/ Contracting Party/ Status

MEMBER COUNTRY	CONTRACTING PARTY	STATUS
Australia	Commonwealth Scientific and Industrial Research Organization (CSIRO)	G
Canada	Natural Resources Canada	G
Denmark	Danish Energy Authority	G
European Commission	European Commission, DG JRC	R
Finland	Energy and Environment National Technology Agency of Finland	G
France	Commissariat à l'énergie atomique (CEA)	R
Germany	Institut of Energy Research, Forschungszentrum Jülich GmbH Head of Programme Group Systems Analysis and Technology Evaluation (IEF-STE)	R
Greece	Centre for Renewable Energy Sources CRES & Hydrogen Technologies	R
Iceland	National Energy Authority	G
Italy	ENEA IDROCOMB Casaccia Research Center	G
Japan	The New Energy and Industrial Technology Development Organization (NEDO)	G
Korea	Ministry of Commerce, Industry, and Energy (MOCIE)	G

Lithuania	Lithuanian Energy Institute	R
New Zealand	NZ Business Council for Sustainable Development Inc.	O
Norway	The Research Council of Norway	G
Spain	Instituto Nacional De Técnica Aeroespacial (INTA)	G
Sweden	Swedish Energy Agency	G
Switzerland	Swiss Federal Office of Energy	G
The Netherlands	Senter Novem	G
Turkey	TUBITAK Marmara Research Center Energy Institute	R
UK	Department of Energy & Climate Change	G
USA	Department of Energy	G

G: Government **R**: Research Institute **O**: Other

Table 2 lists the countries that joined the HIA during this term, along with their year of accession.

Table 2: List of Countries that Joined the HIA 2004-2009

COUNTRY	ACCESSION YEAR
France	2004
Finland	2005
Australia	2005
Korea	2005
New Zealand	2005
Germany	2006
Turkey	2006
Greece	2006

While Germany and Turkey rejoined the HIA, the other new members were first time HIA participants. Non IEA member country participants were Lithuania and Iceland, which acceded to the Implementing Agreement during the previous 1999-2004 term. There were no withdrawals during the five year period 2004-2009.

3.2 Task Participation by Current Members

Table 3 introduces the tasks active during the 2004-2009 term by number and name.

Table 3: HIA Tasks 2004-2009

TASK #	TASK NAME
15	Photo-biological production of H_2
16	H_2 from Carbon-Containing Materials
17	Solid & Liquid State H_2 Storage Materials
18	Integrated Systems Evaluation
19	Hydrogen Safety
20	H_2 from Waterphotolysis
21	BioHydrogen
22	Fundamental and Applied Hydrogen Storage Materials Development
23	Small-Scale Reformers for On-Site Hydrogen Supply (SSR for Hydrogen)
24	Wind Energy and Hydrogen Intergration
25	High Temperature Production of Hydrogen
26	Advanced materials for Waterphotolysis
27	Near-Term Market Routes to H_2 by Co-utilisation of Biomass as a Renewable Energy Source with Fossil Fuels
In Definition	Infrastructure and Mass Storage

Table 4 shows task participation by current members. It includes the total number of members who participate in each task and the total number of tasks each member participates in.

Table 4: HIA Task Participation by HIA Members

Members	15	16	17	18	19	20	21	22	23	24	25	26	27	Total Tasks/ Member
Australia			1			1		1			1	1		**5**
Canada	1	1	1	1	1		1	1		1				**8**
Denmark		1		1				1	1	1	1	1		**7**
European Comm.		1	1	1	1			1		1			1	**7**
Finland							1				1		1	**3**
France		1		1	1	1	1	1	1		1	1		**9**
Germany		1		1			1	1	1	1	1			**7**
Greece				1				1		1	1			**4**
Iceland				1				1						**2**
Italy		1	1	1	1		1	1			1		1	**8**
Japan	1	1		1	1	1	1	1	1	1		1		**10**
Korea						1	1	1				1		**4**
Lithuania			1					1						**2**
The Netherlands	1	1		1	1	1	1	1	1			1	1	**10**
New Zealand				1								1		**2**
Norway	1	1		1	1		1	1	1				1	**8**
Spain		1	1	1				1		1	1	1	1	**8**
Sweden	1		1	1			1	1	1					**6**
Switzerland		1	1	1		1		1		1	1	1		**8**
Turkey									1				1	**2**
UK	1	1		1	1	1	1	1		1	1			**9**
US	1	1	1	1	1	1	1	1	1	1	1	1	1	**13**
Total Members/ Task	**7**	**13**	**9**	**17**	**9**	**8**	**12**	**19**	**9**	**10**	**11**	**10**	**8**	

3.3 Industry Participation

The role of industry in the HIA has grown during the 2004-2009 term and promises to be of increasing importance to the Agreement in the future. Presently, there are no industry sponsors in the Implementing Agreement.

The Executive Committee includes two individuals from industry, one from the Danish Gas Technology Institute and the other from Solid Energy of New Zealand Ltd., who serve on behalf of their Contracting Parties.

Significant industry participation has occurred in the tasks. For example, Hydro, formerly Norsk Hydro, served as Operating Agent for completed Task 16. The Operating Agents for Tasks 17, 18 and 19, and a Co-Operating Agent for 27 are with private sector consulting firms. Industry presence is strongest in the area of expert participation, most notable in Tasks 16 and 23. Task 16 expert participation consisted largely of industry, as is almost entirely the case with Task 23, one of its successor tasks. Industry is also well represented in Task 18 and Task 24.

Table 5: Industry Participation in HIA Tasks

Companies	Tasks												
	15	16	17*	18	19	20	21	22	23	24	25	26	27
Air Liquide									FR				
ALPHEA				FR									
BP-Amoco		USA											
BP		UK											
BTG		NL											NL
Catator									SWE				
Chevron Texaco		USA											
Danish Gas Tech				DEN									
Directed Technologies Inc												USA	
DNV													NOR
EA Technology				UK									
EGJ Udvikling		DEN											
Elcogas													SPA
ENAA				JAP						JAP			
EnCana		CN											
Energetics				USA									
Ergenics			USA										
Endesa										SPA			
ENEL		ITA											ITA
ENI		ITA											
ET Energie Technologie			GER										
Gas Natural		SPA								SPA			
Gastec		NL											
Gamesa										SPA			
Gaz de France		FR							FR				
Grontmij				SWE									
Haldor Topsøe		DEN							DEN				
Hydro		NOR											
HyGear BV									NET				
Hyradix		USA											
H2PIUSA		FR											
IGS Mahler		GER							GER				
IHT										SWI			
Intematix Corporation												USA	
Intelligent Energy		USA							USA				
IRL				NZ									
Longitude 122 West				USA									
Mitsubishi Kakoki		JAP							JAP				
MVSystems												USA	
Midwest Optoelectronics												USA	
N-GHY									FR				
Norske Skog													NOR
Osaka Gas		JAP											
Services Mij				CAN									
Shell		UK											NL
Statoil		NOR											
StatoilHydro									NOR				
Suna Tech			USA										
Suncor		CN											
Sydkraft				SWE									
Tokyo Gas Co									JAP				
United Technologies			USA					USA					

* Due to confidentiality agreements, it was not possible to list all industry participants in Task 17. An additional half-dozen companies made significant contributions to this Task.

3.4 Potential for Increased Participation

3.4.1 Near-term Candidates for HIA Accession

Both the Russian Federation and Brazil, IPHE members, have formally expressed interest in joining HIA by signing official Letters of Intent (LOI) to this effect. These LOIs were executed under the framework of an HIA Memorandum of Understanding (MOU) between the HIA and the International Partnership for a Hydrogen Economy (IPHE.)

In the near future, the United Nations Industrial Development Organization (UNIDO) is expected to become the first international organization to join the HIA. UNIDO's accession to the HIA will be a watershed event for the IEA as it will mark the first time a UN organization has joined an IEA implementing agreement.

3.4.2 Qualified Prospective Participants

Austria hosted the second quarter 2004 Executive Committee meeting as a first step in exploring HIA membership. Although Austria did not then follow through on accession it has been closely involved in definition of the new HIA Task 27 - Near-Market Routes to Hydrogen by Co-utilisation of Biomass as a Renewable Energy Source with Fossil Fuels. Austria also has an active interest in hydrogen storage and photoelectrolytic production of hydrogen. Similarly, Portugal has closely followed HIA Task 27 and Task 21 - BioHydrogen, to the extent that one of its research institutes sponsored a Task 21 meeting in 2008. Portugal is also interested in Task 26, Advanced Materials for Waterphotolysis. Portugal has received HIA invitations to Executive Meetings but has not yet been able to attend. Hungary, which has highly regarded expertise in biohydrogen, has not yet accepted an invitation to attend an Executive Committee meeting. Belgium attended an Executive Committee meeting but did not follow through on membership in view of its current R,D&D priorities.

Singapore, a non-IEA member country that hosted the fourth quarter 2005 Executive Committee meeting, has not yet acted on its invitation to join the HIA. However, Singapore remains very interested in Task 21, BioHydrogen.

Poland, an IEA member country, is interested in Task 26, Advanced Materials for Waterphotolysis as is Israel, a non-IEA member country. Poland will be invited to participate in an Executive Committee meeting pending contact with appropriate officials. Although it has as yet been unable to attend, Israel has been invited to participate in an Executive Committee meeting. Argentina, a non-IEA member country, has expressed interest in Task 24 and will be invited to a future Executive Committee meeting.

Taiwan has participated as an observer at HIA Executive Committee meetings. Further action toward accession is not possible at this time.

3.4.3 Potential IPHE and G8 Plus Five Participants

In addition to the Russian Federation and Brazil, IPHE members that have already declared their intent to join the HIA through the IPHE MOU mechanism, the People's Republic of China and India are also IPHE members. People's Republic of China and India are likewise G8 "+ 5" member countries, and therefore prime targets of the NEET initiative. Extremely interested in HIA Task 25, High Temperature Production of Hydrogen, the Oil and Natural Gas Corporation Limited (ONGC) India has expressed a strong interest in India's accession to the HIA. By ONGC request, a special dossier on the HIA has been prepared for Indian authorities. India has also been invited as an observer at Executive Committee meetings, but has thus far been unable to attend. In the case of the People's Republic of China, the HIA participated in the NEET China workshop.

Two pathways to HIA membership are possible for China and India. As IPHE members, they can accede through the MOU mechanism. Alternatively, they can accede through the regular process.

The HIA also had the opportunity to participate in a NEET workshop for South Africa, another Gleneagles "+ 5" nation. The HIA has extended invitations for South Africa to attend an HIA Executive Committee meeting. While interested, South Africa has not yet been able to attend. Mexico, another Gleneagles "+5" nation, is interested in hydrogen and several of the HIA activities. However, it is unable to pursue membership at this time due to funding priorities.

3.4.4 Sponsorship Possibilities

The HIA will consider the possibility of sponsors, most likely industry, during the 2009-2015 term.

4.0 The Work Program

4.1 Introduction

The HIA addresses many innovative, short and long-term pre-commercial R,D&D issues related to hydrogen production, storage, safety, codes & standards, integrated systems, analysis, economics and markets. Collaborative R,D&D, near and long-term, is in fact the HIA's core business, one whose history dates to the 1977 formation of the Agreement. During this term, there has also been increasing emphasis on analysis of near and mid-term applications, as well as systems and infrastructure issues related to technology development and deployment. There has been an increasing focus on outreach as well. But the major focus of the HIA's R,D&D continued to be production and storage.

4.1.1 Production and Storage

In 2004, as discussed in Section 1.5, the HIA undertook a thorough and in-depth examination of near, mid and long-term gaps and priorities in hydrogen production and storage, the two key R&D challenges to widespread, large scale use of hydrogen technologies. On-board storage in vehicles is, in particular, a major hurdle to introduction of hydrogen powered vehicles to the global mass market. The HIA's gap analysis ultimately resulted in publication of *Hydrogen Production and Storage: R&D Priorities and Gaps*,[9] which the HIA utilized to guide development of its production and storage tasks for the balance of the current term and the upcoming 2009-2015 term. Given the diversity of production options, the HIA began to classify production approaches into high temperature and low temperature midway through the current term in order to facilitate development of production activities.

4.1.2 Systems

The integration of production, storage and end-use components optimized for cost savings and energy efficiency is requisite to deployment and market penetration of hydrogen energy systems. Detailed life cycle assessments, component models and system models provide the platform for standardized comparison of application specific energy systems.

[9] Op.cit., http://www.ieahia.org/pdfs/Hydrogen_Gaps_and_Priorities.pdf

4.1.3 Outreach and Analysis

The Outreach strategy, a new HIA initiative, was key to membership recruiting, information dissemination and coordination of hydrogen related R&D efforts worldwide. As the outreach strategy began to succeed, the HIA's concern with analysis intensified. In order to influence policy and investment decisions in R&D and infrastructure, the HIA had to be able to reach stakeholders and decision makers with information that increased their knowledge of and comfort with hydrogen. This resulted in creation of an Analysis Group in late 2007.

4.1.4 Safety

The scopes of the market environment goal were: Codes & Standards, Non-Energy Processes and Infrastructure Options. However, as the Executive Committee's focus gravitated toward analysis of strategic importance, safety emerged as a dominant theme. Hydrogen safety is recognized as a critical issue that cross cuts all R&D, infrastructure and market considerations.

4.2 The HIA Portfolio and its Tasks

Over the course of its lifetime, the HIA has created a broad portfolio of twenty-seven (27) tasks. Nine of these tasks, 33% of the entire HIA portfolio, were approved during this five year term. While the HIA EOT Report for 1999-2004 considered activities and progress in six tasks (Tasks 13-18), the EOT Report for 2004-2009 reviews progress and activities in thirteen tasks (Tasks 15-27), as well as one task that is in definition. This is more than **double the activity level** reported in the previous EOT. Four of these tasks have been completed; nine are current and one is in definition. As measured in number of tasks, the actual size of the HIA's 2004-2009 portfolio (13 tasks) exceeds the number of tasks (8) targeted in the 2004-2009 Strategic Plan by some 40%.

See Table 6 below for the status of tasks active during the 2004-2009 term:

Table 6: Status of Tasks Active during 2004-2009 Term

TASK #	TASK NAME	DATES	STATUS
15	Photo-biological production of H_2	1999-2004	Completed
16	H_2 from Carbon-Containing Materials	2002-2006	Completed
17	Solid & Liquid State H_2 Storage Materials	2001-2006	Completed
18	Integrated Systems Evaluation	2004-2009	Continuing
19	Hydrogen Safety	2004+	Continuing
20	H_2 from Waterphotolysis	2005+	Completed
21	BioHydrogen	2005	Continuing
22	Fundamental &Applied H_2 Storage Materials Development	2006-2009	Continuing
23	Small-Scale Reformers for on-Site H_2 Supply	2006+	Continuing
24	Wind Energy and Hydrogen Production	2006+	Continuing
25	High Temperature Production of Hydrogen	2007-2009	Continuing
26	Advanced Materials for Waterphotolysis with H_2	2008+	Continuing
27	Near-Term Market Routes to H_2 via Co-Gasification with Biomass	2008+	Continuing
In Def	Infrastructure and Mass Storage		Approved for Definition

Among the four tasks completed in 2004-2009, it is significant that all generated successor tasks. One task, Task 16, actually produced two successor tasks. See Table 7 for the list of Successor tasks.

Table 7: Task Succession

COMPLETED		CURRENT	
Predecessor Task #	**Predecessor Task Name**	**Successor Task(s) #**	**Successor Task(s) Name**
Task 15	Photo-biological production of H_2	Task 20	H_2 from Waterphotolysis
Task 20	H_2 from Waterphotolysis	Task 26	Advanced Materials for H_2 from Waterphotolysis
Task 16	H_2 from Carbon-Containing Materials	Task 23	Small-scale Reformers for On-Site H_2 Supply
Task 16	H_2 from Carbon-Containing Materials	Task 27	Near-Market Routes to Hydrogen by Co-utilisation of Biomass as a Renewable Energy Source with Fossil Fuels
Task 17	Solid & Liquid State H_2 Storage Materials	Task 22	Fundamental and Applied H_2 Storage Materials Development

The table below depicts the organization of the HIA portfolio by strategic goal and scope of work. A discussion of each task follows, ordered by its position in the strategic framework. **Major Achievements and Success Stories** for all tasks may be found in **Table 14**.

Table 8: HIA Portfolio by Strategic Goal and Scope of Work

GOAL	**Science & Technology** Advancement of Science via Pre-Commercial Collaborative RD&D			**Market Environment** Assessment of Market Environment, including non-Energy Sector; and Analysis, Safety and Economics			**Outreach Program** Increasing Knowledge and Comfort with Hydrogen		
SCOPES	Production	Storage	Systems	Non-Energy & Ind. Processes	Foundation for Codes and Standards	Infrastructure	Membership and Participation	Information Dissemination	Synchron-ization Worldwide
TASKS	15, 16, 20, 21, 23, 24, 25, 26, 27	17, 22	18		19	Infra. & Mass Storage (In def) 18, 23	ExCo All Tasks Secretariat	ExCo All Tasks Secretariat	ExCo Secretariat

4.2.1 Tasks Related to Science and Technology Goal – Advancement of Science via Pre-Commercial Collaborative RD&D

4.2.1.1 Production Tasks

Task 15 Photobiological Production of Hydrogen (completed**)**
Task 15, originally planned as a five year effort, was approved in 1999 and concluded in 2004. The overall objective of Task 15 was to advance the basic and early-stage applied science in biophotolysis, i.e., the biological production of hydrogen from water and sunlight using microalgal photosynthesis. The main objective was to develop hydrogen production by microalgae (both green algae and cyanobacteria) emphasizing early-stage applied research on biophotolysis processes with intermediate CO_2 fixation. The work in Task 15 was divided into four subtasks: Subtask A Light-driven Hydrogen Production by Microalgae; Subtask B Maximizing Photosynthetic Efficiencies; Subtask C Hydrogen Fermentations; Subtask D Improved Photobioreactor Systems for Hydrogen Production. The Task 15 Final Report may be found on the HIA website at http://www.ieahia.org/page.php?s=d&p=documents&t=task&id=15.

