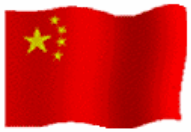
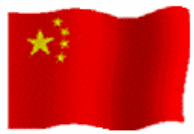


China's Activities Related to Hydrogen Development

Lun Jingguang

GEF-UNDP-CHINA
Demonstration for fuel cell bus commercialization in China
Project Management Office

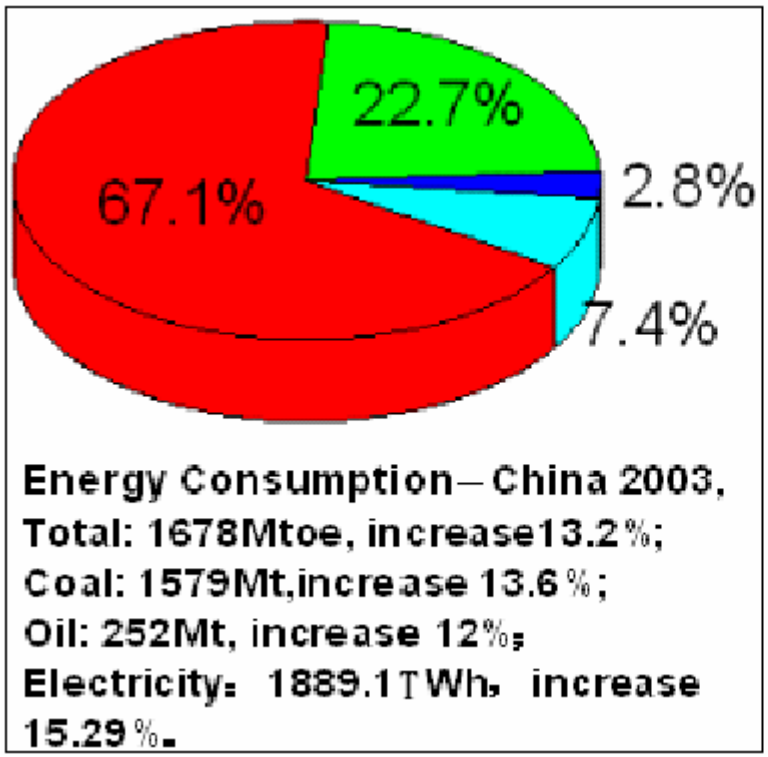
May 16, 2005 Honolulu



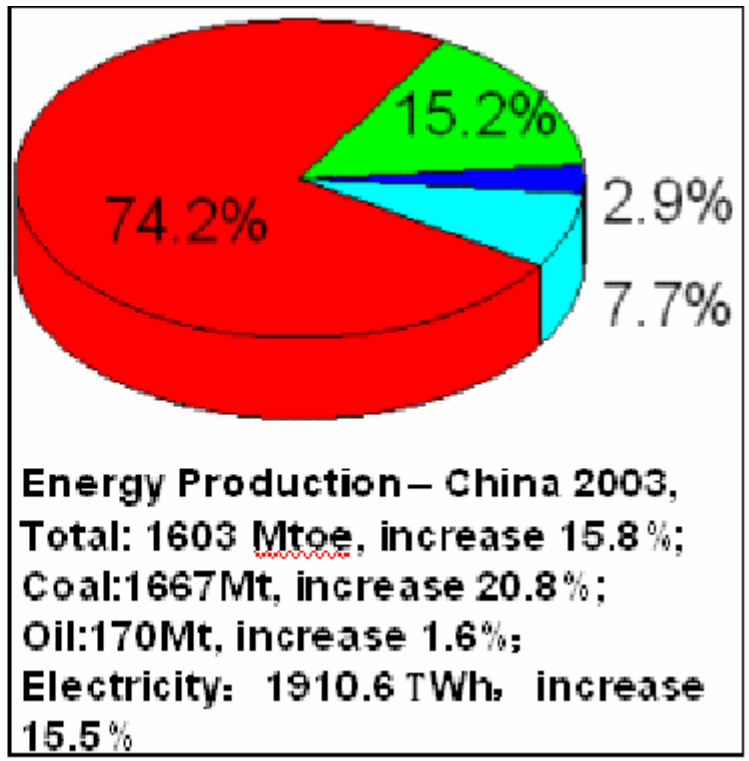
Outline

- Current status and prospect of China's energy system
- Challenges confronting China's energy system
- Hydrogen – an option for energy sustainable development
- Activities related to hydrogen development in China

Current Status of China's Energy System



Energy Consumption – China 2003,
Total: 1678Mtoe, increase13.2%;
Coal: 1579Mt,increase 13.6%;
Oil: 252Mt, increase 12%;
Electricity: 1889.1TWh, increase 15.29%.



Energy Production – China 2003,
Total: 1603 Mtoe, increase 15.8%;
Coal:1667Mt, increase 20.8%;
Oil:170Mt, increase 1.6%;
Electricity: 1910.6TWh, increase 15.5%

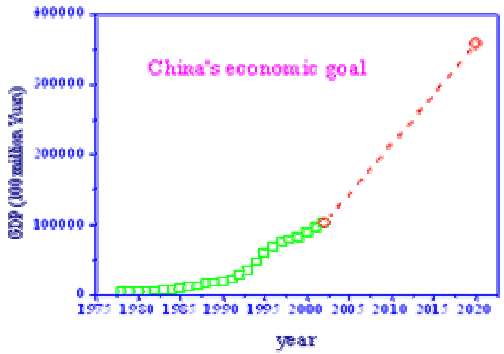
China's 2003 energy consumption accounts for 12.1% of that of the world, ranking second after the USA.

