

# APEC

## Advanced Biohydrogen Newsletter



The food security, climate change, energy security and interlinked challenges for the APEC region.



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### Main Story

§ 39th APEC-ISTWG Meeting §  
20-22 September 2010  
THE WESTIN SENDAI, Sendai, Japan

#### Agenda

20TH September 2010 (MONDAY)

08:45~09:00	Meeting Registration (Host Economy)
09:00~09:10	Administrative Remarks (Host Economy & APEC Secretariat)
09:10~09:20	Adoption of Agenda for the Innovation Policy Forum & the 39th ISTWG Meeting (Lead Shepherd)

#### Innovation Policy Forum

Opening Session	
09:20~09:30	- Opening Remarks by Chair: Ms. Wan Zaharah Wan Mohamad*, Under Secretary, MOSTI, Malaysia (Lead Shepherd of ISTWG)
Presentation by guest speaker from OECD	
09:30~10:10	- Mr. Andrew Wyckoff*, Director, OECD Directorate for Science, Technology and Industry
Presentations on innovation policies of APEC economies	
10:10~15:40	- Overall innovation policy - Public-Private Partnership - Funding and financing policies for the promotion of R&D
15:40~16:10	Speeches from representative of private sector (P)

21TH SEPTEMBER 2010 (TUESDAY)

09:00~12:30	Visit to Tohoku University
12:30~14:00	Lunch hosted by the Japanese Government (METI)

21TH SEPTEMBER 2010 (TUESDAY) - CONTINUED

#### ISTWG Sub-Group Meeting

Subgroup A – “Human Resource Development”	
14:30~15:45	- 4th APEC Youth Science Festival (Thailand)
	- 2010 APEC R&D Management Training Program (Korea)
	- Enhancement of Interaction and Networking of IST Human Resources in the Region by Utilizing ICT (Japan)
	- APEC International Master’s Program: Policies for Technology Innovation and Entrepreneurship (Chile)
- S&T Mentoring Center for the Gifted in Science (Korea)	
Subgroup B – “International Science and technology Network” (Chinese Taipei)	
16:00~17:30	- APEC Network for Materials Evaluation Technology (Korea)
	- Linking Research and Innovation: Sharing Challenges, Policy Initiatives and Success Stories (New Zealand)
	- APEC ISTI Database (Japan)
	- APEC Research Network for Advanced Biohydrogen Technology (Phase I) (Chinese Taipei)
	- APEC Research Network: Convergence in Nano Science & Technology” (Japan/Korea)
- Benchmarking Research Integrity Policies and Management within APEC Economies (Australia)	

<b>Agenda</b>	<b>22 TH SEPTEMBER 2010 (WEDNSDAY)</b>
<b>ISTWG Sub-Group Meeting – Continued</b>	
<b>Subgroup C – “Innovation &amp; High Technology” (China)</b>	
<b>09:00~10:15</b>	- Establishing Academia-Industry Network to Develop Bio-energy and Conserve the Natural Ecosystem in APEC Economies (Korea)
	- APEC International Biogas Resources Development and Utilization Science and Technology Cooperation Forum (China)
	- Seminar on Satellite Data Application for REDD Project Support in APEC - Satellite Imagery Data Application to Resolve Climate Change Response Tasks by Monitoring Forest Cover Dynamics in the APEC Economies (Russia)
	- Innovation Technology of Helium Industrial Processing and its Influence on Economic Impacts of Helium Distribution under Regional Aspects in the APEC Zone (Russia)
	- APEC Capacity Building Seminar on Nutrigenomics Forum (Philippines)
<b>Subgroup D – “Sustainable Development &amp; Climate Change” (New Zealand)</b>	
<b>10:30~12:00</b>	- APEC Climate Center for Climate Information Services to Society (Korea)
	- APEC Symposium on Low-Carbon Technology and Industrial Cooperation (China)
	- Disaster Reduction Hyperbase-Asian Application (DRH-Asia) (Japan)
	- Research on the Futures of Low Carbon Society: Climate Change & Adaptation for Economies in APEC beyond 2050 (Thailand)
	- Initiative of APEC Center for Typhoon and Society (Chinese Taipei)
	- APEC Virtual Center for Environmental Technology Exchange (APEC-VC) (Japan)
	- Develop the Eco-Environmental Impact Assessment Estimating Tool (Chinese Taipei)
- Comparative Research on wastewater Treatment Technologies (China)	
<b>ISTWG Plenary Meeting</b>	
<b>Opening Remarks</b>	
<b>14:00~14:15</b>	- Election of Chair and Rapporteur (LS)
	- Endorsement of the 38th ISTWG Meeting Summary Record (LS)
<b>APEC Secretariat Report</b>	
<b>14:15~14:45</b>	- APEC Project Management
	• 3rd Approval Session
	• Project Monitoring & Completion Report Mechanism
- APEC Communication & Outreach Strategy	
<b>14:45~15:15</b>	<b>ISTWG Medium Term Work Plan</b>
	- Next ISTWG Meeting & APEC STMM Schedule (LS)
<b>Expected Outcomes and Deliverables for ISTWG 2010</b>	
<b>15:30~16:00</b>	- Expected ISTWG Outcomes and Deliverables in 2010 (Japan)
	- ISTWG LS’ Report to the APEC Senior Officials/Ministers in 2010 (LS)
<b>16:00~16:45</b>	<b>Side Meeting Reports</b>
	<b>16:45~17:00 Any Other Issues and End of Meeting</b>