Task 16 – Hydrogen from Carbon-Containing Materials (completed**)**

Task 16 officially began in 2002 and concluded in 2006. Its overall objective was to promote the development of economically viable and environmentally acceptable processes for hydrogen production via thermal processing of carbon-containing materials. Task 16 examined hydrogen production from carbon-containing materials in three subtasks carried out in parallel. Industrial companies dominated the participation in Subtask A and C, while R&D companies and institutes were more represented in Subtask B (Figure 2). The 22 industry participants included major companies as well as medium and small enterprises (SMEs), mostly from IEA countries.

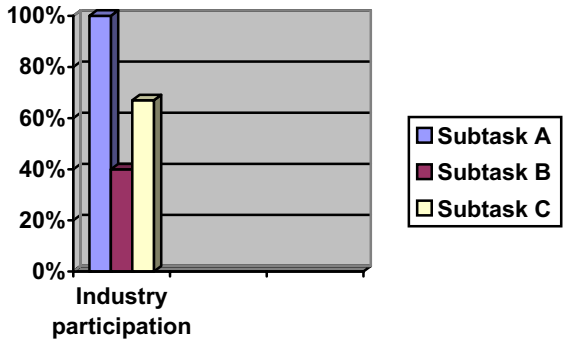

Figure 2: Industry Participation in Subtask 16

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Subtask A Large-scale Integrated Hydrogen Production with Precombustion Decarbonization. This task entailed development of a detailed engineering study coordinated by the IEA Greenhouse Gas (GHG) R&D Programme with the support of the CO_2 Capture Project (CCP) partners. [10] The CCP is an international effort of the world's leading energy companies (BP, Chevron, Texaco (now part of Chevron), ENI, Hydro, EnCana, Shell, Statoil Hydro, and Suncor Energy) to develop new low-cost technology options for CO_2 capture and storage. In a departure from standard HIA procedure, Jacobs Engineering was hired and paid by the CPP and Klimatek to carry out the cost reduction engineering study entitled *Large-Scale Integrated Hydrogen Production for Power Generation/Precombustion Decarbonization*.

Subtask B Hydrogen from Biomass Biomass represents a major direct pathway from renewable energy sources to hydrogen that can be implemented on a large scale without major R&D breakthroughs. This subtask performed a complete technology assessment that resulted in a set of summary conclusions and identification of major gaps in technology development, R&D needs and recommendations geared toward an industry audience. The Subtask B Report is called *Prospects for Hydrogen from Biomass*. Task 27 is the successor to Task 16 Subtask B.

Subtask C Small-scale Reformer for Distributed Hydrogen Production Subtask C performed a comprehensive technology assessment and analysis of market requirements for a small-scale reforming business. A task-shared activity with nine industrial companies, six academic institutes and R&D companies, Subtask C investigated issues associated with reformer suppliers, customer requirements as well as issues such as CO_2 handling, other emissions and research linked to interfacing institutes and organizations. The Subtask C Final Report, *Small-scale Reformers for Stationary Hydrogen with Minimum CO_2 Emissions* and final reports for Subtasks A and B may be found at http://www.ieahia.org/page.php?s=d&p=documents&t=task&id=16. Task 23, Small-Scale Reformer Technology, is the successor to Task 16 Subtask C.

Task 20 Hydrogen from Waterphotolysis (completed**)**

From 2004-2007, HIA Task 20 investigated photoelectrochemical (PEC) watersplitting. PEC cells can decompose water into hydrogen and oxygen upon solar illumination. PEC cells employ photoelectrodes that are immersed in an aqueous electrolyte or directly into water (sea water included). Photon conversion efficiency and durability are considered the main measures of Task 20 success. Task 20 succeeded Task 14. Key objectives included:

[10] The CCP is a project of the IEA Greenhouse Gas R&D Programme, an implementing agreement of the IEA.

- Advancement of photoelectrode materials science, especially as to low-cost materials and corrosion challenges
- Development of engineering challenges with a focus on thin-film deposition as well as powder techniques and system integration
- Demonstration of the leading concepts

Task 21 BioHydrogen (continuing)

The BioHydrogen task, approved in 2005 for three years, is the successor to Task 15, Photobiological Production of Hydrogen. Task 21 recently received a two year extension, as foreseen in the original work plan. Over the course of this task, global interest in biohydrogen has grown. Task 21 is carrying out collaborative research activities in the biological production of hydrogen using bacterial dark fermentation, photosynthetic microbes, and in-vitro or bio-inspired systems. The overall objective is not only to advance the basic and applied science but also to evaluate biohydrogen from the perspectives of economics and social acceptance. The first three subtasks are R,D&D related while the fourth is analytical. Task 21 includes industrial participation.

Subtask A: BioHydrogen Systems. Subtask A is focusing on:

- Metabolism, genetics, and thermodynamics of H_2 producing bacteria to identify critical genes, pathways, and regulatory components for high yield H_2 production
- Genetic and physiological interventions to maximize H_2 production – identification of bacteria and conditions that allow for high H_2 production rates
- Fermentations that produce H_2 from organic substrates under high yield conditions

Subtask B: Basic Studies for BioHydrogen Production. To demonstrate potentially practical processes for the conversion of water or organic substrates to H_2 using solar energy. Subtask B is focusing on:

- Genetics and metabolism of H_2 production in photosynthetic microbes (Green algae and cyanobacteria are key areas of investigation)
- Physiology and cultivation of photosynthetic microbes to maximize H_2 production from water or organic wastes
- Overcoming limiting factors of photosynthesis

Subtask C: Bio-Inspired Systems. Subtask C is focusing on:

- Enzyme systems for hydrogen production
- Bio-inspired systems or hydrogen production
- Biological fuel cells coupling enzymes and even whole organisms to electrodes

Subtask D: Overall Analysis. This analysis focuses on: 1) the effects of biohydrogen on societal systems and human life; 2) analysis of critical factors and risks to economic and social conditions necessary to implement biohydrogen in the future.

Task 23 Small Scale Reformers for On-Site Hydrogen Supply (continuing**)**

Task 23 succeeds Task 16, Subtask C – Reformer Technology. Approved in 2007 for three years, Task 23's main objective is to provide a basis for harmonization of the technology for on-site hydrogen production from hydrocarbons – fossil and renewable biomass. On conclusion of its initial term, it is anticipated that Task 23 will seek an approximately one year extension. Task 23 is expected to directly enable development of hydrogen refueling infrastructure development and promote introduction of on-site hydrogen reformers. This task consists almost entirely of industry participants. Industry participation in Task 23 is expected to accelerate the process of market introduction and penetration of small-scale reformers for on-site hydrogen supply. Two subtasks focus on information exchange among members according to the agreed-upon work program, while the third subtask consists of market studies.

Subtask 1: Harmonized Industrialization. Develop an understanding about a harmonized approach to reformer capacity that will facilitate industrialization and cost reduction.
Subtask 2: Sustainability and Renewable Sources. Facilitate on-site hydrogen production based on small-scale reformer technology. The approach entails development of systems for fuel diversification and use of renewable sources. Nine feedstocks are under consideration, among them: biogas, ethanol, bio-diesel, dimethylether, glycerin, ammonia and sugars. Other topics of investigation are emissions and their handling.
Subtask 3: Market Studies. Facilitate market development by preparation of market studies and dissemination of results. The market studies will compare Japanese, North American and Northern European markets.

Task 24 Wind Energy and Hydrogen Integration (continuing**)**
http://task24.hidrogenoaragon.org/
Task 24 was approved in 2006 with a four year term of operation. It is expected to contribute directly to hydrogen supply through mid-term R&D featuring shared activities and information exchange associated with the entire wind to hydrogen production chain. The task objectives are: 1) to explore in detail all possible issues (technical, economic, social, environmental, market and legal) related to hydrogen production using electrolysis with wind energy; and 2) to explore in detail possible applications for this hydrogen, with special emphasis on wind and hydrogen integration by means of hydrogen storage and electrical conversation that balances the original wind energy production. Task 24 has four subtasks:

Subtask A: State of the Art. Subtask A is conducting an in-depth review of the current state of the art in wind turbines, electrolyzers, and intermediate equipment, as well as a survey of market and electrical system regulation.
Subtask B: Improvements Needed & System Integration Technology Development on Main Equipment and System Integration Concepts. This subtask is developing specifications for two main components for hydrogen production, the wind turbine and the electrolyzer as well as the intermediate components (including power electronics and control or system integration equipment).
Subtask C: Business Concept Development. Subtask C will include an economic assessment and forecast of market potential with a detailed hydrogen production cost study of different concepts within representative markets.
Subtask D: Applications, Emphasis on Wind Energy Management. This subtask will consider near-term applications for wind-generated hydrogen with a special focus on one of the main applications specified in Subtask C, wind energy management within the wind and hydrogen full integration concept. An analysis similar to those undertaken in tasks A to C will be performed for relevant components not previously taken into account. These components include hydrogen to electricity converters such as fuel cells, internal combustion engines and gas turbines.

Task 25 High Temperature Production of Hydrogen (continuing**)**
https://www-prodh2-task25.cea.fr/
Task 25 was approved in 2007 for a three year term of operation. The purpose of Task 25 is to support production of massive quantities of zero-emission H_2 through use of high temperature processes (> 500ºC) coupled with nuclear and/or solar heat sources. Task 25 research focuses on three process families: steam electrolysis; thermochemical cycles (including pure and hybrid thermochemical processes); and innovative direct water splitting. The overarching objective is to share existing worldwide knowledge on high temperature processes (HTPs) and to develop expertise in global assessment of the HTPs that can be integrated in Hydrogen Production Road Mapping. The specific objectives appear below followed by a subtask list with descriptions:

- To identify and classify HTPs and establish different and coherent criteria for each family of HTPs identified, based on a scientific/technological approach
- To establish the state of the art and investigation of the existing knowledge, programs, projects on HTPs and other innovative ideas for massive production of hydrogen.

Subtask A: Scientific, Technological Review and Analysis of Temperature Processes and State of the Art. Develop summary sheets for each process using the same evaluation method presentation format. **Subtask B: Development of a Methodology Approach and Integration of HTPs.** Define the main criteria for integration of HTPs into the hydrogen chain, including the interface and primary energy source. **Subtask C: Establishment of Benchmarks, Recommendations for HTP R&D and Future Industrial Deployment.** Identify the most promising technologies and recommendations for R&D needs based on the Subtask A review. Develop further studies and recommendations to meet the needs in large future facilities and/or demonstration programs and to facilitate accelerated introduction of HTPs.
Subtask D: Coordination and Links with Other International Organizations; Dissemination of Information. Develop and maintain communication and coordination with other projects and groups. It is also facilitating utilization of experimental facilities.

Task 26 Advanced Materials for Hydrogen from Waterphotolysis (continuing)
This task, the successor to Task 20, was approved in 2008 for a three year term to pursue development and optimization of new photoelectrochemical (**PEC**) material systems that integrate the newest theory, synthesis and characterization techniques. Task 20 strongly recommended an acute focus on advanced materials research to the exclusion of work on PEC devices. Emphasizing intensified international collaboration, that includes the U.S. PEC working group organized by USDOE, the task looks to advance photoelectrode materials science, demonstrate stable and efficient water-splitting, and promote water photolysis through four sub-tasks:
Subtask A: Materials theory. Calculation of materials electronic structure and properties; modeling of semiconductor-electrolyte junctions
Subtask B: Materials Synthesis. Materials discovery via synthesis of enhanced PEC surfaces "traditional" synthesis; advanced materials discovery techniques
Subtask C: Materials/Interface Characterizations. Materials characterizations; PEC-interface and in-situ characterizations; standardized PEC-device performance measurements
Subtask D: PEC Information Coordination/Database. Database development; research coordination; database management and promotion

Task 27 Near-Market Routes to Hydrogen by Co-utilisation of Biomass as a Renewable Energy Source with Fossil Fuels
(continuing)
This task, successor to Task 16 Subtask B, was approved at year end 2008 for a three-year term. In early 2009 this task remained at a start-up stage. Cooperation is planned with the Bioenergy Implementing Agreement whose portfolio *does not* include hydrogen. The four subtasks and their objectives appear below:

Subtask A: Co-gasification of Biomass with Fossil Fuels. Identify and evaluate the most attractive and realistic process pathways towards a large-scale demonstration of biomass co-gasification with fossil fuels.
Subtask B: Hydrogen Market Facilitation – Based on Distributed Processing of Biomass to New Tradable Intermediates. Establish the potential for a renewable-based hydrogen supply chain based on the distributed production of a "biomass carrier," its commercial transport and use in centralized gasification plants.

Subtask C: Near Term Stand-Alone Biomass Gasification. Evaluate the most attractive ways of utilizing stand-alone biomass gasification technology in near-to-medium-term H_2 markets.
Subtask D: Roadmap – Development and Verification. Develop a business-oriented roadmap for hydrogen produced with biomass as a renewable source.

This research, information-exchange and analysis task is "task-shared," as is customary, but includes two Co-Operating Agents, one with the lead on strategy and the other the lead on administration.

4.2.1.2 Storage Tasks

Task 17 Solid and Liquid State Storage (completed)
Task 17 was approved in 2001 for a three year term and extended another two years in 2004. It succeeded Task 12. While HIA tasks are typically structured in subtasks, Task 17 consisted of a series of **36 R&D projects** led by project leaders from participating countries. The projects and Final Report (http://www.ieahia.org/page.php?s=d&p=documents&t=task&id=17) were divided into three categories by media: Hydride, Carbon, and combined Hydride + Carbon. There were various categories of projects, including experimental, engineering, theoretical and modeling efforts. The main application of interest was onboard vehicular storage, although stationary storage was also a topic of interest. The three task objectives were:

1) To develop a reversible H_2 storage medium with >5 wt. % H_2 recoverable at <80ºC and 1 bar absolute pressure, with charging and discharging rates suitable for practical use in a fuel cell or internal combustion engine H_2 fueled vehicle.
2) To develop low-cost, reversible hydrogen storage medium that can be rapidly charged and discharged at near-ambient temperatures, is tolerant to impurities in the H_2 used, and discharges hydrogen of ultra high purity for use directly in a PEM fuel cell.
3) To develop the fundamental and engineering understanding of hydrogen storage by advanced storage media that have capability of meeting Targets 1 and 2.

Substantial progress was made towards these objectives. In addition, Task 17 participants contributed substantially to the review of gaps and priorities in storage. The series of hydride databases (http://hydpark.ca.sandia.gov) created under Task 12 were updated as well. At its conclusion, Task 17 recommended continuation of HIA storage research in a new task.

Task 22 Fundamental and Applied H_2 Storage Materials Development (continuing)
Following on Task 17, Task 22 was approved in late 2006 for a three year term. Like Task 17, the successor task is built on projects where international collaboration is strongly encouraged. Task 22 is **the world's largest collaboration** in hydrogen storage, even larger than its predecessor. Task 22 is open to the same broad spectrum of project types (experimental, engineering, theoretical and modeling). Material reactivity aspects of hydrogen storage materials are also included on the list, which includes 53 projects, a 50% increase over the size of Task 17. All projects have been approved by the task experts. The projects are classified into three categories: Hydride; Nanoporous; and combined Hydride Nanoporous. The following classes of materials are included: reversible metal hydrides; regenerative hydrogen storage materials (chemical hydrides); nanoporous materials; rechargeable organic liquids and solids. The investigations highlight transportation uses but also include stationary applications. Task 22 retains Task 17's objectives. To meet the challenge of hydrogen storage, particularly for vehicular applications, Task 22 experts share the conviction that new materials and solutions (as opposed to simple, incremental improvements in current technologies) are needed.

Progress to date on this significant international collaboration includes the following: new promising complex hydrides including different boron-based compounds; new results on several physisorption systems, like metal-assisted carbon-material; and new simple methods for synthesis of Mg-based compounds.

4.2.2 Tasks and Activities Related to Market Environment Goal – Assessment of Market Environment, including non-Energy Sector

4.2.2.1 Tasks

Task 18 - Integrated Systems Evaluation (continuing)
http://iea-hia-annex18.sharepointsite.net/Public/default.aspx
Task 18 was approved for a 2004 start and a three year term. Initially, Task 18 had two subtasks: Subtask A Information Base Development; and Subtask B Demonstration Project Evaluation. It was then extended another two years through December 2009. The second phase includes a third subtask, Synthesis and Learning. The overall goal of Task 18 is to provide information about hydrogen integration into society around the world. The final reports from Phase I of Subtask A and Subtask B, as well as the Gillie/Platt *Survey of Support Mechanisms for the Development and Demonstration of Hydrogen Systems,* have been published and posted on the Task 18 website and the IEA HIA website[11]. The subtasks are described below:

Subtask A: Information Base Development. Provides data and analysis to the hydrogen community and the public in the form of inventory databases and compiled summaries
Subtask B: System Studies – Demonstration Project Evaluation for the Future. Employs modeling and analysis tools: 1) to evaluate hydrogen demonstration projects; 2) to guide their design; 3) and to validate models and assumptions. The project portfolio consists of 16 projects in which hydrogen is produced either from renewables or fossil fuel (natural gas) and is used either in an electric power production application (grid), a transportation fuel application or a combination thereof. There have also been an infrastructure demonstration and a residential heat and power evaluation. Subtask B also includes six descriptive case studies.
Subtask C: Synthesis and Learning. Bridging the other two subtasks, Subtask C is developing products that disseminate the learning from spectrum of Task 18 activities. Nine new case studies are being developed under this task.