Coal
Oil
Natural Gas
Hydroelectricity

Prospect of China's Energy System

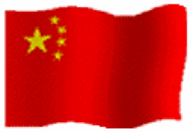
Gigantic demand corresponding to economy development

China will strive to quadruple its gross domestic product (GDP) of 2000 by the year 2020, energy demand will increase correspondingly.



It is predicted that by 2020, the total demand for primary energy will be among 2500-3300Mtce, within which:

Coal: 2100-2900Mton
Oil: 450-610Mton
Natural gas: 140-160 GNm^3
Power generation capacity: 860-950GW



Challenges Confronting China's Energy System

- High dependency on oil import threatens supply security
- Traditional utilization of coal leads to severe pollution
- Responsibility for alleviation of greenhouse gas emission
- Low energy efficiency and high energy-saving stress

Challenges Confronting China's Energy System

High oil import dependency threatens supply security

2004 Domestic production 175 mt, net import 117 mt
import dependency 40%

2010 160-200 mt, import dependency about 50%

2020 160-200 mt, import dependency about 60%

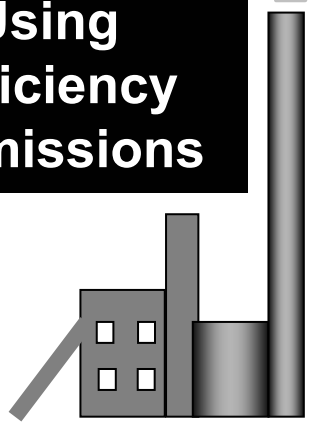
China's Main Sources of Oil Imports, 2003 (%)

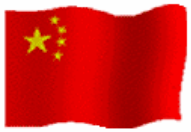
Challenges Confronting China's Energy System

Traditional utilization of coal leads to severe pollution

- Fly ash: 70%, $SO_{2:}$ 90%, $NO_{X:}$ 67%,
- SO_2 emission surpasses 20Mt, 1/3 land area is subjected to acid rain.

Large Quantity
Direct Using
Low Efficiency
High Emissions





Challenges Confronting China's Energy System

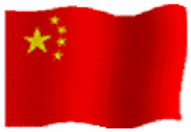
Responsibility for alleviation of greenhouse gas emission

China's per-capita carbon emission is still low, but the whole amount is large. With coal still the cornerstone of China's energy system, if without proper handling, the carbon emission amount is expected to increase rapidly

China has been positive in activities aiming at global greenhouse gas alleviation, measures including:

*Foundation of national coordination group for climate change (1990),
*Approval of the Kyoto Protocol (2002),

*Drafting of National Strategy for Climate Change (2005), et al.



Challenges Confronting China's Energy System

Low energy efficiency and high energy-saving stress

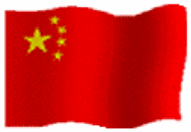
Energy efficiency in China is currently about 31.2%, ten point less than that of developed countries. Energy consumption per unit industrial product is 30% larger than that of developed countries.

China is facing international transferring of manufacturing industry, acceleration of urbanization process and another round of heavy chemical industry development. Dependence of economy development on energy is predicted to be heavier. It is challenging to achieve 2020 energy goal, that is, quadruple of GDP with doubled energy consumption.

Guideline for China's energy development

The Second Session of the 10th National People's Congress opened in the Great Hall of the People on Mar. 5, 2005, and Premier Wen Jiabao delivers the government work report.

China will depend primarily on domestic resources, and dramatically increase energy efficiency, to alleviate the conflict between energy and social-economical development. Both resources exploitation and energy saving will be addressed, with the later given top priority. New energy and renewable energy will be explored, as important elements for a cyclic economy. Energy-saving production and consumption manners will be advocated with great effort, to accelerate construction of a society featured with resources saving.



Energy Issues - Given Top Priority by the Government

"The Law for Renewable Energy" has been ratified and published. It will come into force on Jan.1, 2006. The implementation of the law is expected to boost the RD&D and commercialization of sustainable energy technologies.

In the about-to-end "Tenth Five-year Plan"(2001-2005), funding for energy research accounted for about 15% of total supporting effort for the national scientific R&D.

Key areas for innovation in energy sector

National Mid-to-long Term Sci-Tech Plan has been drafted and is being reviewed and revised, seven key areas were given in energy sector

- Technologies for energy saving and efficiency improvement;
- Reasonable, efficient, economic and clean utilization of coal;
- Technological supporting system for oil supply security;
- Advanced nuclear technologies;
- Advanced and reliable electricity transport and distribution system;
- Technologies for large-scale utilization of renewable energies;
- Hydrogen and fuel cell technologies.

Hydrogen

- An option for China's energy sustainable development

- ✓Multi-sources, possibility from renewable sources
- ✓Wide use: for vehicles, power station, portable, etc
- ✓Naturally clean emission, water, no poision
- ✓High efficiency
- ✓Greenhouse gas emission can be easily controlled during production
- ✓Affordable in the future

Transition to Hydrogen Economy - Vision

May 2004 Vision Meeting

A workshop for China's vision of hydrogen economy was held in May, 2004. More than 50 domestic senior executives from industry, government, environmental organizations, and research institutions. 9 experts from America participated in the Vision Meeting.