Delegates of Chinese Taipei, Prof. Lin, Prof. Wu, Mr. Fu and Dr. Tsai (from left to right).



The progress report of APEC Research Network for Advanced Biohydrogen Technology (Phase I) presented by Prof. Wu (Feng Chia University).

## Research Report

### § Biohydrogen technology trend of patented inventions in the P.R.C., Japan, Korea, Europe and United States § Irina Lebedeva<sup>1</sup>, Cristian E. Olivo Quiroga<sup>1</sup> and Chen-Yeon Chu<sup>2</sup>

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The fast and complex industrial development of the world has for biohydrogen production. Patents considered in the lead to the extensive use of non-sustainable sources of energy present research were only those using non-genetically such as fossil fuel. Such anthropogenic development and modified bacteria, which can be found in natural impact on the environment has lead to a global climate change conditions.

which becomes visible by global temperature rising and the Classification came as follows:  
associated natural catastrophes (flood, etc.).

Such problematic situation turned into a driver for increase intense research into alternative energy sources generation and inventions patenting. Among possible routes, one attractive option is to use biological processes to produce biofuel, focusing more on biohydrogen gas, since its potentially higher efficiency of conversion to usable power, low to non-existent generation of pollutants and high energy density. Hence, biohydrogen became an attractive energy carrier.

There are three major categories of biological hydrogen production processes, which have experienced strong research along physico-chemical processes:

1. Biophotolysis of water, carried out through algae and cyanobacteria.
2. Photodecomposition of organic compounds, carried out through a photofermentation process by photosynthetic bacteria
3. Fermentation process of organic matter or waste.

So far low yields and production rates have been major barriers to commercial attempts of developed technologies for the application of biohydrogen. Different academic institutions along private companies develop constantly new hydrogen production methods and associated technologies, leading to novel or enhanced approaches to surpass existing prior art.

The present research's aim is to find the technology trend on biohydrogen production methods by analyzing all previous art on both physico-chemical and biological processes in different geographic regions and countries. A search of patented methods based on a series of keywords was carried out at the patent offices of the P.R.C., Japan, Korea, the European Union and the US. The time scope of the present search ranged from 01.01.2000 to 25.05.2010. All related patents within the time scope were selected and analysed.

#### Patent Analysis and Technology Trend

A total of 115 patents from the targeted countries and regions were selected and analyzed. Most of the contribution in the biohydrogen production came from the P.R.C. and Japan, showing the increasing demand of alternative non-fossil energy supply and growing interest for biofuel in those countries, with the subsequent future economic potential.

Methods found in the prior art were classified as belonging to biological and physico-chemical pre-treatment methods and to dark fermentation methods

1. Pre-treatment methods
  - Physico-chemical
  - Dry Anaerobic Fermentation
  - Bioreactor for environmental conditions adjustment
  - Enzymatic Method
  - Environmental Conditions Adjustment
  - Pretreatment and Fermentation cascade
  - Other methods (such as Zymohydrolysis)
2. Dark Fermentation
  - H<sub>2</sub> + renewable fuel production
  - Dark + Photo fermentation
  - H<sub>2</sub> and methane cascade
  - Microbial electrochemical cell
  - Bacteria Screening
  - Bioreactor and application in Fuel cell
  - Bioprocess or Bioreactor Design

Most prior art found belonged to pre-treatment methods (60 patents), of them only 13 patents belong to physico-chemical methods, being the rest are biological methods (see Fig. 1). The most abundant pre-treatment methods were of environmental conditions adjustment (28 patents). An important part of methods belonging to the dark fermentation (55 patents) belonged to bioprocess design in the form of bioreactors (23 patents) and to hydrogen and methane cascade (13 patents).

The biggest amount of prior art found for the most popular methods of pre-treatment of dark fermentation, was produced between 2005-2009 coinciding with the time of energetic crisis and the green movement for finding alternative fuels (see Fig. 2). Some methods such as hydrogen and methane cascade, or environmental conditions adjustment became more popular after 2005, while others remained equally used on time.