Task 19 -Safety (continuing**)**
http://www.ieahydrogensafety.com
This cross-cutting task, which lays the foundation for codes and standards and the accelerated adoption of hydrogen systems, was approved in 2004 for three years and then extended an additional three years. Its goal, through task-sharing and information exchange, is to survey and analyze effective risk management techniques, testing methodologies, and test data; and to develop targeted information products that will facilitate market introduction and penetration. Task 19 has four subtasks, each with multiple subtasks, which are briefly described below:

Subtask A: Risk Management. Addresses quantitative risk analysis (QRA) and development of testing methodologies around which collaborative testing programs can be conducted.
Activity A1: Survey of existing risk assessment methodologies for relevant case studies. Develop uniform risk acceptance criteria and link with risk-informed codes and standards
Activity A2: Comparative Risk Assessment of H_2 Systems with Hydrocarbon Fuel Systems

[11] http://iea-hia-annex18.sharepointsite.net/Public/default.aspx and http://www.ieahia.org/page.php?s=d&p=documents&t=task&id=18

Activity A3: Probabilistic Risk and Consequence Analysis.
Subtask B: **Experimental Testing.** Collaborative program to close knowledge gaps on consequences of equipment or system failures and effects of mitigation measures through actual testing. There will be an emphasis on Subtask B activities in the second phase of Task 19.
Subtask C: Development of Targeted Information Packages for Stakeholder Groups. Targeted stakeholder groups include permitting officials, insurance providers, and early adoptors of these new products and systems. The suite of existing products and future Task 19 products will be packaged for dissemination to stakeholder groups.

New Task in Definition: Large-Scale Hydrogen Infrastructure and Mass Storage
The September 2007 IEA Green House Gas Programme Study on *Co-production of Hydrogen and Electricity by Coal Gasification with CO_2 Capture* [12] concludes that further work on large scale underground hydrogen storage is worthwhile and suggests that the HIA carry out this work. Currently in definition is a new task with a three + year time horizon and the following objectives:

- To establish an international basis for the academic techniques and industrial practices required to implement a hydrogen pipeline distribution system and mass storage
- Provide an overview of existing and planned hydrogen infrastructure
- Explore and research options for mass storage of hydrogen
- Technical and economic comparison of different infrastructure options by modeling

The preliminary draft work program for the new task identifies the following subtasks: infrastructure, pipelines, mass storage, system modeling, economic modeling, coordination and dissemination.

4.2.2.2 Executive Committee Directed Analysis & HIA Analysis Group

The emphasis on analysis at the Executive Committee level has increased over the past five years. The Executive Committee decided to take a more direct approach to the HIA's analytic needs and activities by pursuing development of the HIA's own analytic products. These products are expected to promote the adoption and market penetration of hydrogen technology by providing stakeholders and decision makers, at the IEA and around the world, with clear and coherent information that advances the business case for hydrogen energy and simultaneously enhances the HIA's reputation as a premier global resource for technical expertise in hydrogen. This effort began with design of a study of where the hydrogen will come from. However, with the late 2007 creation of the Analysis Group,[13] that study was folded into a broader analytic effort that will also include non-energy uses of hydrogen. The Analysis Group made the following recommendations:

1) Structure a *Hydrogen Resources Study* effort in the following parts: a literature review that will examine major existing assessments of hydrogen supply and demand; a demand side assessment and a supply side assessment.
2) Because cooperation with the IEA on its analytic and infrastructure efforts is requisite to success, contribute to IEA analysis efforts through all pertinent IEA vehicles, notably the Energy Technology Perspective (ETP) and the World Energy Outlook (WEO), from the beginning of their production cycles. Cooperate on other studies and activities as appropriate. In late 2008, Chairman García-Conde and Secretariat Manager Ms. de Valladares visited with the IEA Secretariat to request cooperation beginning in 2009. The Chief Economist's office has welcomed input to the 2009 WEO.

[12] Co-Production of Hydrogen and Electricity by Coal Gasification with CO_2 Capture, IEA Greenhouse Gas R&D Programme, Technical Study/Report Number: 2007/13, S
[13] The Analysis Group consists of ExCo Representatives, Operating Agents, experts and the Secretariat

4.2.2.3 The Role of Analysis in HIA Activities at the Task Level

Analysis has played a large role in the HIA activities at the task level during this term. Consider the major modeling and analyses efforts in Task 18, Integrated Hydrogen Systems Evaluation and the groundbreaking, fundamental analyses in Task 19, Hydrogen Safety. From the early 1990's to 2006, the Executive Committee funded a consultant to prepare descriptive studies of hydrogen. This activity then became part of Task 18. Altogether, 11 case studies have been produced to date. As a sub-task level activity, analysis plays a crucial supporting role in Task 21, BioHydrogen; Task 23, SSR for Hydrogen; and Task 24, Wind and Hydrogen Integration.

As both a stand-alone activity and a component of individual tasks, analysis will play an even larger role in the HIA's new term. This enhanced role reflects the critical importance of timely information in supporting the IEA shared goals for collaborative R&D, the CERT and REWP technology policy development and deployment objectives, as well as the HIA's goals for adoption and use of hydrogen.

4.2.3 Activities Related to Outreach Program Goal – Confidence with Hydrogen

4.2.3.1 Introduction

The HIA's Outreach Program aims to raise the level of awareness, knowledge and understanding about hydrogen technologies and thereby build community acceptance and support. It also builds awareness about the Agreement's purpose and activities. This activity, informally known as Communication and Outreach, welcomes and actively pursues cooperation and liaison with a full range of interested groups in public and private sectors. The implementation of the IEA HIA's Outreach Program is primarily the responsibility of the Secretariat, which coordinates this HIA-wide function under the direction of the Executive Committee.

The HIA's outreach activities primarily serve IEA/OECD governments. Efforts are underway to expand HIA outreach efforts to non-IEA member countries. This is occurring through IEA programs, particularly the NEET program, HIA interaction with the IPHE and incipient cooperation with UNIDO. Moreover, industry participation is growing and is expected to increase.

The HIA Outreach goal has three scopes: membership and participation, information and synchronization worldwide.

4.2.3.2 Membership and Participation

The first scope of HIA Outreach goal is membership and participation. One clear measure of outreach success is a rise in membership. As previously mentioned, membership has grown 60% since the beginning of this term (please refer to Table I which lists the 22 current members) and other members are in pipeline. Recruiting continues and prospects for continued growth are good. The membership recruiting effort is a natural outgrowth of interest in HIA tasks and activities.

The cornerstone of the HIA is the task, as is the case in most implementing agreements. Adequate participation is requisite to successful execution of all tasks. The HIA is a task-shared Agreement, meaning that Members pay their experts directly. The same holds true in the case of Operating Agents, i.e., Members who support an Operating Agent(s) pay them directly. In both instances, payment amounts are made according to prevailing labor rates. The minimum time commitment for an Operating Agent is 0.33 person years per annum. The minimum expert time commitment is set by each task and applies to all classes of participants, including industry, in that task.

As a task-shared implementing agreement, expert participation is committed and measured by the number of experts per task and person years/year (the annualized aggregate of person hours or person months). See Expert Participation Summary Table 9 below for the level of effort during this term expressed in person years.

Table 9: Expert Participation in Person Years over 2004-2009 Term

Task #	Minimum Required Person years/year	Experts Total by Task	Total Person years per year for each Task	# Years Active in Term	Cumulative person years 2004-2009 (30 June)
15	0.75	7	5.25	0.5	2.6
16*	Varied by Subtask			3 net	53.0
17	1.0	39	39	3	117
18	0.5	33	16.5	5	82.5
19	0.3 min			5.5	65.7
20	0.5	31	15.5	3	46.5
21	0.5	48	24.0	4.5	108.00
22	1.0	55	55	2.8	154.00
23	0.5	17	8.5	2.75	23.38
24	0.5	18	9.0	3.0	27.0
25	Varied	21	5.4	3.0	16.5
26	0.5	25	12.5	1.00	12.5
27 new	0.5	8	4.0	1.00	4.00
				Total	**712.68**

*Note that the Task 16 data include all three sub-tasks. Subtask A was funded by a ~$400,000 contribution from the GHG and the CCP, which has been converted to person years.

Table 9: arrays participation information (where available) as follows: minimum required person years/year; experts total by task; total person-years/task per year; number of years active during this term; cumulative person years during this term.

In addition to the experts accounted for in the table above, there is another category of unofficial expert participation, the non-industry "contributor." This contributor category is open to HIA members who are also members of a particular task and thus already supporting an official task expert. The contributor can provide input to the task but it is neither supported through institutional member commitment nor entitled to direct access to information task matters. The contributor is also exempt from the minimum time contribution. This participation innovation resulted from a proposal by Task 24, Wind Energy and Hydrogen Integration.

4.2.3.3 Information Dissemination

The second scope of the HIA Outreach Program is Information Dissemination. The IEA places high value on this activity, which is intended to disseminate information to participating countries, IEA member countries and non-member countries as well. The HIA Executive Committee likewise places much emphasis on its effort to diffuse the nature and results of the HIA's R,D&D collaboration. At the HIA, information dissemination encompasses the full range of HIA information vehicles and products, including: the HIA Annual Report, technical reports and articles, website, newsletter, exhibition display, brochures, presentations, press releases, etc. The Secretariat is primarily responsible for implementation of the Outreach Program, including Information Dissemination. However, the Executive Committee, Operating Agents, experts and Secretariat all contribute to development and dissemination of information vehicles and products.

To enhance the Agreement's corporate identity, all HIA communications have been redesigned during this term, beginning with the logo. The suite of HIA communication products and materials use the new Agreement logo as a graphic design platform. The HIA logo appears below.

The Executive Committee meeting itself serves as a valuable internal vehicle for information exchange among members, observers and IEA representatives as well. During this term all of these mechanisms have been used to increase the visibility of the Agreement.

The HIA also contributes on a regular basis (five articles during this term) to the IEA's Open Bulletin.[14] In addition, it has contributed to the IEA's periodic publication, *Energy Technologies at the Cutting Edge*.[15]

A list of the major HIA publications during this term appears below. The majority of these high quality publications are of a summary nature. While the list is substantial, it does not by itself convey the extent of either the HIA's productivity in information dissemination or technical progress during this term. Another aspect of the HIA information dissemination story is found in **Table 10,** which reports the HIA publications/articles, presentations and patents by task. Note that Task 22 alone has produced over 900 publications and presentations in less than 3 years; its predecessor, Task 17, produced some 900 publications and presentations between 2004 and 2006. Yet another part of the HIA's information dissemination story is told through its major communication and outreach products, which are also discussed later in this section.

Major (summary) Publications

- *2004 Annual Report* http://www.ieahia.org/pdfs/2004_annual_report.pdf
  2005 Annual Report http://www.ieahia.org/pdfs/2005_annual_report.pdf
- *2006 Annual Report* http://www.ieahia.org/pdfs/2006_annual_report.pdf
- *2007 Annual Report* http://www.ieahia.org/pdfs/2007_annual_report.pdf
- *2008 Annual Report* (publication pending)
- *HIA's 25th Anniversary Report: In Pursuit of the Future*
  http://www.ieahia.org/pdfs/IEA_AnniversaryReport_HIA.pdf
- *Hydrogen Production and Storage: R&D Gaps and Priorities*
  http://www.ieahia.org/pdfs/Hydrogen_Gaps_and_Priorities.pdf
- *Final Report Task 15* http://www.ieahia.org/pdfs/Final%20Repor%20-%20Annex%2015.pdf
- *Final Reports Task 16*
  - *Subtask A – Large-Scale Integrated Hydrogen Production Decarbonisation*
    http://www.ieahia.org/pdfs/finalreports/Task16AFinal.pdf
  - Subtask B – *Prospects for Hydrogen from Biomass*
    http://www.ieahia.org/pdfs/finalreports/Task16BFinal.pdf
  - Subtask C – *Small-Scale Reformers for Stationary H_2 Production with Minimum CO_2 Emissions* http://www.ieahia.org/pdfs/finalreports/Task16CFinal.pdf

[14] http://catsearch.atomz.com/search/catsearch?sp-q=open+bulletin&sp-a=sp10029401&sp-p=all&sp-f=ISO-8859-1
[15] http://www.iea.org/textbase/nppdf/free/2007/Cutting_Edge_2007_WEB.pdf

- Final Report Task 17 http://www.ieahia.org/page.php?s=d&p=documents&t=task&id=17
  - Introduction
  - Carbon Section
  - Carbon-Hydride Section
  - Hydride Section
- Final Report Task 18 phase 1
  - Subtask A: *Information Base Development* http://www.ieahia.org/pdfs//finalreports/Task18AFinal.pdf
  - Subtask B: *Hydrogen Demonstration Projects Development* http://www.ieahia.org/pdfs//finalreports/Task18AFinal.pdf
- Case Studies (Task 18) http://www.ieahia.org/page.php?s=d&p=casestudies
- Task 19
  - *Knowledge Gaps White Paper* http://www.ieahia.org/pdfs/Task19/Knowledge%20Gaps_White%20Paper_R1.pdf
  - *Survey of Hydrogen Risk Assessment Methods* http://www.ieahia.org/pdfs/Task19/Main%20Report%20-%20Survey%20of%20Hydrogen%20Risk%20Assessment%20Methods%20rev%202.pdf
  - *Risk Assessment Studies of Hydrogen and Hydrocarbon Fuels Fuelling Stations* http://www.ieahia.org/pdfs/Task19/RA_studies_comparison%20Rev1.pdf

Task Publications/Articles, Presentations and Patents

The table below reports this term's publications/articles, presentations and patents. Fundamental and earlier stage tasks, such as Task 15, 17, 21and 22 – tended to produce a relatively larger volume of publications and articles than near, mid-term and engineering analysis tasks.

Table 10: Summary of Publications/Articles, Presentations and Patents

Task #	Task Name	Publications/Articles	Presentations	Patents
15	Photobiological Production	72	50	
16	Hydrogen from Carbon-Containing materials	7	6	-
17	Solid and Liquid State Storage	420	465	17
18	Integrated System Evaluation	19	17	-
19	Hydrogen Safety	9	9	-
20	Hydrogen From Waterphotolysis	unavailable	unavailable	-
21	BioHydrogen	159	unavailable	
22	Fundamental and Applied Hydrogen Storage Materials Development	450	450	16
23	Small-Scale Reformers for On-Site Hydrogen Supply (SSR for Hydrogen)	1	-	-
24	Wind Energy and Hydrogen Integration	16	16	-
25	High temperature Production of Hydrogen		2	-
26	Advanced materials for waterphotolysis	New	-	-
27	Near-Term Market Routes to H2 by Co-utilisation of Biomass as a Renewable Energy Source with Fossil Fuels	New	-	-
	Totals	**1,153**	**1,015**	

Note that not all tasks reported the number of their publications/articles and presentations. Therefore, it is believed that the actual numbers in both categories exceed the reported numbers. To be eligible for inclusion, the subject of the task publication/article and/or presentation had to be entirely task related content.

The major HIA communication and outreach products and vehicles are described below.

Annual Report

The HIA's Annual Report contains substantive updates for each task and each Member. In addition, it features an article by the Chair on current progress and an article by the Secretariat on a topic of timely importance. Some 750 copies of the HIA's annual report are distributed each year. Members, Operating Agents and task experts, as well as the IEA, are key recipients. In addition, HIA Annual Reports are distributed at conferences and other events that include non-HIA and non-IEA member countries.

HIA Website **www.ieahia.org**

During this term the HIA website was redesigned to address the growing global interest in hydrogen, incorporate advances in information technology and convey the Agreement's new corporate identity. There is now a public website and a private website. The latter is password restricted to members and participants. The existence of the private website, which includes all matters germane to governance, is not apparent to public site users. A Content Management System (CMS) serves as a permanent archive for HIA documents. The website includes a "What's New" and "Search" features. It is updated continuously to capture the latest HIA developments. The Site Map for the HIA public website appears below:

Newsletter

The first edition of the biannual IEA HIA News was published in the Fall of 2006; four issues have been published to date. The newsletter is posted on the website, distributed electronically and printed for distribution at conferences and events as budget permits. In the *IEA HIA Technology Spotlight* section, each issue features a task, explaining the task and the associated technology and research. The companion *Tech Talk* column contains an interview with the Operating Agent. The other regular newsletter features are: *The IEA HIA Today* overview; *Publication Alert*; *Task Ink* (Task news); *DiploTech* (newsworthy related developments around the world); and a Message from the Chair.


IN THIS ISSUE

Brochures

Beginning in the 1999-2004 term, the IEA HIA began production of a one page flyer that has proven very effective for a broad range of uses. It is updated as needed.

Exhibit Booth Display

During this term the HIA developed a simple, low-cost, easy to transport display for Exhibit Booths. The display covers the following topics: IEA HIA framework (e.g. mission, vision, strategy); member list; list and description of current tasks; list of entire HIA portfolio. While all banners are produced in English, they have also been produced in Japanese and French for the convenience of the host country at the major biennial hydrogen conference, the World Hydrogen Energy Conference. The Exhibit booth display is used on average 1-2 times/year.

4.2.3.4 Worldwide Synchronization

The third scope of the HIA Outreach Program is Worldwide Synchronization. The HIA intent in adopting this scope was to facilitate coordination of hydrogen energy development efforts around the world in pursuit of our mission. It is another key aspect of outreach. Of course, the major avenue for synchronization is the HIA's collaborative R,D&D Program, which has already been discussed. The breadth and depth of our RD&D portfolio and the growing membership, including the world's largest national programs in hydrogen, attest to synchronization success during this term.

The outreach aspects of the synchronization process are important as well. If the IEA and HIA truly seek to influence policy and technology deployment by synchronizing efforts worldwide, then the Agreement must be visible and its messages must reach relevant communities, stakeholders and decision makers.

Conference/Meeting/Event Strategy

The HIA developed a conference/meeting/event strategy at the Executive Committee level that speaks to both the information dissemination and world synchronization scopes of the Communication and Outreach Program. The impetus for the conference strategy is straightforward: it is a standard mechanism for dissemination of information to target audiences on a global scale.

The HIA organized its conference strategy into internal (to IEA) and external (to IEA) conferences. The HIA then segmented the external conference market into the following categories: hydrogen and fuel cell; renewable/sustainable; environmental; conventional energy; transportation; and utilities/infrastructure.