Transition to Hydrogen Economy - Roadmap

January 2005 Roadmap Meeting

A workshop for China's Roadmap hydrogen economy was held in January, 2005. More than 90 domestic senior executives from industry, government, environmental organizations, and research institutions participated the workshop.

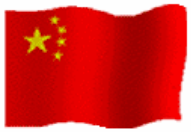
Transition to Hydrogen Economy - timetable

- By 2010 - Technology Development and small scale Demo
- By 2020 – Technology Development and bigger scale demo, preparing commercialization and planning
- By 2020-2050 - Market Penetration Phase: Electric power and transport market begin to develop and build infrastructure
- Beyond 2050 - Fully Developed Market and Infrastructure Phase: The hydrogen economy is realized.

Ongoing Projects Supported by the MOST

	2000	2001	2002	2003	2004	2005	2006	2007	2008
973	Fundamentals of Large-scale Production, Storage and Transportation of Hydrogen and the related Fuel Cells								
973				Basic Research of Hydrogen Production in Scale Using Solar Energy					
863		Post-Fossil Thematic Project on Hydrogen Technology							
863		Post-Fossil Thematic Project on High-Temperature Fuel Cell Technology							
863		Target-Oriented Key Project on Electric Automobile							
					Beijing Hydrogen Transportation Partnership and Demonstration Park				

During the past 5 years, funding for EV&H2/FC-related programs added up to 40% of total energy research budget.