Prior art found showed a tendency of using organic waste, organic matter or waste water as main raw material for hydrogen production. This shows the enormous attempt to foster recycling and waste treatment. Only in few countries materials such as bran, cellulose and sludge are used as raw materials, being therefore valuable.

Most of the prior art found was reduced to a country level, and few were patented in several countries or regions at the same time. When comparing all patents found, we noticed that most European patents are limited to a country level, only companies from United States tended to patent in Europe and other countries, being therefore of long scope. Most Japanese and all Chinese patents showed the same tendency of Europeans, having therefore local scope.



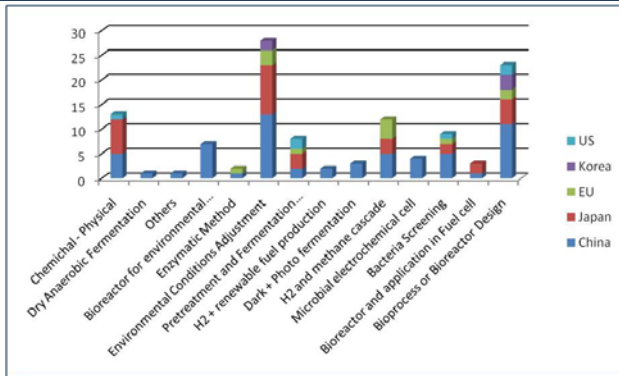


FIGURE 1. Number of patents found in the P.C.R., Japan, Korea, the European Union and US classified by production methods.

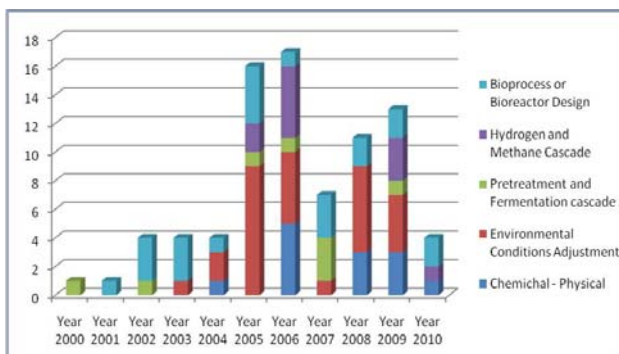


FIGURE 2. Number of patents granted per year of the most used hydrogen production methods (biological and physico-chemical).

The present findings show the strong need to foster academic cooperation between countries, which can allow both to improve the quality and potential of methods discovered and the number of patents of a given invention in more than one country. Further, this allows academic incubator centres to foster technology diffusion to the industry.

Even if non-green methods for producing hydrogen still being patented for pre-treatment raw material, biological processes have a specific advantage for the efficient conversion of organic matter with high moisture content to pure hydrogen. Besides that, fermentative processes require small on-site plant installations for economy of scale, which also allows a cost-effective conversion and to prevent loss of energy through transport. Several patents combine thermophilic fermentation with photofermentation in an attempt to enable the complete conversion of organic matter to hydrogen, in order to achieve a highest efficiency.

Interested customers in reducing energy costs and with growing energy needs may increase their product revenues by choosing green-low cost bio-energy supply. Further, there are no commercial and technical thresholds or barriers for commercialization of bio-energy such as biohydrogen. Future application of such technologies and demand of bio-energy production could lead to the development of new beneficial governmental energy policies with deep socio-economic impacts.

## Special Column

The 2010 APEC Advanced Biohydrogen Technology Conference with Short-term Training Course organized by FCU was from November 15th to 20th, 2010. Three joint events, the 2010 Asian biohydrogen symposium and Asia Bio-HyLinks (ABHL) and IAHE-Biohydrogen Division Business Meetings were also organized by Feng Chia University. Some of these events were financially supported by the Department of International Cooperation, National Science Council and Bureau of Energy, Ministry of Economic Affairs, Chinese Taipei.

These conferences focused on four major topics: (1) Biohydrogen Application, (2) Biohydrogen Process Design, (3) Biohydrogen Economic Analysis, (4) Molecular Biology of Biohydrogen Production.

In these conferences, a total of 120 papers from 23 countries was presented. In addition, we had invited 14 keynotes and 17 invited lectures in the conferences. High quality papers will be selected and published in this special issue of the International Journal of Hydrogen Energy after a regular peer-reviewed process. These conference activities and the publication of this special issue would not only promote the advances on biohydrogen technology, but also strengthen the friendship and partnership of biohydrogen researchers in Asia and in the rest of the world. Photos: APEC Advanced Biohydrogen Technology Conference, Short-term Training Course and some Keynote/ Invited speakers.