Whether internal or external, conference participation typically consisted of delivering an oral paper on the overall Agreement, its activities and progress. Written papers were often submitted for conference proceedings. Conference participation sometimes included an exhibit booth, generally engaged at a discount or no cost. Brochures and Annual Reports were distributed at the conference booth.

During this term, the HIA gave presentations at a dozen key internal IEA conferences/events, which are listed in the table below. A comment about the HIA's 2007 Ministerial participation is in order. Through member generosity, the HIA was able to exhibit a vehicle sized fuel cell (with open housing to expose the actual fuel cell stack) (courtesy of CEA) and an illuminated scale model of the Utsira Wind/Hydrogen Project (courtesy of Hydro). This proved an excellent opportunity for many Ministerial participants to gain firsthand experience with hydrogen and fuel cell hardware.

Table 11: Internal Presentations (HIA Presentations to IEA)

2004	
CERT	Chairman's Presentation of 1999-2004 EOT and SP
Hydrogen Coordinating Group	Presentation on Hydrogen Gaps and Priorities
2005	
CERT	Presentation on Hydrogen Gaps and Priorities
IEA/IPHE Infrastructure Workshop	Overview and Update Presentation
REWP Conference	Renewable Hydrogen Presentation
2006	
NEET Kick-off Meeting	Overview Presentation
2007	
South Africa NEET Workshop	Overview Presentation
People's Republic of China NEET Workshop	Overview Presentation
Brazil NEET Workshop	Virtual Presentation
IEA Ministerial Meeting	Exhibit with fuel cell and H_2 hardware
2008	
NEET Rural Energisation Workshop	Overview Presentation
Russian Federation NEET Workshop	Overview Presentation

Table 12: Conference Participation Score Card below reports HIA participation in external conferences by year and target market segment. As the first order of outreach business, the HIA has focused its conference efforts on the hydrogen community: nearly forty of the presentations and exhibits during the 2004-2009 term took place at hydrogen events. Highlights of HIA conference participation included the three WHEC conferences in 2004, 2006 and 2008, all of which included exhibits as well as presentations. The scale of the HIA presence at WHEC has grown from a single presentation on the HIA in 2004; to multiple HIA presentations in 2006; and, in 2008, an entire dedicated HIA track that included a plenary session.

Table 12: Conference Participation Score Card

Conference/Event	Presentation	Exhibit	Target Market Segment
2004			
World Hydrogen Energy Conference - Japan	1	1	H_2
US National Hydrogen Association	1		H_2
Windsor Workshop – Canada	1		H_2 & FC
Int. German H_2 Energy Conference	1		H_2
World Renewable Energy Conference -Denver	1		Renewable
Fuel Cell Seminar – San Antonio, TX	1		H_2 & FC
2005			
World Hydrogen Technology Conf.- Singapore	1	1	H_2
U.S. Program Review – Washington, D.C.	1		H_2
IPHE Storage Conference	3	1	H_2
UNIDO Ichet Conference	3	1	H_2
IPHE Education Workshop	1		H_2
Austrian Hydrogen Conference	1		H_2
IPHE Renewable H_2 Workshop	1		H_2
European Hydrogen Energy Conference	1	1	H_2
US Agency for International Development	1		Sus/Environ.
2006			
World Hydrogen Energy Conference - Lyon	4	1	H_2
U.S. National Hydrogen Conference - CA	1		H_2
2007			
World Hydrogen Technology Conference-Italy	1	1	H_2
World Energy Council (poster)	1		Conventional
UNIDO-Ichet Meeting	1		H_2
Islenet	1		H_2
2008			
World Hydrogen Energy Conference-Brisbane	6	1	H_2
National Hydrogen Association - Sacramento	1		H_2
IPHE Steering Committee – Moscow	1		H_2
Roads to HyCom with HIA – Athens	1		H_2
	37	**8**	

The conference strategy has yielded manifold benefits. Conference presentations have helped to clarify the Agreement's purpose and activities as well as fundamental misconceptions about how the IEA and the HIA function.[16] And of course, conference participation contributes to the HIA's dissemination of information to participating countries and IEA member countries as well as IEA non-member countries. It also facilitates networking. The HIA's success with its conference strategy led it to co-sponsor the Roads to HyCom Workshop in 2008.

Networking Appreciation Dinner

All too often, neither HIA experts nor the greater hydrogen community ever have the opportunity to meet or visit either with other HIA experts or the Executive Committee. To provide an opportunity for networking that strengthens the implementing agreement, the HIA has instituted the tradition of a no-host "Appreciation" dinner on the occasion of major conferences.

[16] For example, even entities within the hydrogen community thought the IEA was a fund granting entity.

Additional Public Relations and Media Engagement Activities

IEA Prize

The creation of a hydrogen prize was proposed early in the 2004-2009 term. By mid-term, the Executive Committee decided to proceed with two prizes, one for an Individual and the other for a Project.[17] The IEA HIA Individual Prize was created to celebrate hydrogen research and development distinguished by technical excellence and harmony in international cooperation that contributes to the understanding and advancement of basic and applied science. The Agreement awarded its inaugural IEA HIA Individual Prize in June 2008 to Dr. Gary Sandrock. Although the Individual Prize was conceived as a single award, the Executive Committee determined that special circumstances call for special treatment: the late Dr. Tapan Kumar Bose, who passed away in 2008, was honored as the recipient of the IEA HIA Memorial Prize for lifetime achievements in hydrogen R&D.

It is expected that the first Project Prize will be awarded in 2009.

Media Engagement: Press Conference, Press Releases and Letter to the Editor

To announce the release of our 25th anniversary report, *In Pursuit of the Future*, the HIA held a press conference at the National Press Club in Washington, D.C. in early September 2004. Then Chairman Trygve Riis presented the report and discussed the HIA's current activities. Dr. Giorgio Simbolotti spoke on behalf of the IEA Secretariat in Paris, and Mr. Steve Chalk spoke on behalf of the U.S. Department of Energy. The event was attended by members of the press, representatives of member embassies and members of the metropolitan Washington energy and environmental community.

The centerpiece of the HIA media engagement strategy involves preparation of press releases to launch HIA reports. Some dozen press releases were prepared during this term. In addition, the HIA responds to relevant articles and media press about events with letters to the editor, of which a half dozen have been prepared to date, all but one in English.

5.0 Coordination with Other Bodies

The main strength of the HIA is its position as technical leader in hydrogen R&D. With an established tradition of cooperation R,D&D and a sizeable membership (21 member countries and the European Commission, plus a pipeline of prospective members) the HIA has the capacity and track record for effective coordination with the IEA and external entities, as well as its own membership. Coordination enhances productivity in the HIA's portfolio of tasks and activities, reduces duplication and provides a larger and stronger platform for information dissemination in pursuit of the Agreement mission to accelerate adoption of hydrogen technology.

[17] The Executive Committee selects the winners from nominations proposed through its members, in the case of the Individual Prize, and also the Operating Agents, in the case of the Project Prize.

5.1 Internal to IEA

The HIA cooperates with the Paris Secretariat on an on-going basis.

5.1.1 CERT

By invitation of the CERT, then Chairman Riis made a presentation at a 2005 CERT meeting on the HIA reports that were subsequently published by the IEA as *Hydrogen Production and Storage: R&D Priorities and Gaps*. The HIA has followed the activities of the CERT created Ad-hoc Group on Science and Energy Technology (AGSET). In addition, the HIA contributed to the IEA Study on Transmission Markets and Technology.

5.1.2 Hydrogen Coordinating Group (HCG)

In view of its technical capabilities and at the express request of Desk Officer Dr. Simbolotti, the HIA prepared reports on hydrogen gaps and priorities in production and storage. These reports enabled the IEA Secretariat to respond to Executive Director Claude Mandil's directive to the Hydrogen Coordinating Group (HCG) to provide this information.

5.1.3 Working Parties

As the premier technical resource on hydrogen, the HIA is a resource for its own working party, the Renewable Energy Working Party (REWP) and other working parties as well.

REWP

Executive Committee member Mr. Ray Eaton and REWP Vice-Chair Antonio Pflüger presented *Hydrogen Production and Storage: R&D Priorities and Gaps* at a REWP meeting.

Fossil Energy Working Party

The Fossil Fuel Working Party is interested in hydrogen production with carbon reduction. Discussions are now underway with the Fossil Fuel Working Party to cooperate on activities of mutual interest.

End-Use Working Party

By special request of the End-Use Working Party (EUWP) the HIA contributes on a semi-annual basis to the EUWP survey on implementing agreement activities.

5.1.4 NEET

IEA created the NEET initiative in response to the G8's clarion call for strategies aimed at a "clean, clear and competitive energy future" that includes the "+ 5" nations. The HIA was very pleased to have participated in all NEET workshops held to date, including the initiative on "Rural Energisation." NEET provides a valuable marketing service that supplements the HIA's outreach activities in member recruiting and information dissemination. The HIA coordinates with NEET on an on-going basis.

5.1.5 5.1.5 Other Implementing Agreements

Many IEA implementing agreements have a considerable interest in hydrogen. In an effort to leverage resources and avoid duplication, the HIA seeks to cooperate, as appropriate, with other implementing agreements on issues of direct and complementary concern.

Advanced Fuel Cells

Because fuel cell technologies operate on hydrogen, the HIA is very interested in the Advanced Fuel Cell Implementing Agreement tasks and activities. A joint meeting of the two IAs was held in 2004, resulting in several joint activities. Another meeting is planned for 2010. Task 17 held a joint meeting with the Advanced Fuel Cell Task 20 in 2005. Information exchange also takes place via the Executive Committee Chairs and Secretariats on a regular basis.

Bioenergy
Task 27, Near-Term Market Routes to H2 by Co-utilisation of Biomass as a Renewable Energy Source with Fossil Fuels will include participation by the Bioenergy IA.
Electricity Networks Analysis, Research and Development (ENARD)
The HIA plans to participate in ENARD's fall 2009 workshop on load balancing. Load balancing is an important topic for renewable energy and the production of hydrogen from renewable energy sources such as wind.
Greenhouse Gas (GHG)
The Greenhouse Gas Programme was the subtask leader for Task 16 Subtask A. At their request, the HIA reviewed the IEA Greenhouse Gas Study on Electricity and Hydrogen.
Wind (WIA)
Motivated by its interest in WIA Task 25, HIA Task 24 (Wind Energy and Hydrogen Integration) proposed formal information exchange with the WIA. The Executive Committee approved WIA Task 25 liaison with HIA Task 24.
Energy Technology Data Exchange (ETDE)
ETDE will cooperate with the HIA on archiving its publications and reports, facilitating access to a wider audience.

5.2 External to IEA

5.2.1 EU Hydrogen and Fuel Cell Technology Platform and Joint Technology Initiative

Past Chair Trygve Riis (2002-2005) served as a member of the EU Mirror Group of the then newly launched EU Hydrogen and Fuel Cell (HFP) Technology Platform. In 2006, an industry-led Joint Technology Initiative (JTI) was created and is expected to implement the HFP's key Strategic Research Agenda (SRA) and Deployment Strategy (DS). As the European Commission (EC) representative to the HIA, the Directorate General (DG) of Joint Research Petten has extensive involvement in all EC hydrogen matters. The Eurocentric nature of the EC focus is at once both its strength and its limitation. The EC efforts are both a resource for and a contributor to the HIA. For its part, the HIA will continue coordinate with EC efforts as appropriate.

5.2.2 IPHE

The International Partnership for a Hydrogen Economy (IPHE**)** was established in 2003 "as an international institution to accelerate the transition to the hydrogen economy. The IPHE provides a mechanism for partners to organize, coordinate and implement effective, efficient, and focused international research, development, demonstration and commercial utilization activities related to hydrogen and fuel cell technologies. The IPHE provides a forum for advancing policies, and common technical codes and standards that can accelerate the cost-effective transition to a hydrogen economy; and it educates and informs stakeholders and the general public on the benefits of, and challenges to, establishing the hydrogen economy."[18]

From the outset, there was considerable overlap in membership between the HIA and the IPHE, the initial exceptions being Brazil, People's Republic of China, Germany, India and the Russian Federation. Moreover, in many cases, the actual representatives to both groups were the same individuals. Consequently, the HIA made immediate efforts to promote cooperation in pursuit of mutual goals. The HIA also sought to minimize IPHE duplication and overlap with HIA activities. Such duplication was adversely affecting some of the HIA experts, and thus had a negative impact on research efforts. The process of establishing relations took some time.

[18] www.iphe.net

In November 2007, the two groups agreed to a protocol for cooperation in the form of a Memorandum of Understanding (MOU). (The IPHE is not eligible to join the HIA because, legally, it is not an international organization and therefore does not meet the eligibility requirements.) This MOU provides for cooperation on an activity or task basis. A proposed cooperation (activity or task) is then codified in a separate Annex to the MOU. Presently, two annexes have been executed. One is on Task 22, Fundamental and Applied Hydrogen Storage Materials Development, and the other is on Task 19, Hydrogen Safety. The agreements provide that those IPHE countries which are not currently HIA members must execute a Letter of Intent (LOI) to join the HIA within a certain timeframe in order to participate in either task. Essentially, the MOU provides a "fast track" to participation for non-HIA members, while also respecting the HIA membership structure and no-observer policy.

The HIA and the IPHE clearly share an interest in fostering widespread use of hydrogen in the economy. However, their approaches and areas of expertise differ. Our core competence is in planning, executing and analyzing R,D&D as witnessed by the Agreement's long tradition of working successfully in this area. The HIA employs a strategy of internal growth in R,D&D tasks and supporting activities. In contrast, the IPHE has elected an acquisition growth strategy that gathers various types of projects under its umbrella through a labeling process. From inception, the IPHE has set its sights on influencing policy and the political process, as well as promoting hydrogen demonstrations. These activities are both worthy and necessary for the advancement of hydrogen. However, they are by no means the HIA's primary focus. Thus, the HIA welcomes IPHE's policy intervention at high levels of government in support of widespread adoption and application of hydrogen.

5.2.3 IAEA

The International Atomic Energy Agency (IAEA) is slated to hold a technical meeting in March with the IEA and the HIA on application of nuclear methods to advanced material studies for fuel cell and hydrogen cycle technology. This first meeting will include HIA expert participation. The IAEA is then expected to launch a Coordinated Research Project (CRP) on this subject. At a minimum, HIA Task 22 on Fundamental and Applied Hydrogen Storage Materials Development will invite a CRP project within the task framework. It is expected that the subject matter of the IAEA investigation will complement HIA research efforts.

6.0 Management and Scale of Activities

6.1 Management

The 2004-2009 Strategic Plan called for expanding the Secretariat function to deliver a higher level of service to meet the growth requirements of the implementing agreement. The Plan also called for an independent HIA office. Both ambitions have been realized under the direction of the Executive Committee and the capable leadership of three Chairmen: Trygve Riis (2002-mid to mid-2005); Nick Beck (mid-2005-mid 2008); and Antonio G. García-Conde (mid-2008 to present).

At the end of 2005, the IEA HIA opened its own fully dedicated office.[19] In late 2003, the Executive Committee engaged M.R.S. Enterprises, LLC to manage the Secretariat. The M.R.S. management approach combined attention to the HIA fundamentals of R&D administration and

[19] The office is on the 17 acre campus of FASEB, a federation of technical research societies located in Bethesda, MD near the U.S. National Institute of Health. Some 150 federation members have been awarded Nobel Prizes. Easily accessible by public transportation, the campus includes meeting and small conference facilities.

basic information dissemination with value added activities in outreach and communication. The value-added activities were intended: 1) to increase awareness and appreciation of the HIA activities and accomplishments in pursuit of the HIA mission; and 2) to position HIA for relevance with and influence on IEA and greater global direction of R&D for the benefit of the HIA, its members and the greater IEA.

Meetings

The HIA held Executive Committee meetings twice a year. Ten Executive Committee meetings took place during this term.[20] The number of participants/meeting ranged from 35-45 people. The entire portfolio of tasks is reviewed at each meeting. Communication and Outreach activities are also reviewed, as are analysis efforts. The meetings, which take place over two days, typically include a technical tour. An IEA representative attended half the Executive Committee meetings held during this term[21].

HIA tasks also meet twice a year, typically for a two day period. The storage tasks, Task 17 and Task 22, are an exception to the standard practice. These tasks hold two week-long "Gordon-Conference" style meeting that provide intense networking opportunities with formal and informal information exchange.

Unless otherwise indicated, observers are permitted to attend task meetings a limited number of times (once is the standard) and by invitation only. Table 13: HIA Task Meeting Participation and Context lists the tasks, average task attendance, and the number of task meetings held over this term. The practice of holding meetings in conjunction with or at the margin of another conference or event is common among the HIA tasks. In order to convey a sense of the scale of HIA activities, this table lists some of the key conferences, meetings or events coordinated with task meetings. Typical attendance at such events ranged from 200 to 2000.