Milestone of FCVs in China

100kW FC

70kW FC

30kW FC

5kW FC

1999 2001 2002 2004

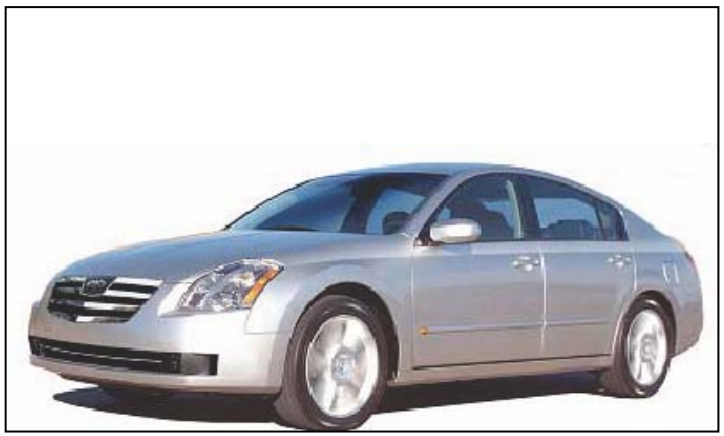
Fuel Cell Car—Chaoyue III in 2004

Fuel Cell Bus in 2004

Hybrid Car (Ice+Battery) in China

DFM hybrid car

Chana hybrid car



Chery hybrid car

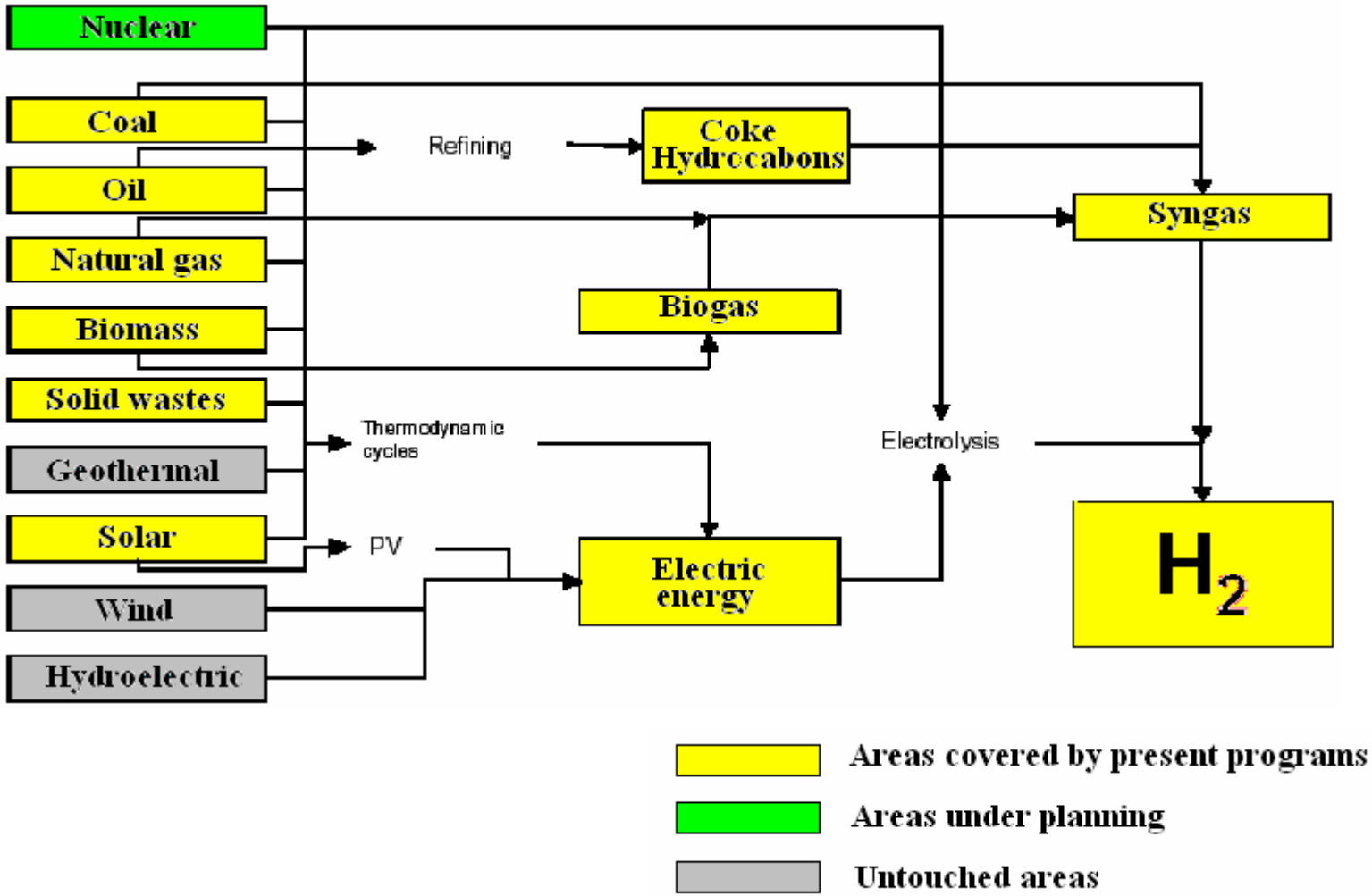
FAW hybrid car

Hybrid Bus (ICE+Battery) in China

FAW hybrid bus

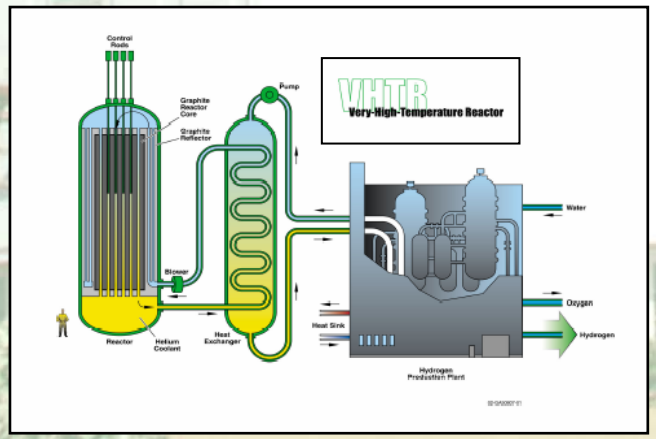
DFM hybrid bus

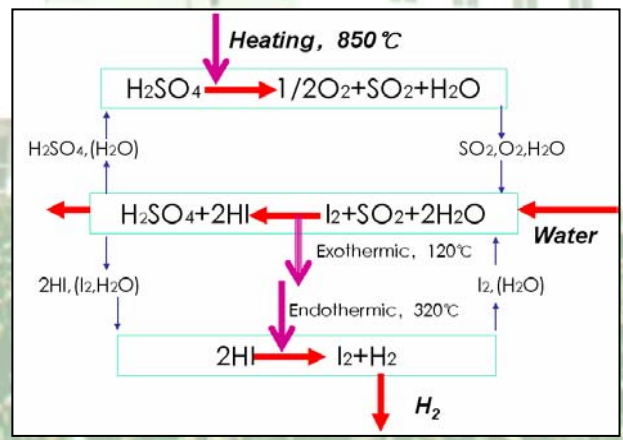
Hydrogen Production from Primary Energies



