HYDROGEN IMPLEMENTING AGREEMENT

IEA Hydrogen Implementing Agreement (HIA)

Proposal for Task 21 Extension— "Bio-inspired and Biological Hydrogen"

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Introduction

- Bio-inspired (*in vitro*, biomimetic, and artificial photosynthetic) Hydrogen and BioHydrogen (microbial) production processes are active fields of basic and applied research.
- Significant R&D programs are continuing around the world.
- An extended IEA HIA Task will cover these areas of R&D, as well as technological/economic evaluations and societal acceptance issues.
- These are of mutual interest to the 12 countries currently constituting the Task.
- The extended task will provide the basis for establishing real collaborative research projects amongst the member countries and an overall coordinated program.

Objective

- The Task will carry out collaborative research activities on the production of H_2 using:
  - – *in vitro*, biomimetic, and artificial photosynthetic systems;
  - – photosynthetic microbes;
  - – dark bacterial fermentations;
  - – biological/enzymatic fuel cells; and
  - – integrated combinations of these technologies.
- The overall objective is to:
  - – sufficiently advance basic and applied science in these areas of research; and
  - – evaluate these technologies from the perspective of economics and sociology.
- A five-year period is considered to be sufficient time to:
  - – initiate a significant directed-research program;
  - – set metrics for evaluation of the R&D status and promise of this field; and
  - – achieve some major advances.

Task Approach

- A five year collaborative R&D program is proposed (3 years plus and option for a 2-year extension during the period).
- The Task will support the development of basic and applied Bio-inspired H_2 and BioHydrogen Sciences .
- A five-year period is considered to be sufficient time to:
  - initiate a significant directed-research program;
  - set metrics for evaluation of the R&D status and promise of this field; and
  - achieve some major advances.

Comparison of Past and Proposed Subtasks

2005-2010

A. BioHydrogen Systems
B. Basic studies for Photobiological H_2 Production
C. Bio-inspired Systems
D. Overall Analysis

2010-2015

A. Bio-inspired Systems
B. Dark BioHydrogen Fermentation Systems
C. Basic studies for Light-Driven BioHydrogen Production
D. Biological Electrochemical Systems
E. Overall Analysis

Subtask A. Bio-inspired Systems

Activity Leader: Peter Lindblad (Sweden)

Focus Areas

- In vitro, enzyme systems for H_2 production.
- Biomimetic systems for H_2 production.
- Artificial photosynthesis for H_2 production.

Subtask B. Dark BioHydrogen Fermentation

Activity Leader: Patrick Hallenbeck (Canada)

Focus Areas

- Metabolism, genetics and thermodynamics of H_2-producing bacteria - identify critical genes, pathways and regulatory components for high yield H_2 production.
- Genetic and physiological manipulation to maximize H_2 production - identify bacteria, the diversity of hydrogenases in different organisms, and conditions that allow for high H_2-production rates.
- Fermentative H_2 production in the dark - identify low cost, biomass/organic substrates and conditions that produce large amounts of H_2 and minimal acid waste (this latter topic will be coordinated with Subtask D).

Subtask C. Basic Studies for Light-Driven BioHydrogen Production

Activity Leader: Marc Rousset (France)

Focus Areas

- Genetics, metabolism, and systems biology of H_2 production by photosynthetic microbes.
- Fundamental studies of hydrogenases and their susceptibility to O_2.
- Selection of algal strains with high H_2 output.
- Physiology and biotechnology of photosynthetic microbes to maximize H_2 production from water or organic wastes.
- Photosynthesis under stress conditions - overcoming limiting factors.
- Development of photobioreactor designs for H_2 production outdoors.
- Examination of bio-sensing in phototrophic organisms.
- Immobilized systems to increase productivity and yield of photofermentation.

Subtask D. Biological Electrochemical Systems

Activity Leader: Alan Guwy (UK)

Focus Areas

- Microbial fuel cells - coupling microbes to electrodes to produce H_2 from waste biomass.
- Enzymatic fuel cells - coupling enzymes to electrodes to produce H_2 from waste biomass.
- Application of the system for real-world wastewater treatment.

Subtask E. Overall Analysis

Activity Leader: Jun Miyake (Japan)

Focus Areas

- Effects of Bio-inspired Hydrogen and BioHydrogen on social systems and human life.
- Integration of other renewable energy sources with Bio-inspired Hydrogen and BioHydrogen to accelerate practical applications
- Economic and social factors required to implement Bio-inspired Hydrogen and BioHydrogen utilization

Work Plans

Please see the Task proposal for details

Level of Effort

- Operating agent – 0.3 person years/year.
- Subtask leaders – 0.2 person years/year.
- In addition a minimum of 0.5 additional person years/year for participating countries.
- A minimum of 12 participating researchers supported to carry ou the research under the Task is thought necessary to achieve it goals.

Task Participants

Current Members

- Canada
- Finland
- France
- Germany
- Japan
- Korea
- The Netherlands
- Norway
- Turkey
- Sweden
- UK
- USA

Future Members

- Brazil – Has expressed interest
- China
- Denmark
- Italy – sending application letter
- New Zealand
- Poland – in process of becoming OECD member
- Portugal
- Switzerland

Milestones and Deliverables

Please see the Task proposal Table 1 for details

Communication Plan

- For efficient and detailed communication and to accelerate the development of region-specific technologies, Regional Coordinators have been selected from among the experts and will support the Operating Agent.
  - Europe – Peter Lindblad
  - The Americas – Patrick Hallenbeck
  - Asia – Jun Miyake