[20] See p. vi of the 2007 Annual Report, Chairmen & Meetings .http://www.ieahia.org/pdfs/2007_annual_report.pdf
[21] Assumes IEA representation at the second quarter 2008 Executive Committee meeting

Table 13: Task Meeting Participation and Context

Task 15-27	Task Name	# Task Meetings	Average Task Attendance	Context and Coordination with other conferences, meetings and events
15	Photobiological Production of Hydrogen	10	15	-WHEC 15 2004 -European Cooperation in the field of Science and Technology (COST); -6th Int. Conf on the Molecular Biology of Hydrogenases; -Marine Biotechnology Conference; -Nordic Bioenergy Research Program
16	Hydrogen from Carbon-containing Materials	8	38	-GHG IA meetings (as Subtask A leader)
17	Solid and Liquid State Storage	7	45	-stand-alone Gordon Conference style meetings
18	Integrated Systems Evaluation	11	26	-HIA Task 24; -HIA Task 23 -International Seminar – "Hydrogen in Islands" and RES2H_2 project commissioning
19	Hydrogen Safety	11	30	-2005 and 2007 HySafe Conferences
20	Hydrogen from Waterphotolysis	6	31	WHEC 16 2006
21	BioHydrogen	10	55	-WHEC 16 2006 (CNRS organized) -IHEC 2005 and European Cooperation in the field of Science and Technology (COST) 2005; -Asia High Technology Network(AHTN) and Asian Bio-Hydrogen Symposium and Asia Bio-Hylinks 2006
22	Fundamental and Applied Hydrogen Storage Materials Development	5	55	Stand-alone Gordon Conference style task meetings
23	Small-Scale Reformers for On-Site Hydrogen Supply	5	18	-workshop in Japan with MKK, NEDO and ENAA -HIA Task 18
24	Wind Energy and Hydrogen Integration	7	20	- International Seminar – "Future of Hydrogen Islands" and RES2H_2; - HIA Task 18 joint meeting
25	High Temperature Production of Hydrogen	3	16	Stand-alone meeting
26	Advanced Materials for Waterphotoloysis	2	25	USDOE PEC Working Group, MRS Meeting
27	Near-Term Market Routes to H2 by Co-utilisation of Biomass as a Renewable Energy Source with Fossil Fuels	1	12	NEW – TBD
		86		

Relative to task participation in conferences, refer also to Table 10 which provides numbers on task presentations made by task experts and Operating Agents at conference and meetings external to IEA during this term. Refer as well to Table 12: Conference Participation Scorecard which reports on Agreement participation (at the Executive Committee/Secretariat level) in conference/meetings. Typical attendance at such events ranges from 200-2000+, a significant indicator of the scale of HIA activities.

HIA Sponsored Seminars

In 2008 the HIA co-sponsored a seminar in Athens Greece to launch Roads2HyCom. In 2009, the HIA will co-sponsor a technical meeting with the IAEA at the IEA. In the future, the HIA plans to hold seminars/workshops on Agreement activities with participation on the order of 50-200. The Agreement is also exploring sponsorship or co-sponsorship of a larger conference on a major aspect of hydrogen.

6.2 Common Fund

The HIA has a Common Fund for administration and promotion. The Secretariat is responsible for administration (bookkeeping, accounting, reporting) of the Common Fund.

Common Fund dues were set at 5,000 USD for over a decade before the Executive Committee raised dues to 7,500 USD for most member countries effective 2005. The 5000 USD dues level was retained for smaller member countries.

The U.S. had been fully supporting the Secretariat function since 1995. It generously continued to fund the Secretariat until mid-2006. At that time the Agreement assumed full responsibility for this vital function. In view of the increased demand on the HIA Common Fund, the Executive Committee decided to raise the Common fund dues to 10,000 USD beginning in 2007, still retaining the 5000 USD level for the smaller members. The U.S. now contributes 20,000 USD level annually.

There has been an increase in the total amount of the HIA Common Fund during this term. The increase in the HIA Common Fund is partly attributable to the increase in dues and partly attributable to the 60% growth in membership during this term. However, the HIA's financial condition did not change greatly. This is, as previously explained, because the Agreement now supports the Secretariat entirely from the Common Fund.

Below please see the budgets for 2008 - the most recently completed year, and 2009 - the current year.

Table 14: Common Fund Budgets

	Budget 2008	Budget 2009
INCOME		
Common Fund dues	215,000	215,000
Total Income (USD)	**215,000**	**215,000**
EXPENSES		
Contract labor - Secretariat	114,520	125,972
Administrative Assistant and Other Contract Labor	25,175	22,960
Dues and Subscriptions	500	1,000
Professional Services: Biennial Financial Review	-	6,000
Insurance	1,450	2,000
Office supplies and Equipment	2,750	2,500
Annual Report Printing (including tax)	19,500	14,000
Annual Report Postage and event shipping	2,250	4,000
Non-event postage and shipping	750	850
Promotion and outreach	11,905	8,000
Rent	7,700	7,868
Telephone (plus internet and e-mail)	2,500	4,800
Travel	14,000	10,000
Website	2,000	2,000
Contingency	10,000	3,050
Total Expenses (USD)	**215,000**	**215,000**

All figures in USD

In 2006, in anticipation of future growth, the HIA also put a financial review in place through a regional accounting firm. The CPA firm of McLean, Koehler, Sparks & Hammond furnished an Accountant's Review Report of the HIA's financial condition as of December 31, 2006. The review concluded that the HIA's financial statements were in conformity with generally accepted accounting principles in the United States. Future reviews will occur on a biennial basis.

In-kind Contributions

As a task-shared Agreement, no money changes hands at the Secretariat/Executive Committee level since members pay their experts and Operating Agents directly at local prevailing labor rates. Member participation is measured by the number of experts and person years/year. This practice applies to industry as well as government and research institutes. In essence, all task labor entails in-kind contribution. See Table 9 for participation data.

A few other contributions should be cited in the in-kind category:

- Hosting of Executive Committee Meetings
- Hosting of Task Meetings
- $400,000 GHG contribution for Task16 Subtask A
- Hosting of our website free of charge by Mr. Darius Carpenter
- Hardware displays for Ministerial Conference

To acknowledge extraordinary service to the HIA that includes in-kind contributions, the HIA has created an Angel Gallery at www.ieahia.org/pages/glance/AngelGallery.html.

7.0 Achievements and Benefits

Section 1.3 Shared Goals and Section 2.0 HIA Strategic Framework provide part of the context for assessment of HIA achievements and benefits during this term.

7.1 Technology Development and Deployment Success Stories

The HIA is pleased to report that there have been many successes. Every task has a story to tell. Accomplishments, benefits and success stories in technology development and deployment are captured in the table below. The success stories are bolded for emphasis.

Table 15: Accomplishments, Benefits and Success Stories in Completed Term

Advancement of Science and Technology via pre-commercial collaborative **Production RD&D** programs	
Task	**Accomplishments, Benefits and Success Stories in Completed Term**
Task 15 Photobiological Production	**R&D Progress toward development of H_2 production by microalgae** - A novel sustainable photobiological production of molecular hydrogen upon a reversible inactivation of the oxygen evolution in the green alga *Chlamydomonas reinhardtii* (Subtask A) - Identification of accessory genes and gene products necessary for the photoproduction of H_2 in *Chlamydomonas reinhardtii*. Finding that STA7 and starch metabolism play an important role in *C. reinhardtii* H_2 photoproduction. (Subtask A) - Identification and characterization of *tla1*, a novel gene involved in the regulation of the Chl antenna size in photosynthesis in *C. reinhardtii* (Subtask B) -The generation of 11.6 mol of H_2 per mol of glucose-6-phosphate using enzymes of the oxidative pentose phosphate cycle coupled to a hydrogenase purified from *Pyrococcus furiosus* (Subtask C) -The development of both smaller and larger Photobioreactors (Subtask D).
Task 16 Hydrogen from Carbon-Containing Materials	**-State of the Art reports for all three** Task 16 **subtasks**: **Subtask A** on the potential for cost reduction of large-scale processing from natural gas with pre-combustion de-carbonization of fossil energy; **Subtask B** on prospects for H_2 from biomass **from an industry perspective; and Subtask C on small-scale reformer technology** for distributed near to medium term H_2 supply. **-Substantial industry participation** on a challenging scope of work was an HIA first that serves as a benchmark for future industry participation
Task 20 Hydrogen from Waterphotolysis	-**Development, acceptance and operation of two multi-year R&D PEC programs,** one at the **U.S**. **DOE** and the other, called **"NanoPEC**" under **EU 7th Framework Program** **-** Pioneered Fe_2O_3 (Hematite) as very promising, abundant, low-cost and environmentally benign photoanode material. -Maturing PEC water-splitting tandem concepts -Photoelectrochemical (PEC) work on tungsten trioxide led to development of novel, highly sensitive, reliable and low-cost **pollution control sensors for auto industry**
Task 21 BioHydrogen	-**Better genomic understanding** of hydrogen-producing **strict anaerobes** -New assessment method for overall analysis of BioHydrogen (Subtask D) has been screened
Task 23 Small-Scale Reformers for On-Site Hydrogen Supply (SSR for Hydrogen)	-Contributing to **development of norms for small-scale reformers to harmonize industrialization.** This effort, which includes carbon capture, is **crucial to development of the hydrogen infrastructure and future distributed generation capability** - Subtask 3 Market Studies stand to materially facilitate HIA analysis efforts - **Fast-tracking the deployment process** of market introduction and penetration **of small-scale reformers for on-site hydrogen supply from multiple feedstocks, fossil and renewable**
Task 24 Wind Energy and Hydrogen Integration	-**Setting** the **stage** for l**arge-scale use of renewable wind energy for hydrogen production** in the near future by addressing the **entire wind to hydrogen production chain** from technical, economical, social, environmental, market and legal **perspectives** -Exploring in detail possible **applications** for this hydrogen produced, with special emphasis on **full wind & hydrogen integration** by means of hydrogen storage and electrical conversion that **balances the original wind energy production**, allowing an approach to demand that closes the gap with **conventional energies.**
Task 25 High Temperature Production of Hydrogen	-Poised to elaborate world-wide knowledge on specific high temperature (>500°C) processes (solar and nuclear) that will support production of massive quantities of zero-emission hydrogen -Producing **summary sheets** on high temperature processes in **general and detailed** versions
Task 26 NEW	On track to create data base on advanced materials for waterphotolysis

Advancement of Science and Technology via pre-commercial collaborative **Storage RD&D** programs	
Task	**Accomplishments, Benefits and Success Stories in Completed Term**
Task 17 Solid and Liquid State Storage	-Evolved into largest global R&D collaboration on hydrogen storage materials of its time, contributing to R&D, information dissemination and transfer of technology -Huge contribution to the literature with 900+ publications and presentations plus 17 patents
Task 22 Fundamental and Applied Hydrogen Storage Materials	-World's largest collaboration to-date on hydrogen storage materials R&D -Biannual week long Task 22 meetings serve as the ultimate global forum for expert cooperation on hydrogen storage R&D (emphasizing materials and the transportation sector), the grand challenge in hydrogen. As of December 2008 it produced 450+ publications/articles, 450+ presentations and 16 patents.

Assessment of Market Environment including non-Energy Sector; and Analysis, Safety and Economics	
Task 18 Integrated Systems Evaluation	**World's best address for worldwide information and analysis on hydrogen and integrated systems** -Database with 200+ National Documents -National Organizations database -National Projects database -State of the art analysis entitled *Demonstration Project Evaluations* - used **technical simulations that may be applied to** other projects to **replicate results** -**General conclusions in critical areas** of system evaluations, data monitoring, modeling tools, system design, control systems and cost-benefit analysis -Synthesis, **lessons learned and trend analysis** relate to permitting, funding and technology performance -More than a dozen relevant case studies
Task 19 Hydrogen Safety	-Contribution to global understanding of H_2 safety through studies and databases **laying foundation for codes and standards** -Phase I laid theoretical groundwork for phase two testing program to evaluate the effects of equipment or system failures under a range of real life scenarios, environments & mitigation measures -Subtask A Activity 1 produced a *Survey of Hydrogen Risk Methods* in Phase 1. -Subtask A Activity 2 produced *Comparative Risk Assessment Studies of Hydrogen and Hydrocarbon Fuel Fuelling Stations.* -Subtask A Activity 3 produced a *Knowledge Gaps White Paper*

7.2 Policy Relevance

While neither policy formulation nor policy promotion is a core HIA activity, the HIA is acutely aware both of their importance. The HIA is also aware that concern for energy policy is central to the CERT's objectives for itself, the working parties and the implementing agreements. Therefore, during this term, the HIA has deliberately begun to position itself for policy relevance by contributing to effective energy and environmental policymaking through select Executive Committee/Secretariat and task activities.

All HIA policymaking contributions recognize that the environmental benefits of hydrogen technology are crucial to mitigating the impact of climate change and improving urban air quality. This assessment is directly related to future prospects for hydrogen use. Hydrogen can be a near zero emission energy carrier when produced from renewable or nuclear energy. It can be a low carbon energy carrier when produced from fossil fuels subject to carbon capture and storage.

In its spring 2008 message to the Executive Committee, the new HIA Analysis Group emphasized that all Agreement analysis must focus on the emissions side of the equation and the "clean, sustainable" aspects of hydrogen use. During this term, emissions issues have also come under scrutiny in HIA tasks. Task 16 addressed the topic of pre-combustion de-carbonization. Task 23 is addressing integration of reformer and carbon capture unit and the implications for carbon capture technology.

The recent Task 18 *Survey of Mechanisms for the Development and Demonstration of Hydrogen Systems* analyzed methods used to fund effective (fostering long term growth) and efficient demonstration projects in 11 developed countries.[22] The survey provided some significant conclusions, notably that the most successful projects were not necessarily from the richest or most populous countries and that a range of funding mechanisms are recommended to address the potential range of applications. One of the Task 18 Subtask C activities is examining the role of policy in stimulating commercial potential of hydrogen systems in niche or early markets.

Outreach activities such as the IEA Ministerial Conference have afforded the HIA the opportunity to interact directly with policy makers in support of research, adoption and penetration of hydrogen technology. Other internal IEA meetings and events have provided the HIA with a platform from which to discuss the status of the technology, the Agreement's portfolio and future prospects.

Notwithstanding the importance of these activities, the HIA recognizes that its analytic efforts and products alone will not be sufficient to influence policy development. Therefore, the HIA is also actively requesting involvement in IEA analysis efforts from their earliest stages.

7.2.1 Committee on Energy Research and Technology (CERT)

The CERT vision is that "technology will have an increasingly decisive impact on progress in the world wide quest for a globally clean, clear and competitive energy future." The CERT's mission is "to maximize energy technology by optimizing international collaborative RD&D and deployment, by initiating timely technology assessment, analysis and scenarios, by engaging non-IEA countries and crucially, by delivery policy guidance that will make a difference." CERT objectives provide leadership that informs the development and implementation of HIA's Strategic Plan. Since the HIA's 2004-2009 term spans the period of two CERT Strategic Plans, HIA task and activity accomplishments are related to CERT objectives for both periods, 2003-2007 and 2007-2011.

Table 16: 2003-2007 CERT Strategic Plan Objectives and HIA Activities

CERT Obj.#	CERT Objectives	HIA Activities in completed term (2004-2009)
1	To better identify and promote effective and innovative policies that stimulate energy technology R&D	-Task 18 Subtask A products and Subtask B Final Report; *Survey of Support Mechanisms for the Development and Demonstration of Hydrogen Systems* plus Subtask C -Synthesis -Task 16 – all three subtasks; Task 19 – Safety; Task 24 -incipient Analysis Group efforts
2	To more clearly define and analyze energy technology issues and opportunities, and to enhance development of analytic tools that inform and support policy and program development in member countries.	-Definition and analysis of issues and opportunities activities: cross-cuts all tasks - Enhance development of analytic tools —Tasks 18, 19, 23, 24, 26, 27
3	To more vigorously foster international networking and collaboration in energy technology R&D	-Entire HIA Portfolio, including Outreach Program -Cooperation with other Agreements: AFC, Bioenergy, GHG, Wind, ENARD, ETDE -Participation in all four NEET workshops -External networking
4	To more effectively communicate key lessons learned through the CERT's activities to IEA member country government and agencies, the research sector and other interested parties.	- 40 external conference presentations by Executive Committee and 6+ HIA Conference exhibits - 12 internal IEA presentations -25+ key publications; over 1100 task publications, over 1000 presentations -continuous website improvement

[22] http://www.ieahia.org/pdfs/Task%2018%20-%20Survey%20of%20Support%20Mechanisms.pdf

Table 17: 2007-2011 CERT Strategic Plan Objectives and HIA Activities

CERT Obj. #	CERT Objectives	HIA Activities in completed term (2004-2009)
1	Leadership and dialogue to support the CERT Working Parties, IAs and expert/ad hoc groups	- Active HIA cooperation with IEA: Secretariat, IAs, working parties, expert/ad hoc groups - Proactive efforts to expand IEA cooperation with Directorates of Global Energy Dialogue (GED), Sustainable Energy Policy and Technology (SPT) and Office of the Chief Economist (OCE)
2	Stronger focus on the role of technology policy in developing cleaner, more efficient energy technologies and in deploying them, and on the role of policy in catalyzing the scientific innovation needed to generate new energy technology approaches; constant efforts to distil for policy makers the important policy messages from work of the IEA energy technology network.	- Outreach Program - Analysis Group and analysis of issues and opportunities: cross-cuts all tasks - Enhance development of analytic tools —Tasks 18, 19, 23, 24, 26, 27
3	Frequent, effective communication to policymakers of messages and perspectives extracted from analysis drawing on works and findings n the IEA's collaborative RD&D networks, notably from the implementing Agreements, Working Parties, expert and ad-hoc groups, and from associated private sector players and financial institutions.	- Outreach Program - Analysis group
4	More fruitful liaison within the IEA family	- Active HIA cooperation with IEA: Secretariat, IAs, working parties, expert/ad hoc groups - Proactive efforts to expand IEA cooperation with Directorates of Global Energy Dialogue (GED), Sustainable Energy Policy and Technology (SPT) and Office of the Chief Economist (OCE)Cooperation with other Agreements: AFC, Bioenergy, GHG, Wind, ENARD, ETDE -Participation in all four NEET workshops -External networking
5	More vigorous collaboration with non-IEA countries	Gleneagles 5, IPHE, UNIDO Ichet

7.2.2 Renewable Energy Working Party (REWP)

The HIA falls under the umbrella of REWP. The 2007-2009 REWP Strategic Plan and Mandate established four objectives, three of which apply to implementing agreement performance. Table 17 lists these three objectives and then indicates HIA Tasks and activities that contribute to their realization.