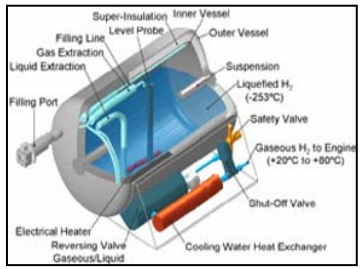
Hydrogen from Nuclear Energy

R&D Plan in initial period

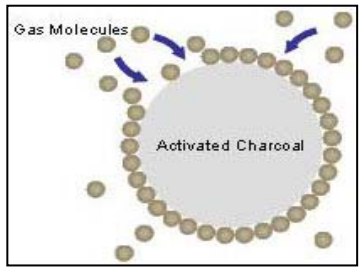




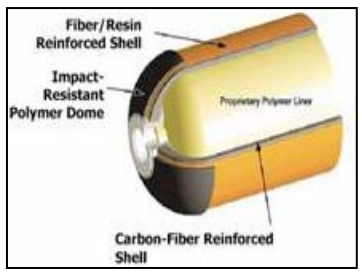
Key areas of Study on Hydrogen Storage



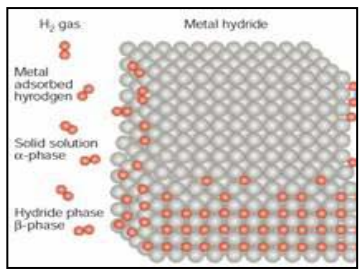
Hydrogen Liquefaction



Physical Adsorption

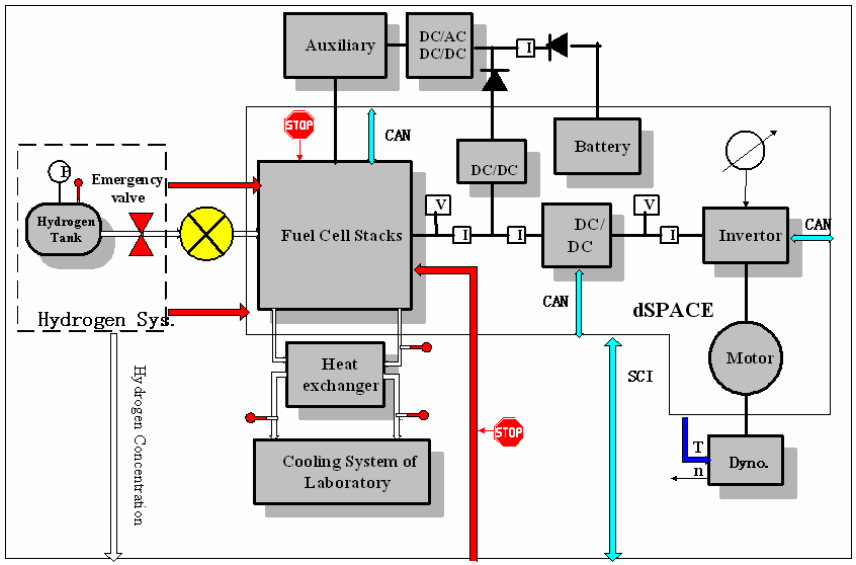


Compressed Hydrogen

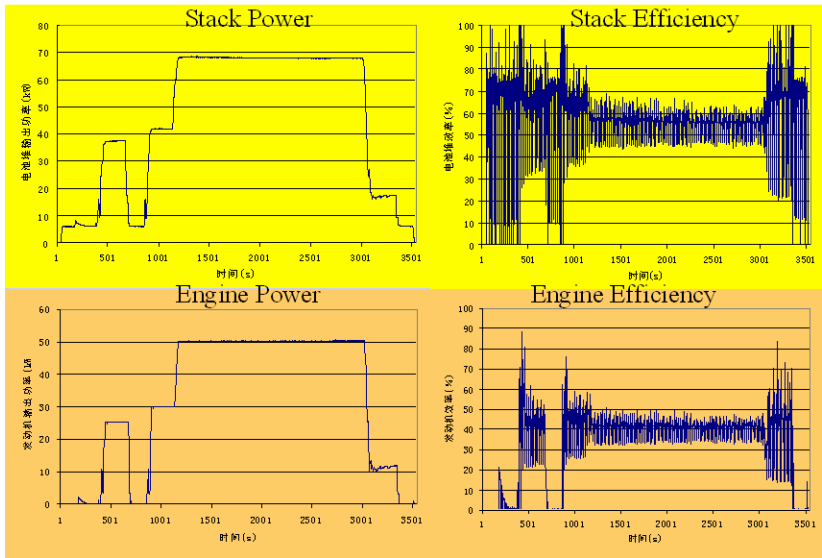


Chemical Absorption

Hydrogen Utilization— PEM-FC



Fuel Cell Engine Evaluation System



Fuel Cell Engine Testing Results

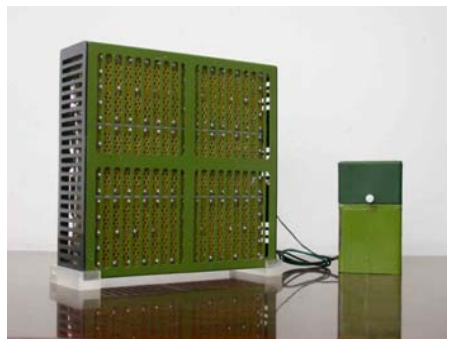
Hydrogen Utilization— DM-FC

Mobile phone

Due to its high energy density, DMFC has been considered as the most favorable portable power sources for mobile phone, PDA, notebook and other electronics. Significant progresses have acquired in China recently, and some of demonstrations are as follows:

PDA

Notebook



50 W DMFC system

Hydrogen Utilization— MC-FC

MCFC stack

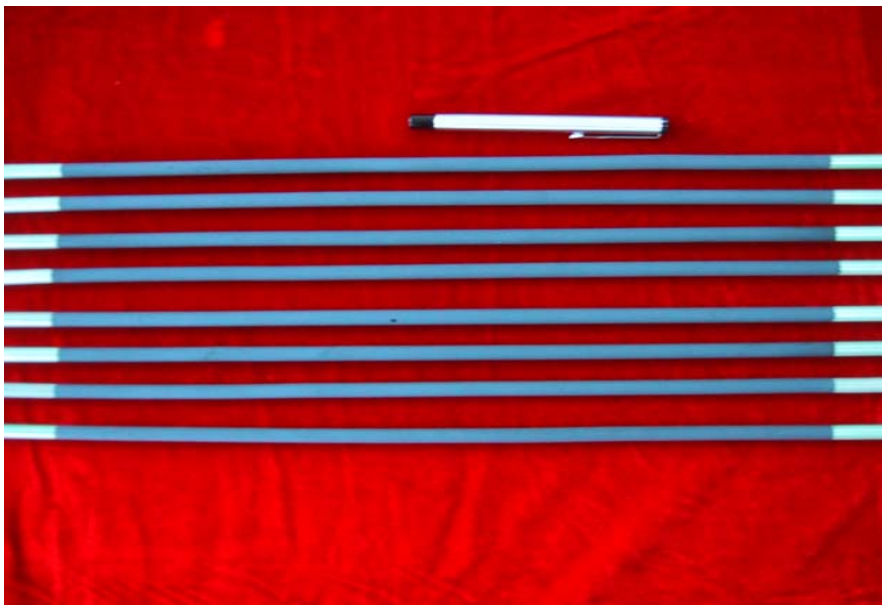
Molten carbonate fuel cells and solid oxide fuel cells can extract hydrogen from a variety of fuels including coal-based fuels. They can achieve an efficiency of 60% stand-alone, or over 80% (net) if the waste heat is used for cogeneration.