Table 18: REWP Objectives and HIA Activities

REWP Objective #	REWP Objective	HIA Tasks and Activities 2004-2009
1	Continue to strengthen the Working Party's role as the primary source of analysis and information on renewable energy technologies and their implementation for IEA committees and offices and non-IEA stakeholders.	-HIA tasks with RE orientation and analysis component: 18, 21, 23, 24, 25 and 26 -New analysis group is strengthening Agreement's role in analysis of hydrogen from renewable energy resources - HIA Chair and Secretariat met with REWP to foster closer working relationship
3	Identify and describe the broad range of policies, technical, financial, regulatory, and other market factors that affect market deployment of renewable energy technologies	-Task 16 B Final Report, *Prospects for Biomass* -Task 18 –Phase 1 Final Reports for Subtasks A and B; *Survey of Support Mechanisms for the Development and Demonstration of Hydrogen Systems*; and Subtask C -Task 21 – Subtask D Study -Task 23 – Market studies on small-scale reformer technology (includes biomass) -Task 24 – Subtask A – State of the Art and Subtask C, Business - Concept Development report
4	Develop and help implement recommendations for accelerated market deployment of renewable energy technologies in the global marketplace	Task 16 B Final Report, *Prospects for Biomass* Task 21 – Subtask D, Overall Analysis -Task 23 –Subtask 3, Market Studies -Task 24 – Subtask C – Business Concept Development study -Analysis Group efforts

7.3 Networking

The support of HIA members is a formidable asset that allows the Agreement to bring the best experts in the world together for cooperative purposes. Essentially, the HIA serves as an "über" technical expert network, a value-added network of expert networks. It doesn't substitute for particular academic networks, bilateral links between countries, international research or trade associations. Rather, it functions as a hub that enables and encourages participants to bring their best understanding and best practices from all these networks to benefit the well-leveraged, democratically developed problem-solving and horizon-expanding activities of the Agreement.

For networking purposes, one great HIA strength is the group's composition, which cross-cuts all relevant communities: academic, research institutes, government and, increasingly, industry. Another great strength is that, as described in 5.0 Coordination with other Bodies, the HIA endeavors on an on-going basis to expand internal IEA and external linkages to increase the flow of information to a variety of stakeholders, including end-users. Internally, the HIA contributes wherever possible to IEA networking efforts, for example, to NEET workshops. As reported in 6.0 Management and Scale of Activities, HIA tasks frequently hold their meetings in conjunction with other conferences, meetings and events, thereby enhancing networking opportunities for researchers. Please refer to Table 13 for a list, by task, of select conferences and meetings that contribute to networking. Specific task contributions to HIA networking, some of which are also technology development and deployment success stories, are called out in the Table 18 below.

Table 19: Task Contributions to Networking

TASK #	TASK NAME
Task 15	**Photobiological Production**
	-Linked effectively with all type and size of entities interested in photobiological hydrogen around the world, notably in the EC and Asia
Task 16	**Hydrogen from Carbon-Containing Materials**
	-Significant cooperation with other IEA IAs: Greenhouse Gas (GHG) led Sub-Task A; and IEA Bioenergy IA Task 33 on Biomass Gasification - Innovation in industry participation: extensive and integral to performance of this work, the linkage with industry opened doors and expanded future opportunities for the HIA
Task 17	**Solid and Liquid State Storage**
	Status as world's largest collaboration in H_2 storage and "Gordon Conference style" meetings assured networking opportunities in research and government communities
Task 18	**Integrated Systems Evaluation**
	-Participation by sixteen national groups -Ten national groups have hosted meetings at hydrogen demonstration locations; guests from other agencies and nations have been invited to observe
Task 19	**Hydrogen Safety**
	-Strong affiliation with HySafe Conference, recently created hydrogen safety conference with worldwide participation
Task 20	**Hydrogen from Waterphotolysis**
	-Effective networking activities enabled 2007 formation of two highly coordinated photoelectrode materials research groups, the USDOE PEC Working Group) and the European Nanopec
Task 21	**BioHydrogen**
	- Task 21 has linked effectively with the rapidly expanding network of entities and individuals around the world interested in photobiological production of hydrogen (EU – Solar-H, Nordic BioHydrogen, Asia BioHyLinks) like its predecessor Task 15
Task 22	**Fundamental and Applied Hydrogen Storage Materials**
	Globally recognized as world's ultimate forum on hydrogen storage
Task 23	**Small-Scale Reformers for On-Site Hydrogen Supply (SSR for Hydrogen)**
	Predominantly industry participation assures strong market connections.
Task 24	**Wind Energy and Hydrogen Integration**
	Networking with industry, research institutes and hydrogen projects (notably with Hydrogen Islands and UNIDO-Ichet) is positioning this task to foster H_2 production from wind energy to non-IEA countries as well as IEA countries
Task 25	**High Temperature Production of Hydrogen**
	Research results will flow out Task 25 network to the established international nuclear community and the emerging high temperature solar community
Task 26	**Advanced Materials for Waterphotolysis**
	This network is poised to link with PEC materials research around the world.

7.4 More Efficient Use of R&D Resources

The Agreement investment numbers – the monetary contribution to the HIA Common Fund and the person years of labor — tell a compelling story about the Agreement's efficiency in cost sharing and resource pooling that reduces the total costs of technology development.

Table 9 in Section 4.2.3.2 aggregates the person year level of effort during this term. This figure comes to 712 person years. Expressed in monetary terms, this level of effort is conservatively valued at $71 million USD.[23] The Common Fund investment per member during this term totaled $42,500 (except for the three smallest and one largest) broken down as follows:

2004 $ 2,500 (half year)
2005 $ 7,500
2006 $ 7,500
2007 $10,000
2008 $10,000
2009 $ 5,000 (half year)
$42,500

[23] The factor used as an investment multipler is $100,000 USD. This represents an average value of a person year of labor among HIA members.

In essence, the investment of $42,500/per member enabled the HIA's 712 person year level of effort during this term. Whether monetized or expressed in labor terms, this a noteworthy return on the member's Common Fund investment The cost-benefit relationship is very attractive: a modest investment leveraged a substantial return.

For all national programs, the leverage factor has great significance. While member programs vary in size, scope and depth, members actively follow HIA progress and activities in order to maximize their investment, which translates into benefit for their programs. While most HIA members do not belong to every task, they receive regular in-depth reports on all activities. The Agreement has strengthened national R&D capabilities by providing participants with improved information and exposure to national hydrogen programs around the world.

By way of concrete illustrations of the value of cost sharing and technology development to members, consider the HIA contribution in the following areas: fundamentals of hydrogen science; near and mid term production; norms and standards for future deployment, and analysis that fosters market adoption and training.

In the mid-long term production arena, Tasks 15 and 21 deal with biological methods, Task 20 and Task 26 focus on advanced materials for photoelectrolytic methods, and Task 25 addresses high temperature nuclear and solar. Near and mid-term, Task 24's work in wind hydrogen integration and Task 27's efforts in biomass offer compelling examples of value added to technology evolution. In the storage area, Tasks 17 and 22 deal with advanced materials for storage. These efforts enable and sustain extensive, in-depth long-term research in basic and applied science wherein collective effort is expected to yield quicker results that benefit all concerned. In many of these cases, individual member efforts would either not be possible or would be severely restricted. Moreover, the existence of Task 20 and Task 26 has enabled members from these tasks to create new or larger, better-funded research member initiatives, specifically in the U.S. and the European Union.

Relative to creation of norms and standards that advance the case for hydrogen, there is Task 19's work on hydrogen safety and Task 23's work on small scale reformers. Such work by definition requires international cooperation to produce results that will be acceptable to the international community.

In terms of information-exchange and analysis, the HIA has assembled and is continuing to create robust databases such as the Task 18 Subtask A Information Bases for Integrated Systems Evaluation and the new PEC database in Task 26. Task 25, High Temperature Production, will map high temperature production programs and link with projects around the world. Task 16 Subtask A developed Large-*Scale Integrated Hydrogen Production for Power Generation/Precombustion Decarbonization*. This $400,000 USD study was funded by the huge industrial CCP countries in the GHG IA: it is a classic example of efficient use of R&D resources.

In the training area, a couple examples bear mention. The Spanish Co-Operating Agent for Task 24, Wind Energy and Hydrogen Integration, is spending part of 2009 at the National Renewable Energy Laboratory in the U.S. Task 25, High Temperature Production of Hydrogen, contemplates embedding a task analyst at various facilities around the world for short periods to perform techno-economic analysis.

In all of these cases, the accomplishments associated with collaborative Agreement efforts far exceed the potential output of any single member, illustrating the HIA's claim to efficient use of its R&D resources.

7.5 Acknowledgments

The HIA would like to acknowledge its appreciation to the Office of the Legal Counsel for their advice and assistance during the 2004-2009 on several issues of importance, notably creation of the MOU with the IPHE and membership matters. The HIA would also like to acknowledge the cooperation of former Desk Officer Dr. Giorgio Simbolotti in the ongoing operations of the Agreement and particularly in connection with the HIA's gaps and priorities effort.

7.6 Overall Significance of Agreement

To recap, the HIA made substantial progress toward or exceeded all benchmarks set in its 2004-2009 Strategic Plan.

Table 20 below summarizes key statistics for the 2004-2009 term, providing a comparison of actual results with projections from the Strategic Plan for that period, where possible:

Table 20: Key Outcomes

Criterion	Achievements/Targets	Actual 1999-2004	Projected 2004-2009	Actual Mid 2004-Mid 2009
Membership	Number of members at end of term	14	~28	22 + three pending
Tasks	Number of R&D Tasks active during period	6-7	~8	13 + 1 in Definition
Level of Effort	Number of person years	~300	~500	740
Expert Meetings		38	~50	88
Publications/Articles	HIA summary publications	11	~20	22
	Expert publications/articles	>200	>200	1,153
Presentations	HIA ExCo/Secretariat – Internal to IEA	-	-	12
	HIA ExCo/Secretariat – External to IEA	~10	~25	37
	Expert	-	-	1,015
Support	Direct member support for Operating Agents	~1 mil USD	~1mil USD	~2 mil USD
	Total Person Years (includes Operating Agent labor)	-	-	712 person years
HIA Budget	Cumulative Operating Budget	0.4 USD M	1.0 USD M	~.85 USD M

The **four main HIA achievements** of the period 2004-2009, the first term in the **Second Generation HIA,** are:

1) the **strong performance** of its **substantial portfolio**, which features the HIA's core business of long-term precompetitive R&D, but also includes mid-term R&D and near-term system-analysis that fosters technology deployment readiness;
2) organizational **growth** as measured by:
   - number of members
   - level of effort in person years
   - creation of an independent office
   - operation of a dedicated professional Secretariat fully funded by the HIA
3) an **outreach** effort that is communicating the potential of hydrogen energy as well as the substance and value of the Agreement's work to members, the IEA, external stakeholders and decision makers around the world
4) a burgeoning **analytic effort** designed to support the HIA's R,D&D and outreach efforts in pursuit of its mission to accelerate the widespread adoption of hydrogen.

7.7 Publications

For a complete list of publications mentioned or referred to in Part I of this report, please refer to http://www.ieahia.org/page.php?s=glance&p=plan

Part II Strategic Plan 2009 – 2014

1.0 Introduction

The HIA has a rich and long-standing tradition of international collaboration in hydrogen R,D&D. The Agreement's tasks and activities encompass the full spectrum of research issues in production, storage, conversion, safety, integrated systems and infrastructure. The HIA is further committed to analysis and outreach in support of its R,D&D activities. Much technical progress has been achieved as a result of HIA coordinated research. Much growth is evident in the Agreement's organizational capacity. The forecast for 2009-2014 is for continued HIA expansion, progress toward fulfillment of the HIA mission and enhancement of the HIA value proposition.

2.0 Strategic Framework

Figure 3: HIA Strategic Framework 2009-2014

2.1 Vision

The Agreement's vision for hydrogen remains unchanged:

The HIA vision for a hydrogen future is one based on a clean, sustainable energy supply of global proportions that plays a key role in all sectors of the economy.

2.2 Mission

The HIA has adopted a mission statement for 2009-2014 that contemplates both the advancement of hydrogen and the role of the Agreement in achieving its vision:

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.

2.3 Strategy

To fulfill its mission and achieve its vision, the HIA's will continue to employ its existing strategy:

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

2.4 Themes

For the period 2009-2014, the HIA has identified three major themes that stem from its mission and vision. These themes, at once goals and priorities, will direct and shape the HIA's portfolios of tasks and activities during the period 2009-2014. They are:

- **Collaborative R,D&D**

  That advances hydrogen science and technology

- **Analysis that Positions Hydrogen**

  For technical progress and optimization
  For market preparation and deployment
  For support in political decision-making

- **Hydrogen Awareness, Understanding and Acceptance**

  That fosters technology diffusion and commercialization

By way of context and orientation, the Guiding Principles found in the HIA Handbook remain valid. [24]

[24] Handbook of Policies and Procedures for the IEA Hydrogen Program, p. 17.

2.5 Portfolios

Each of the three themes for 2009-2014 is associated with a set of portfolios.

The four portfolios associated with the theme of **Collaborative R,D&D** are:

- Hydrogen Production
- Hydrogen Storage
- Integrated Hydrogen Systems
- Hydrogen Integration in Existing Infrastructure

The three portfolios associated with the **Analysis that positions Hydrogen** theme are:

- Technical
- Market
- Support for Political Decision-Making

The three portfolios associated with **Hydrogen awareness, Understanding and Acceptance** are:

- Information Dissemination
- Safety
- Outreach

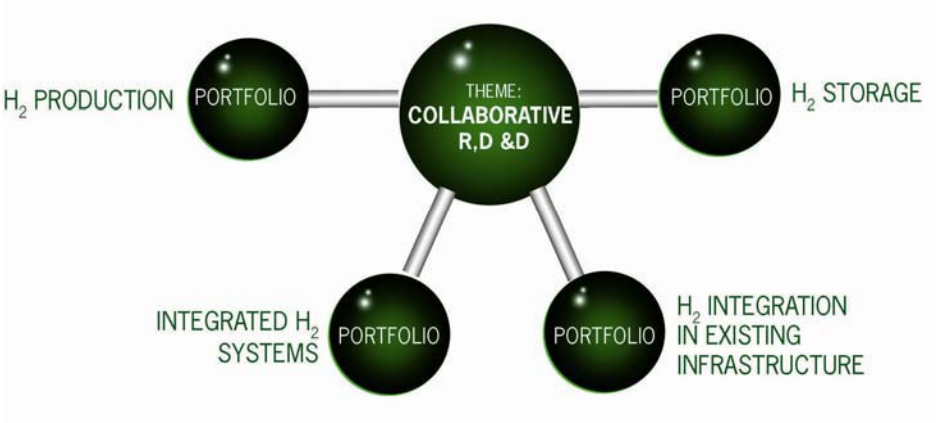
2.6 Governance and Management

The Executive Committee is the governing body of the HIA, comprised of one representative per member. The Executive Committee meets twice a year. Respectful and cognizant of the IEA's mission, Shared Goals and objectives for 2007-2011, the Agreement complies with all IEA CERT management requirements. It cooperates, as well, with the Renewable Energy Working Party, the IEA Secretariat and, wherever possible, with its sister Implementing Agreements (IAs).

The HIA has an independent office managed by its Secretariat. The Secretariat Manager's responsibilities include operations, management and coordination, communications and outreach, and representation. The Secretariat has strong capabilities in outreach and analysis as well as management of R,D&D. The HIA Executive Committee is committed to support such Secretariat expansion during the 2009-2014 term as is appropriate for the ongoing functioning and growth of the HIA.

3.0 Portfolio Planning: Rationales and Content

This section presents the HIA's portfolio planning rationales. It includes a brief statement on the state of the art and/or the status of current activities for each portfolio. Tasks that are now in place and are slated to continue in the new term are identified in the context of their respective portfolios. Discussion follows on the direction of HIA efforts and potential/proposed activities for each portfolio during the 2009-2014 term.



3.1 Collaborative R,D&D Theme

Collaborative R, D&D is the HIA's core business. This R,D&D is typically medium and long-term in scope and pre-competitive in nature. The HIA's *Hydrogen Production and Storage: Gaps and Priorities* examined near, mid and long term research needs in hydrogen production and storage.[25] The HIA's 2009-2014 Strategic Plan will address many or all of these research needs in its quest to advance hydrogen science and technology. Wherever possible and appropriate, the HIA will engage other IEA Agreements in its R&D activities as has been its practice in the past. Cooperation is currently in place with the Advanced Fuel Cell, Wind and Bioenergy IAs.

3.1.1 Production Portfolio

Meaningful progress has been made in new technologies for hydrogen production. However, *Hydrogen Production and Storage: Gaps and Priorities* concluded that, overall, there are significant needs for improvement in increased plant efficiency, reduction of capital costs, and reliability and operating flexibility for all production processes.

With respect to near-term options, **Electrolysis** and natural gas reforming are proven technologies that can be used in the early phases of building a hydrogen infrastructure. While alkaline electrolysis is a mature technology, PEM electrolysis stands to benefit from work in materials development and cell stack design. **Task 24, Wind Energy and Hydrogen Integration**, is working to efficiently combine electrolysers (a constant input device) with variable output wind turbines for production of hydrogen as a transportation fuel and on-site conversion of hydrogen to electricity for load balancing. There may be additional applied R&D in low temperature electrolysis later in the term.

Small scale natural gas reformers remain the subject of research: there are several demonstration cases but limited commercial availability. **Task 23, Small Reformers for Hydrogen Production**, is investigating both technical and marketing issues related to small scale reformers. This effort includes carbon capture and storage.

[25] *Hydrogen Production and Storage: R&D Priorities and Gaps* was published by the IEA in 2006.

There are several medium to long-term hydrogen production options.

In the mid-term, central fossil based production with CO_2 capture and storage could play a significant role. Research is needed on absorption and other types of separation processes as well as overall process layout and configuration.

Biomass to hydrogen processes are also a midterm option. More focus on feedstock preparation is needed. Logistics pose a challenge for this method and production appears economical only at large scale. **Task 27, Near-Market Routes to Hydrogen by Co-utilisation of Biomass as a Renewable Energy Source with Fossil Fuels**, addresses the full range of biomass to hydrogen issues.