The following demonstrations were developed at Shanghai Jiao Tong University, China

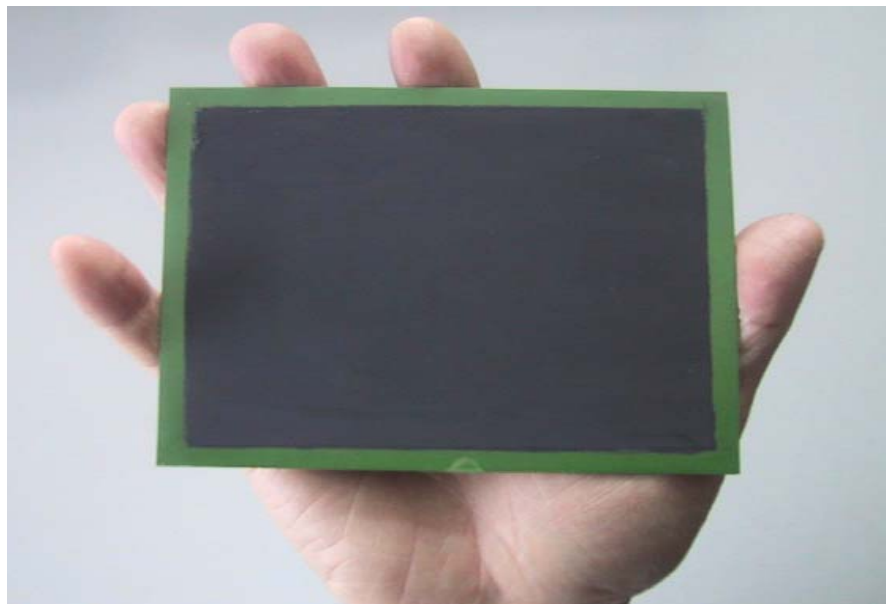
10-100 kW MCFC system

Hydrogen Utilization— SO-FC

Both tubular and planar type SOFC are being developed. The following key components showed a good performance, and the R&D plan is to set up several kilowatts tubular SOFC demonstration in the coming year.



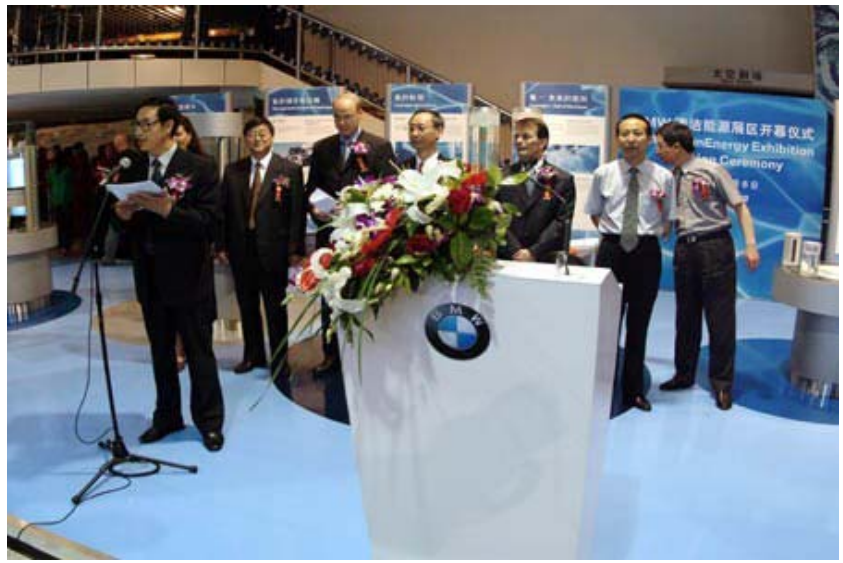
Tubular Cells
Length: 500 mm
Cell power: >25 W at 0.7V



Planar Cells
Effective area: 100 cm^2
Cell power: > 50 W at 0.7V

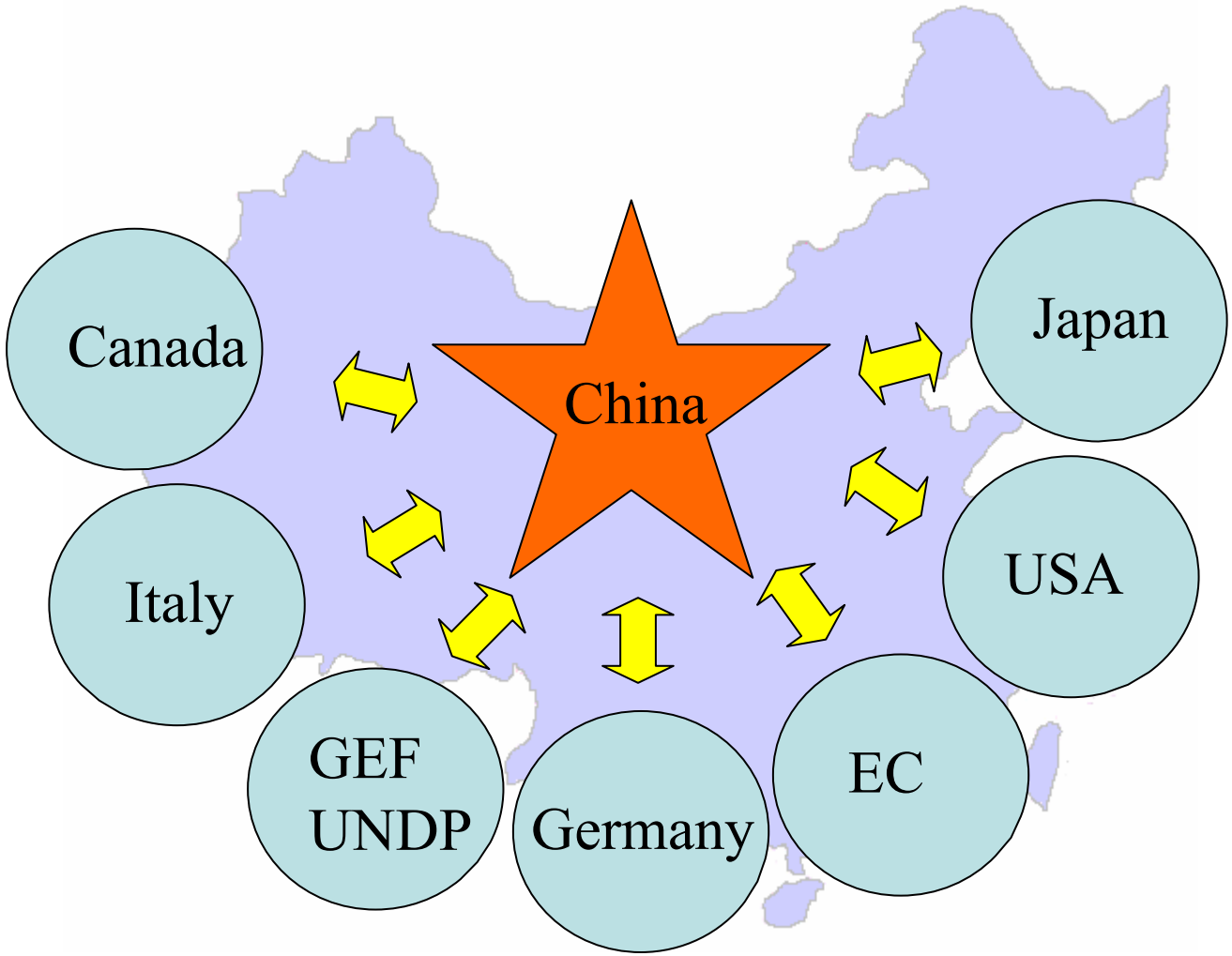
Public Educations on Hydrogen Energy

Monographs

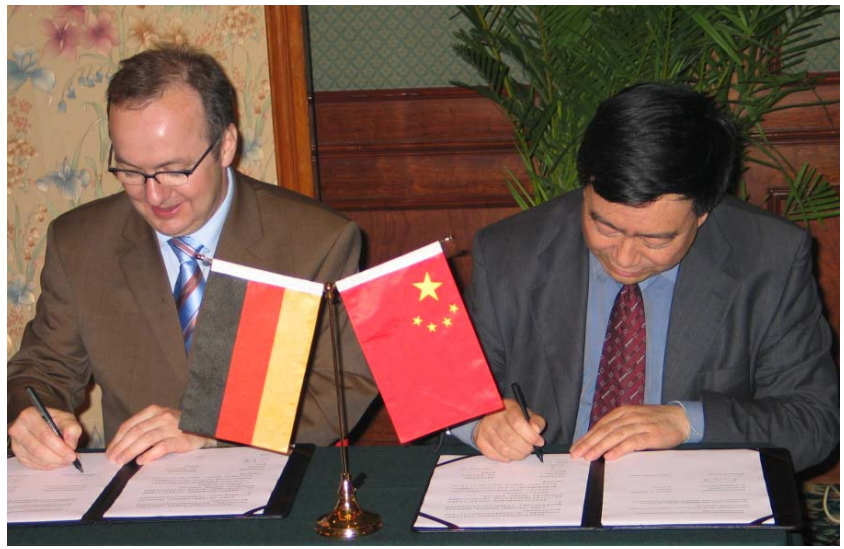


BMW Clean Energy Showcase opening ceremony in the China Science and Technology Museum, on June 6th, 2004.