With respect to fossil energy carbon-containing materials, the potential for Carbon Capture and Sequestration (CCS) and pre-combustion decarbonization expand possibilities for sustainable use of these conventional resources. New efforts in this area during the 2009-2014 term may be gasification related.

Farther out on the time scale, basic and applied research is needed for both photoelectrolytic and biohydrogen production methods. These early-stage hydrogen production methods are the subjects of **Task 26, Advanced Materials for Waterphotolysis** (photoelectrolysis) and **Task 21, BioHydrogen**.

Photoelectrolysis faces significant materials and system integration issues. So vital is the materials challenge to development of photoelectrolysis that Task 26 has elected to concentrate on advanced materials research rather than continue at this time with design and development of **photoelectrochemical (PEC) devices**. However, it is anticipated that the Agreement will address fundamental and applied research in development of (PEC) devices later in this term, assuming sufficient progress in advanced materials research.

Hydrogen production in **Biological processes** that entail the use of hydrogenases (enzymes) as well as genetically engineered organisms is characterized by low conversion efficiencies. Fundamental research is needed to understand the natural processes and genetic regulation involved in these reactions. It is anticipated that this work will continue through much or all of this term.

High temperature (>500ºC) production of hydrogen is also an important area of investigation for the mid and long term. Key high temperature research topics include **materials development, high temperature membranes and heat exchangers**. Currently, Task 25 is investigating high temperature hydrogen production from nuclear and solar, which offers the potential for production of massive quantities of hydrogen. This effort will likely generate successor research efforts. **High temperature electrolysis** has been identified as an important, discrete research topic for the coming term.

The need for continuing or additional **advanced materials research** was a recurring topic in the HIA's strategic assessment for 2009-2014. The need for research on catalysis was another recurring motif. Consequently, new basic an applied research activities in these areas are anticipated in this term.

As systems evolve for all types of hydrogen production methods, the HIA expects a heightened interest in **applied technology research and development** efforts on the componentry necessary for various hydrogen production methods.

3.1.2 Storage Portfolio

Both **compressed gas and liquid hydrogen** are commercially available today but research in these areas continues to improve performance and reduce costs. R&D issues related to compressed gas include fracture mechanics, safety, compression energy, and volume. In liquid hydrogen important R&D issues include: more efficient liquefaction, lower cost/better insulated containers, automated boil off capture (e.g., via hydrides), re-liquefaction and volume.

For on-board hydrogen storage applications, research has focused on materials-based solid state storage, which is currently in the development phase. The potential advantages of materials-based storage are lower volume, lower pressure (greater energy efficiency), and higher purity of hydrogen output. Important materials storage R&D issues include: volume, weight, lower desorption temperatures, improved desorption kinetics, recharge time & pressure, heat management, cost, chemical and environmental reactivity, durability, container compatibility and optimization.

Task 22 is a current research task that focuses in large part on materials R&D for transportation. It is anticipated that **Task 22** will be **extended** mid-term. The main objectives of Task 22 are to develop reversible or regenerative hydrogen storage media that meet international targets for hydrogen storage, while contributing to fundamental and applied understanding and development of storage materials and systems in stationary application.

In parallel, it is expected that a more **application oriented storage task**, again related to the automotive sector**,** will be proposed. Substantial industry participation will be solicited for this task. Potential topics include: 1) technologies for hydrogen storage (compressed gas, liquid and materials); 2) comparison between different alternatives (engineering aspects, economics etc). Likewise anticipated as a research topic are the **interfaces with conventional resource chains**.

Later in this term, as storage systems meet technical targets, emphasis will shift to include R&D on componentry for all applications.

3.1.3 Integrated Systems Portfolio

Systems integration is an essential next step in collaborative hydrogen R&D. Systems integration brings component subsystems together, ensuring their efficient functioning. **Task 18 has undertaken modeling and evaluation** of a broad collection of hydrogen demonstration projects expressly for the purpose of analyzing and modeling their overall design and performance. This will continue into the next term and may be extended during the term, modeling resources permitting.

Market introduction and penetration of hydrogen technology require optimized, well-integrated systems. Therefore, as time goes on, the Agreement will focus increasing effort and attention on 1) the **componentry, devices and sensors** that comprise the systems; and 2) their **engineering as integrated systems**. This will likely translate into new activities and new tasks during the 2009-2014 term. Relative to production, potential component development and system integration activities might begin with carbon-containing materials and conventional production methods and proceed to advanced production methods. Relative to storage, there are opportunities for

component development and system integration in transport, stationary, mass storage and delivery applications.
As an energy conversion device, the fuel cell is one of the most important hydrogen technologies, one in which the HIA has an abiding interest. As systems integration efforts advance, the HIA will certainly investigate fuel cell issues more closely, likely in cooperation with the IEA Advanced Fuel Cell Implementing Agreement.

The Executive Committee has also expressed an interest in demonstration and deployment activities, given sufficient resources and favorable circumstances.

3.1.4 Integration in Existing Infrastructure Portfolio

Future delivery of hydrogen requires the integration of hydrogen systems into the existing energy infrastructure. The existing **infrastructure services all sectors of the economy** but the world's attention has focused **first on the transport sector** with its mass markets, **followed by the stationary power** sector. Expansion of the infrastructure will require coordination on many fronts: technology; finance and insurance; market mechanisms and policy instruments; construction and engineering; operation and maintenance; and codes and standards. While all these factors warrant attention, the HIA's focus is on R,D&D issues and technical barriers. This augurs for potential research activities that **interface with conventional resource chains** (the grid, pipelines, trucking and other delivery systems). Likewise at issue are **centralized and distributed hydrogen production**, as well as mass storage.

A task on **Infrastructure and Mass Storage** that will consider the hydrogen distribution network from production sites to end users is already in definition. The scope of this task is likely to include **pipelines** (pumps and valves), as well as both gas and liquid mass storage above ground and underground storage in man-made and natural structures.

3.2 Analysis that Positions Hydrogen Theme

In less than a decade, the avalanche of interest in hydrogen has translated into development of roadmaps and a wide array of analytic efforts on R,D&D, infrastructure and market issues around the world. Some fine analytic work on hydrogen is available today. But a comprehensive analysis of global energy conditions that incorporates hydrogen in the world's energy future is a complex and challenging proposition, complicated by high levels of political, technical, environmental and

economic uncertainty. The HIA experience clearly suggests that some stakeholders and decision makers have unanswered questions about hydrogen, the collective efforts-to-date of the HIA, IEA and others notwithstanding. There is, in effect, a **hydrogen information gap** that **needs** to be filled with coherent and **balanced information**, providing a clearer picture of hydrogen R&D needs and the future of hydrogen in the economy. Furthermore, the information needs to be appropriately packaged for specific target audiences.

Therefore, the HIA has reaffirmed its commitment to rigorous, independent analysis that supports collaborative R&D efforts and addresses the larger issue of the transition to hydrogen in the economy. This commitment amounts, in no uncertain terms, to an "**Analytic Imperative**." As the premier global resource for technical expertise in hydrogen energy, who is better positioned to offer balanced analysis on these questions than the HIA?

The HIA has traditionally played a role in **techno-economic** analysis on a technology specific basis. It will continue to play this role in the new term, which cross-cuts R&D portfolios.

During the last term, the HIA began the process of organizing for analysis that will address important questions about hydrogen demand, supply, and infrastructure. This process, spearheaded by the Executive Committee Analysis Group, is growing into an analysis task that will position hydrogen for widespread adoption and penetration. Definition of the Analysis Task will begin immediately in the new term. The task will endeavor to optimize the resources dedicated to analysis, maximizing the benefits of the HIA's analysis investment. The results of the analysis task will be packaged into appropriate products that best meet the needs of its target audiences. The products will then be disseminated through all available and appropriate channels. The Executive Committee expects that development of these products will not only contribute to **filling the information gap** but also more firmly establish the HIA as **the leading technical resource** in hydrogen.

There is an additional critical focus to the analysis theme, which concerns the HIA's contribution to IEA analytics. Pursuant to the Analysis Group's recommendation, the HIA has approached the IEA to propose close **cooperation on IEA analytic efforts** that currently include or in the future might appropriately include hydrogen. The HIA has asked that its involvement begin early in the research and analysis process. The well regarded Energy Technology Perspectives (ETP) and the World Energy Outlook (WEO) publications are high on the list of noteworthy targets for HIA analytic cooperation.

Three portfolios are associated with the Analysis theme: technical, market and support for political decision-making. The expectation is that clear, carefully crafted technical, market, and public policy analysis will positively influence every aspect of development and deployment of hydrogen. Collectively, these three portfolios will provide the analyses needed to provide relevant stakeholders and policy makers with balanced information that stimulates R, D&D, market adoption and widespread application of hydrogen.

3.2.1 Technical Portfolio

The technical portfolio comprises analysis intended, first and foremost, to promote advancement and optimization of the technology. This effort is also intended to ensure that the HIA provides a clear picture of evolving hydrogen R,D&D needs.

Some elements in the technical portfolio will consist of technology specific analyses conducted in various tasks, e.g., **Task 24, Wind Energy and H_2 Integration, Subtask B** – Needed

Improvements and Systems Integration Technology Development on Main Equipment and System Integration Concepts; and technical materials developed for **Task 25, High Temperature H_2 Production, Subtask B – Development of a Methodology Approach and Integration of HTPs**. There is, in fact, a need to make the technical case for individual technologies. It is anticipated that the Analysis Task will interact with individual tasks and cooperate on the process of performing full life-cycle analyses.

There is a larger need to make a cross-cutting technical case for all hydrogen technologies – production, storage, conversion (including fuel cell) delivery and infrastructure. This effort will be based in the Analysis Task. The foundation for the effort is underway in the form of a literature review and gap analysis.

3.2.2 Market Portfolio

The market portfolio of analysis activities will deal expressly with issues of market preparation and deployment. These issues include the topic of market transformation that supports the deployment of innovative technology, bridging the early, and often fatal, stage of market introduction and the later stage of market penetration. The analytic market portfolio effort will make the business case for hydrogen, positioning hydrogen for competitive advantage in the marketplace. This analysis will entail both supply and demand side assessments, including the non-energy sector. The supply side analysis will incorporate a market perspective. As previously stated, techno-economic analysis with a market perspective will be performed on individual technologies.

3.2.3 Support for Political Decision-Making

While the technical portfolio speaks to technology, and the market portfolio speaks to market adoption, penetration and the "business case" for hydrogen, there is yet another important variable in the technology advancement equation: support for political decision-making. The CERT Strategic Plan 2007-2011 emphasizes the CERT's commitment to policy. The REWP's Strategic Plan 2007-2009 also addresses policy factors that affect market deployment of renewable energy technologies. Therefore, the rationale for the analysis portfolio in support of political decision-making is: 1) that public policy will play a crucial role in development of hydrogen technology and its deployment in the marketplace; and 2) that support for political decision-making is considered indispensable to a future with hydrogen energy.

The Support for Political Decision-making Portfolio will undertake analysis that aligns investment in hydrogen technology with global public policy concerns, notably climate change and emissions reduction. Wherever appropriate, this analysis will utilize findings and conclusions from the technical and market analyses. The results will be presented in position papers and briefs. This analysis activity will be undertaken in coordination with CERT strategic objectives, in particular Strategic Objective #3.[26]

[26] *Frequent, effective communication to policy makers of messages and perspectives extracted from analysis drawing on work and findings on the IEA's collaborative RD&D network, notably from the Implementing Agreements, Working Parties, expert and ad-hoc groups and from associated private sector players and financial institutions.* CERT Strategic Plan, 2007-2011, IEA Committee on Energy Research and Technology (CERT), p5.

3.3 Hydrogen Awareness, Understanding and Acceptance Theme

The Hydrogen Awareness, Understanding and Acceptance theme complements the HIA's principal theme - Collaborative R&D, and its supporting theme - Analysis. It acknowledges that awareness, understanding and acceptance are requisite to technology diffusion and commercialization. It recognizes that the benefits of hydrogen must be articulated to stakeholders and decision makers. And it accepts a major role for the HIA in the communications process. Through this three portfolio effort to foster technology diffusion and commercialization, the HIA expects to increase its visibility as the reference institute for hydrogen.

3.3.1 Information Dissemination Portfolio

This function is basic to building hydrogen awareness, understanding and acceptance. It targets key stakeholders in the science, energy and environmental communities, as well as the media. It also targets key stakeholders and decision makers in government and industry, who are of great and growing importance. And, of course, regular information dissemination to member countries is one of the benefits of HIA membership. In addition, the HIA appreciates that the IEA is itself an important target audience. As an Agreement whose membership includes non-IEA member countries, the HIA appreciates the potential benefits of the IEA's call to disseminate information beyond the borders of IEA member countries. Further, the information dissemination function aims to inform and educate the interested public(s).

The HIA understands that the ultimate success of the Analysis Imperative depends upon effective information dissemination. At the end of the 2004-2009 term, information dissemination entailed distribution of various HIA products through a number of channels at both the Executive Committee level and at the task level. For the 2009-2014 term, both expansion in the HIA information products – resulting in significant part from the analysis efforts — and more frequent use of distribution channels are planned. In addition, new platforms for information dissemination will also be adopted.

At the Executive Committee level, utilizing the Secretariat, information is now developed and disseminated through the website, newsletter, brochures and the Annual Report. The HIA also

contributes to IEA publications. Information is also disseminated through the HIA's conference strategy, which divides conferences into those internal to the IEA and those external to the IEA. The external market is further segmented into the following categories: hydrogen and fuel cell; renewable/sustainable; environmental; conventional energy; transportation; and utilities /infrastructure. The conference strategy entails preparation and delivery of abstracts, papers and related presentations as well as exhibits. Finally, there is a public relations and media strategy that also contributes to information dissemination. All of these activities will continue in the new term.

In addition, the HIA will expand its conference participation in the new term budget permitting. First, it will add value to established conference opportunities by expanding the HIA presence at these conferences, via a larger number or higher profile speaking opportunities, or exhibition. Second, it will add conference participation in new market segments to broaden its audience exposure opportunities.

New this term is a conference/meeting initiative that will allow the HIA to hold meetings/ conferences to discuss progress, activities and achievements. These gatherings may be held at IEA Headquarters in Paris, the HIA office in metropolitan Washington, D.C., and as yet unidentified venues. Expected attended would range from 50-200. New also this term is pursuit of a major technical conference as an HIA sponsorship (or co-sponsorship) and branding opportunity.

During the 2009-2014 term, the HIA expects to make increased use of Information Technology (IT) to create new platforms and channels for information dissemination. Webinars and podcasts are prime candidates. The Agreement also expects to enhance delivery of HIA news through Really Simple Syndication (RSS). These platforms will allow the HIA to tailor information offerings to target audiences from its substantial, and growing, knowledge and analysis base.

At the task level, HIA experts have produced over 1,000 HIA related publications/reports and 1,000 HIA related presentations. The trend toward increased production of information in publications/reports and presentations is expected to continue during this term.

As hydrogen progresses toward commercialization during the 2009-2014 term, the HIA newsletter will expand or possible evolve into two products. This expansion is intended to capture growing interest in hydrogen demonstrations and the hydrogen marketplace.

The HIA also plans to coordinate to the greatest extent possible with its sister Agreement, the IEA Energy Technology Data Exchange (ETDE).

3.3.2 Safety Portfolio

Hydrogen safety and consumer comfort with hydrogen are vital ingredients for acceptance of hydrogen. Hydrogen safety considerations cross-cut the HIA R,D&D portfolios. Task 19 explicitly deals with safety through analysis, testing and the development of target information products. During this term, as safety information products become available, Task 19 plans to distribute them as broadly as possible. The Secretariat will participate directly in distribution and promotion of the Task 19 safety products. Further, the Secretariat will incorporate Task 19's findings and conclusions on safety into other HIA communication vehicles whenever possible. Additional safety activities – one or more tasks – are projected for the new term. Precise topics will be defined as Task 19 nears its 2010 conclusion; the regulatory framework for codes and standards is likely to be included in the mix.

3.3.3 Outreach Portfolio

The Outreach Portfolio focuses not only on informing but more importantly on **engaging** a critical subset of HIA stakeholders and decision makers. In so doing, it builds on the function and activities of the Information Dissemination Portfolio, which seek to inform a variety of target audiences and interested publics. However, the Outreach Portfolio goes beyond information dissemination in pursuit of active engagement with the HIA.

Engagement with the HIA may take several forms, including participation as an HIA expert, a member or possibly a sponsor. Engagement may also imply cooperation on a more limited timeframe or for a particular purpose. Engagement categories are discussed later in this section.

To engage this important subset of the greater target audiences, the Outreach Portfolio will employ the full array of HIA information and analysis products and materials. It will utilize all available channels and vehicles, including networking opportunities. Active participation of the Executive Committee Members and Operating Agents, who are well-positioned to carry out these activities in strategic situations around the world, is considered essential. The Secretariat will support this effort.

Potential Participants: Experts

HIA Experts are the labor force that carries out the HIA's Strategic Plan and Program of Work. Operating Agents and Sub-task leaders positions are mission-critical management functions in every HIA task. As a task-shared Agreement, experts are contracted and compensated directly by members. Nevertheless, the identification and training of potential experts, Operating Agents and Sub-task leaders is a continuous process for the HIA. This process involves current experts, Operating Agents, Sub-task leaders and members as well as the Secretariat.

Potential Participants: Members

Today, HIA membership is comprised entirely of Contracting Parties — countries and the European Commission. International organizations are also eligible for membership as Contracting Parties; UNIDO, a leading international organization, is now in the HIA membership pipeline. Additional countries, IEA member and non-member (including the Gleneagles "+ 5") countries, are either in the membership pipeline or in discussions with the HIA about membership. The HIA seeks to engage other IEA member and non-member countries as it looks forward to continued growth in membership. The HIA is most especially interested in attracting members who are willing and able to commit to active participation in Agreement tasks and activities.