Hydrogen-related International Cooperation

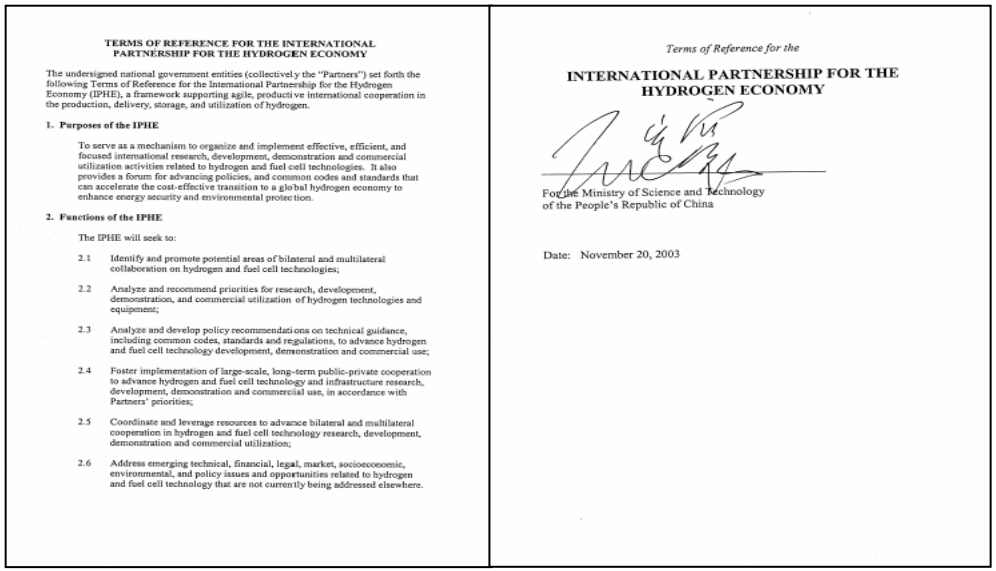


Sino-Germany Cooperation on Renewable Transport



The first working meeting of Steering Committee of "Sino-Germany cooperation on renewable transport energy" was held on May 24th, 2004. The meeting decided to carry out cooperative research on alternative transportation fuel in China, devised bilateral projects on production of different syn-fuels, and implemented first demonstration project aiming at fuel cell bus commercialization.

Hydrogen-related International Cooperation



TERMS OF REFERENCE FOR THE INTERNATIONAL PARTNERSHIP FOR THE HYDROGEN ECONOMY

The undersigned national government entities (collectively the "Partners") set forth the following Terms of Reference for the International Partnership for the Hydrogen Economy (IPHE), a framework supporting agile, productive international cooperation in the production, delivery, storage, and utilization of hydrogen.

1. **Purposes of the IPHE**

To serve as a mechanism to organize and implement effective, efficient, and focused international research, development, demonstration and commercial utilization activities related to hydrogen and fuel cell technologies. It also provides a forum for advancing policies, and common codes and standards that can accelerate the cost-effective transition to a global hydrogen economy to enhance energy security and environmental protection.

2. **Functions of the IPHE**

The IPHE will seek to:

2.1 Identify and promote potential areas of bilateral and multilateral collaboration on hydrogen and fuel cell technologies;

2.2 Analyze and recommend priorities for research, development, demonstration, and commercial utilization of hydrogen technologies and equipment;

2.3 Analyze and develop policy recommendations on technical guidance, including common codes, standards and regulations, to advance hydrogen and fuel cell technology development, demonstration and commercial use;

2.4 Foster implementation of large-scale, long-term public-private cooperation to advance hydrogen and fuel cell technology and infrastructure research, development, demonstration and commercial use, in accordance with Partners' priorities;

2.5 Coordinate and leverage resources to advance bilateral and multilateral cooperation in hydrogen and fuel cell technology research, development, demonstration and commercial utilization;

2.6 Address emerging technical, financial, legal, market, socioeconomic, environmental, and policy issues and opportunities related to hydrogen and fuel cell technology that are not currently being addressed elsewhere.

Terms of Reference for the

INTERNATIONAL PARTNERSHIP FOR THE HYDROGEN ECONOMY

For the Ministry of Science and Technology of the People's Republic of China

Date: November 20, 2003

To enforce international cooperation in hydrogen sector, the Ministry of Science and Technology signed the Terms of Reference, International Partnership for Hydrogen Economy (IPHE), in Washington DC in November 2003.

Hydrogen-related International Events

HYFORUM, May 2004, Beijing

More than 700 participants, including senior officials, investors, experts and entrepreneurs from all over the world gathered together to discuss technical and non-technical issues in transition to hydrogen economy. Totally more than 200 papers were received.

Hydrogen-related International Events

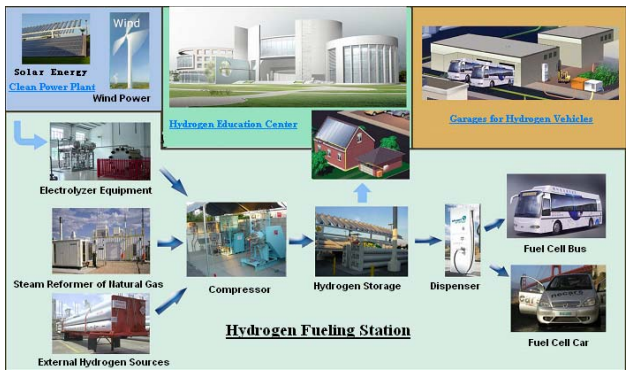
2nd IPHE SC Meeting, May 2004, Beijing

The second steering committee meeting of IPHE was held successfully in Beijing, leading to "Beijing Action Plan".

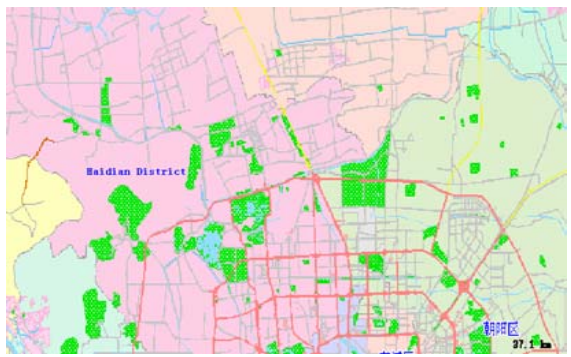
Hydrogen-related International Projects

The project "GEF/UNDP Demonstration for Fuel Cell Bus Commercialization in China" has just finished its first phase implementation, and now is at the beginning of second phase.

The project "Beijing Hydrogen Transportation Partnership and Demonstration Park" got approved in April 2004.



Scheme of the Hydrogen Park



Location of the Hydrogen Park

Thanks for your Attention