Potential Participants: Sponsors

Industry is eligible to join in the sponsor category. As of the end of the 2004-2009 term the HIA had no "sponsor" members but industry has sponsored a number of task experts, often up to 100% over the task period. It is clear from the example of other Agreements that industry sponsors have the potential to make significant contributions to the advancement of hydrogen technology and the realization of the HIA mission. The HIA will consider parameters for sponsorship early in the new term.

In tandem, the HIA will continue to encourage greater participation by industry experts at the task level. Each task will be asked to set a target for industry participation.

Cooperation within the IEA

The HIA looks forward to cooperation with the IEA family at all levels. Continued engagement with the IEA Secretariat and Office of Legal Counsel is important to the success of our ongoing operation. HIA Analysis and Outreach activities are expected to provide especially important opportunities for IEA cooperation during this term. The HIA hopes to enhance its ties to the REWP and cooperate with sister Agreements wherever possible.

Cooperation within the Hydrogen Community

The HIA will continue to engage the greater hydrogen community, which includes the International Partnership for a Hydrogen Economy (IPHE) and trade organizations, in cooperative efforts to accelerate widespread use and application of hydrogen. The HIA recognizes that the greater hydrogen community, and certainly the IPHE, has the capacity to reach out effectively to key stakeholders and decision makers for support in policymaking and development of the marketplace.

Cooperation with the Renewable Community

The HIA will seek to engage and educate the renewable energy community about hydrogen to foster harmonious relationship in pursuit of mutual objectives. As part of this process, the HIA will seek closer ties with other implementing agreements in the REWP, the REWP itself, renewable trade organizations and the renewable industry.

Outreach to Key Stakeholders and Decision Makers

Certain prospects — key stakeholders and decision makers in government and industry – are high priority targets of this outreach effort because their influence and support are needed for R,D&D prioritization and funding, policy formulation and market development. The HIA will make every effort to identify, inform and engage key stakeholders who are likely to contribute to the diffusion and commercialization of hydrogen science and technology.

Country Outreach: IEA Member Countries and IEA non-Member

The HIA will pursue engagement with IEA member and non-member countries via HIA membership or cooperation in areas of mutual interest. Country prospects will be prioritized according to their inclination and capacity for HIA cooperation. The new HIA conference strategy, a part of the information dissemination portfolio of activities, is expected to facilitate engagement efforts.

Finally, the HIA continues to welcome and plans to actively pursue cooperation and liaison with a full range of interested groups in public and private sectors. Examples of groups in the public sector include the International Atomic Energy Association (IAEA), the Intergovernmental Panel on Climate Change (IPCC) and the United Nations Environment Programme (UNEP). Examples of groups in the private sector include energy and automobile industry trade associations.

4.0 Work Program

In formulating the 2009-2014 Strategic Plan there was a clear sense in the Executive Committee that the Program of Work must contemplate the big picture needs of near, mid and long term hydrogen R,D&D. In addition, however, the Executive Committee stressed that Program of Work must also address issues germane to the 2009-2014 timeframe, the term for this Strategic Plan. Accordingly, the Work Program will be revisited at regular intervals during the 2009-2014 term to ensure maximum relevance to near and long-term time horizons.

4.1 Work Program Table

Table 1 summarizes the Program of Work. The table is organized by Theme & Portfolio, Key Issues and Approach. The Approach is broken into two parts: those tasks and activities that were in place at the beginning of the term in mid-2009; and those activities and tasks that have been proposed as potential additions to the Program of Work during the 2009-2014 term.

Table 1: Work Program

	THEME & PORTFOLIO	KEY ISSUES	APPROACH In place 2009	APPROACH Proposed/Potential
FUNDAMENTAL		-Anaerobic use of bacterial dark fermentations and photosynthetic microbes; increased yields; biomimetics; biohydrogen acceptance	Task 21, BioHydrogen	Extend Task 21 past 2010
		-Advanced materials for photoelectrochemical (PEC) watersplitting	Task 26, Advanced Materials for Waterphotolysis	Possible extension of Task 26 past 2011
		-Advanced materials (catalysts) for other production methods		Task on catalyst research for other production methods
		-High temperature production from nuclear and solar		Possible extension of Task 25
		-Electrolysis	Task 25, High Temperature Production	High temperature electrolysis activity
TECHNOLOGY	**R,D&D** ***Production*** 	-Biofuels for reformers; CCS & emission handling	Task 23, Small-Scale Reformers for On-Site Supply of Hydrogen	-Possible one year Task 23 extension past 2009
		-Gasification and gas clean-up		-Task on Purification / separation, ICE for on-site reformers
		Design/development of photo-electrochemical (PEC) devices		-Possible successor to Task 26 on development of PEC devices
		Fully integrated wind and H_2 application	Task 24, Wind Energy and Hydrogen Integration	-Possible Task 24 extension
		Co-gasification of biomass with fossil fuels; tradable intermediates	Task 27, Near-Market Routes to Hydrogen by Co-utilisation of Biomass as a Renewable Energy Source with Fossil Fuels	-Follow-up activities/successor task on low temperature electrolysis - Follow-on efforts TBD

	THEME & PORTFOLIO	KEY ISSUES	APPROACH In place 2009	APPROACH Proposed/Potential
FUNDAMENTAL	**R,D&D** ***Storage*** 	Reversible/regenerative H_2 storage media fulfilling int. targets -fundamental & engineering understanding -materials for stationary applications -Compression -Metal Embrittlement	Task 22, Fundamental and Applied H_2 Storage Materials Development	Task 22 seeking 2-3 year Extension past 2009; there-After, disposition of activity TBD -Possible Task/activities on H_2 interactions with materials
TECHNOLOGY		Applied Aspects of H_2 storage systems in vehicles: compressed gas, liquid and materials-based;	.	-New task examining technologies for H_2 storage: compressed gas, liquid and materials-based; Techno-economic analysis of alternatives. -Component task
	R,D&D ***Integrated Systems*** 	All purpose information on H_2 integration Harmonization of components for reformer systems; technology performance and cost; CCS & emission handling Specifications for Integrated Systems	Task 18, Integrated Systems Evaluation Task 23, Small-Scale Reformers for On-Site Supply of Hydrogen Task 24, Subtask B	-Possible continuation of Current modeling and Analysis of demonstration systems -Possible one year extension of Task 23 -New Task H_2 Communities Modeling and Design: islands, remote and rural communities Possible one year Task 23 extension past 2009
	R,D&D ***H_2 Integration in Existing Infrastructure*** 	Geologic storage; pipelines; "mass" storage	In Definition – Infrastructure and Mass Storage Task	TBD

	THEME & PORTFOLIO	KEY ISSUES	APPROACH In place 2009	APPROACH Proposed/Potential
CROSSCUTTING	 **Analyses that position H_2** *Technical* 	"Where will the H_2 come from" -What role will H_2 play? -Balanced view Competition in transport sector	Analysis Group Task 18 – H_2 Literature Review	Analysis Task: Supply, Demand -Comprehensive report that includes CO_2 reduction based on introduction of H_2 technology Part of proposed storage task: Techno-economic analysis of alternatives in automotive industry. Proactive cooperation with IEA analytics
	Analyses that position H_2 *Market* 	"Where will the H_2 come from" -What role will H_2 play? Including non-energy sector	Analysis Group Task 23, Subtask 3 Market Studies Task 24, Subtask C and D, Business Concept Development Task 27, Subtask D, Roadmap Development and Verification	Analysis Task: Supply, Demand from a market perspective – a comprehensive report that includes CO_2 reduction market, cap & trade Proactive cooperation with IEA analytics Successor task on Market Studies for on-site reformer Technology
	Analyses that position H_2 *Support for Political Decision-making* 	Lack of information and clarity about the benefits of hydrogen (notably, CO_2 and pollution reduction) among stakeholders and decision makers whose influence is needed and useful for R&D, planning, demonstration and deployment		Analysis Task: Briefs and Position Papers that address all issues, including CO_2 reduction, climate change

	THEME & PORTFOLIO	KEY ISSUES	APPROACH In place 2009	APPROACH Proposed/Potential
CROSSCUTTING	 **H_2 Awareness, Understanding and Acceptance** *Information Dissemination* 	Broader and deeper information dissemination needed along with targeted dissemination.	An element of Outreach Program managed by Secretariat, it features: -Website -Annual Report -Conference strategy - Communication/Promotion materials -Public relations and media -contributions to IEA events and publications Target audiences include: IEA member countries and IEA family Gleneagles "+5" and potential H_2 members Hydrogen community	Increase information Dissemination by Continuing current activities And augmenting with: -Enhanced Conference Strategy that features HIA seminars/workshops <200; and possible sponsorship of larger conference; -webinars, possible pod-casts and other IT vehicles -dissemination of safety Products -dissemination of analysis products -cooperation with ETDE to Expand market for information Expand target audiences Non-IEA member countries/ Developing world Greater energy community
	H_2 Awareness, Understanding and Acceptance *Safety* 	All aspects of hydrogen safety and consumer comfort with hydrogen	Task 19	Task 19 concludes in 2010. High potential for multiple follow-up tasks in key areas; definition of successor tasks to occur early in term. Task 19 to complete information products and distribute with Secretariat support.
	H_2 Awareness, Understanding and Acceptance *Outreach* 	Inform and engage	An Element of Outreach Program directed by ExCo and managed by Secretariat.	Inform and engage through information dissemination and targeted networking, Build participation. Influence stakeholders and decision makers. <u>Potential participants</u> Members, experts, sponsors <u>Stakeholders and decision makers</u> IEA, IEA member countries, IEA no-member countries Government and Industry Hydrogen Community Renewable Community

4.2 Work Program Timeline

Table 2 sets forth a tentative timeline for the tasks and activities proposed in the Program of Work with the exception of the activities covered in Outreach and Information Dissemination Portfolios connected with the Hydrogen Awareness, Understanding and Acceptance theme. In summary, all nine (9) current tasks will continue in the new term 2009-2014. Another task, now in definition, is expected to launch just before or right after the new term begins. Six (6) of the existing tasks are expected to be extended during the term. Some seven (7) tasks are expected to be formed as successors to current tasks. Finally, five (5) other new tasks are forecast. Altogether, it is expected that 12 tasks will be approved during the new term. Of these tasks, nine are expected to continue past mid 2014, the end of the new term. If the Work Program is realized as planned, the End of Term Report for 2009-2014 would report on progress in a total of twenty-one tasks.

Key to Work Plan below:

- Solid black line = current task
- Solid grey line = task in definition
- Short dash broken line = task extension
- Long dash green black broken line = successor task
- Long dash red broken line = new task
- Arrow at end = means task is expected to continue after end of 2014 term

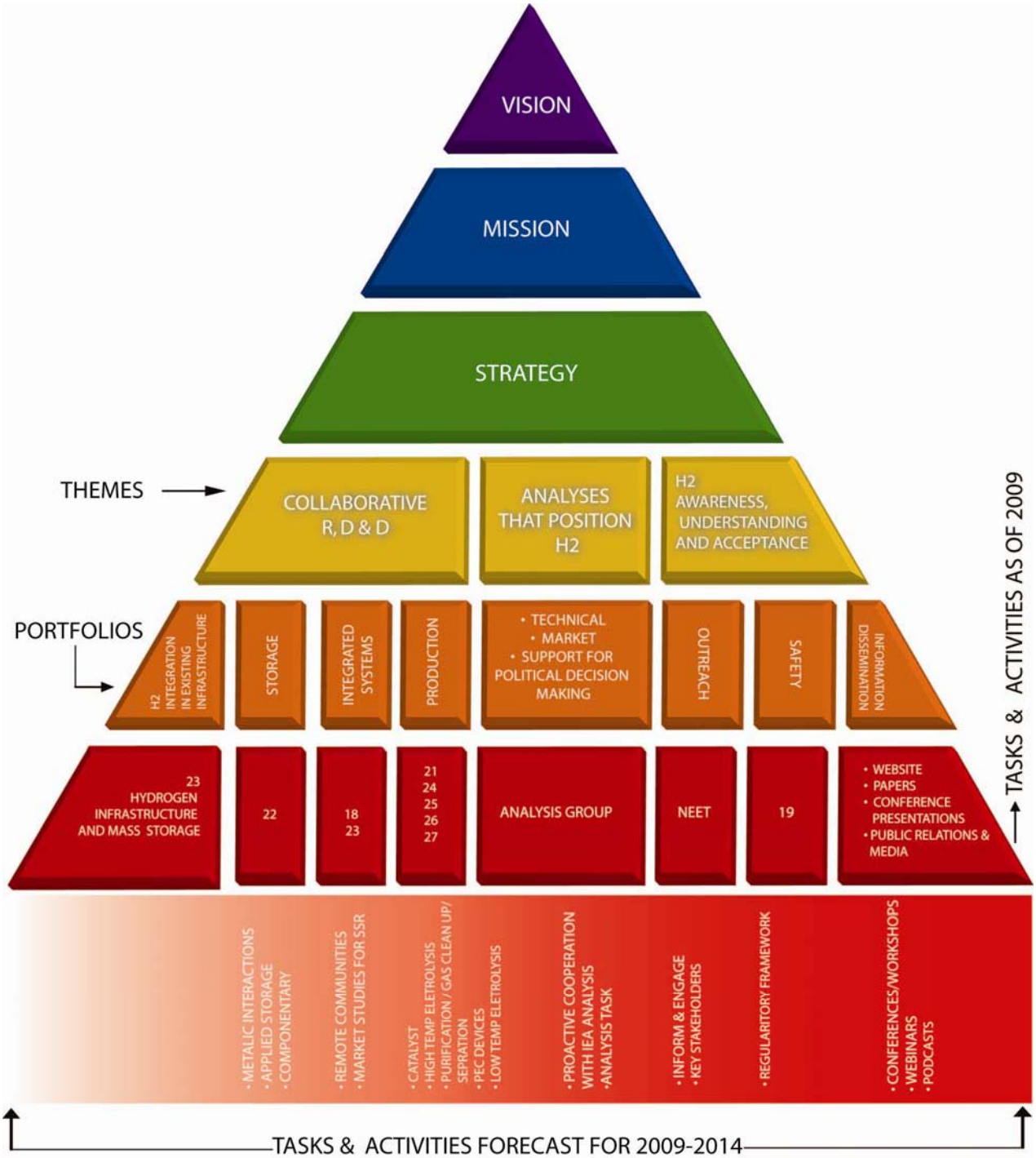
Table 2: Work Program Timeline

	Mid 2009	2010	2011	2012	2013	Mid 2014
Task 18: Integrated Systems Evaluation						
Successor: Remote Community Modeling						
Task 19: Hydrogen Safety						
Successor Safety: Regulatory Framework						
Task 21: BioHydrogen						
Successor: BioHydrogen						
Task 22: Fundamental and Applied Hydrogen Storage Materials						
New Task: Applied Storage						
Task 23: Small-Scale Reformers for On-Site Hydrogen Supply (SSR)						
Successor: Market Studies for SSR						
Task 24: Wind Energy & H_2 Integration						
Successor: Componentry & Low Temp Electrolysis						
Task 25: High Temperature H_2 Production						
Successor: High Temp Electrolysis						
Task 26: Advanced Materials for Water photolysis						
New Task: PEC Devices						
Task 27: Near-Term Market Routes to H_2 by Co-Utilization of Biomass as RE with Fossil						
Successor: Gasification & Gas Cleanup						
Task 28: Infrastructure and Mass Storage						
New Task: Analysis						
New Task: Catalyst Research						
New Task: Production Componentry						

4.3 Pyramid Summary

This image integrates all the elements or "building blocks" of the HIA's 2009-2014 Strategic Plan in a layered pyramid diagram that communicates the Plan's strategic essentials at a glance. A key feature of the pyramid is that each layer supports the achievement of the layer above.

Figure 4: Pyramid Summary of HIA Strategic Plan 2009-2014



5.0 Actions for Improvement – Specific IEA Support

In order to improve the Agreement's performance in a manner that is consistent with the IEA's mission, Shared Goals and Strategic objectives for 2007-2011, and that takes into account the IEA business model for Implementing Agreements, the HIA respectfully requests the following IEA support:

- Encourage IEA member countries that are qualified prospective members in the HIA to follow through with the accession process at the earliest possible time.
- Endorse the HIA's Analytic Imperative by calling for HIA participation and cooperation in IEA analysis efforts 1) that involve hydrogen; or 2) that stand to benefit from consideration of hydrogen. HIA participation would begin in early stages of IEA analysis and continue to completion.
- Support the Hydrogen Awareness, Understanding and Acceptance theme by sharing contact information that builds the HIA database for purposes of information dissemination.
- Provide administrative assistance for HIA outreach efforts to inform and engage stakeholders and decision makers in order to increase participation, membership and sponsorship. In particular, the HIA welcomes participation in IEA conferences, meetings and events that may provide appropriate opportunities for networking with government and industry.
- Continue to invite HIA participation in NEET meetings and events
- Continue to provide legal counsel where necessary and appropriate
- Host HIA conferences, seminars and workshops for a variety of IEA and non IEA member countries and industry audiences.

6.0 Projected Outcomes and Closing

Criterion	Achievements/Targets	Actual 2004-2009	Projected 2009-2014
Membership	Number of members at end of term	22 + three pending	30
Tasks	Number of R&D Tasks active during period	13 total + 1 in Definition	~20 total
Level of Effort	Number of person years	~712	~875
Expert Meetings		88	~120
Publications/Articles	HIA summary publications	22	~25
	Expert publications/articles	1,153	1,500
Presentations	HIA ExCo/Secretariat – Internal to IEA	12	12
	HIA ExCo/Secretariat – External to IEA	37	40
	Expert	1,015	1,200
Support	Direct member support for Operating Agents	~2 mil USD	~2.8 mil USD
HIA Budget	Cumulative Operating Budget	0.85 mil USD	~1.0 mil USD

The Strategic Plan for 2009-2014 forecasts progress in HIA R,D&D and continuing growth in the Agreement. These outcomes are expected to enhance the Agreement's value proposition, contributing to realization of the HIA's mission and recognition of the HIA as the world reference for hydrogen energy.