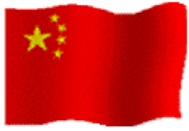


# China's Activities Related to Hydrogen Development

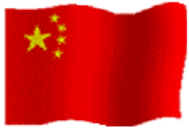
*SHI Dinghuan*

**Ministry of Science and Technology – China**

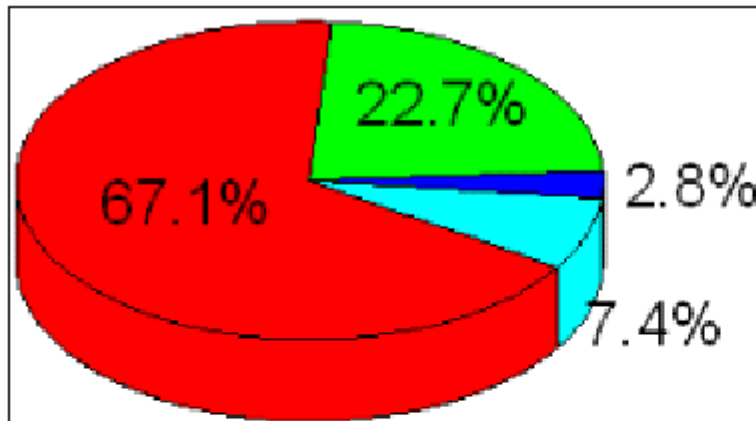


# Outline

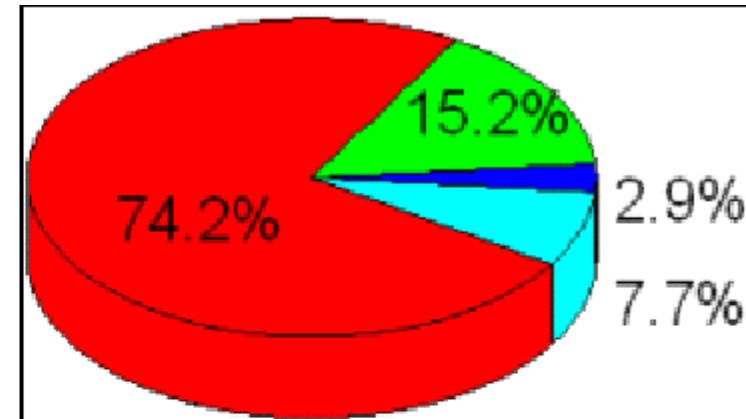
- **Current status and prospect of China's energy system**
- **Challenges confronting China's energy system**
- **Hydrogen – an option for energy sustainable development**
- **Activities related to hydrogen development in China**



## Current Status of China's Energy System

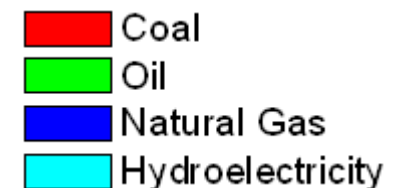


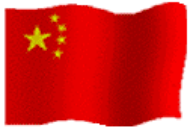
**Energy Consumption – China 2003,**  
**Total: 1678Mtoe, increase 13.2%;**  
**Coal: 1579Mt, increase 13.6%;**  
**Oil: 252Mt, increase 12%;**  
**Electricity: 1889.1TWh, increase 15.29%.**



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

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

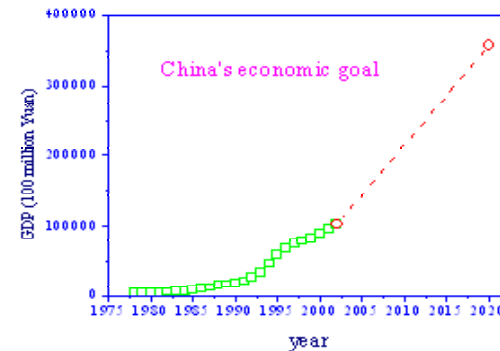




## Prospect of China's Energy System

### 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.



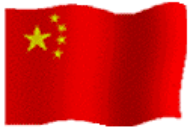
It is predicted that by 2020, the total demand for primary energy will be among 2500-3300Mtce, within which:

**Coal: 2100-2900Mton**

**Oil: 450-610Mton**

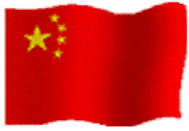
**Natural gas: 140-160 GNm<sup>3</sup>**

**Power generation capacity: 860-950GW**



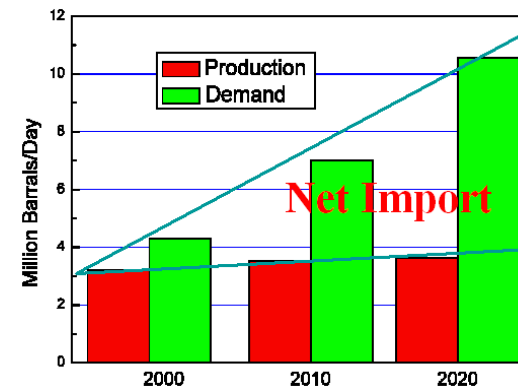
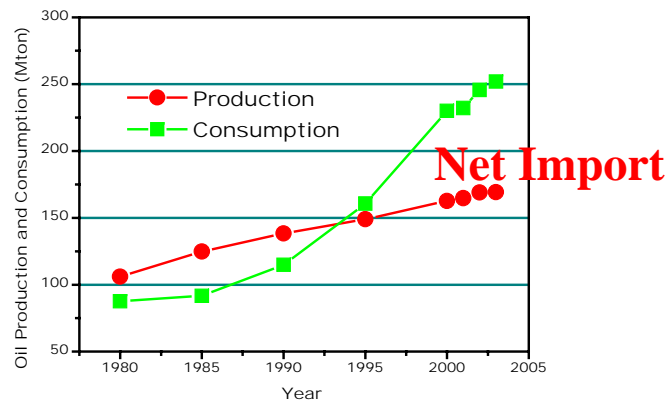
## Challenges Confronting China's Energy System

- **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**



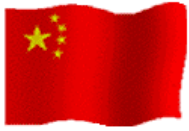
# Challenges Confronting China's Energy System

## High oil import dependency threatens supply security



Saudi Arabia	16.8
Iran	13.8
Angola	11.2
Oman	10.3
Yemen	7.7
Sudan	6.9
Russia	5.8
Congo	4.1

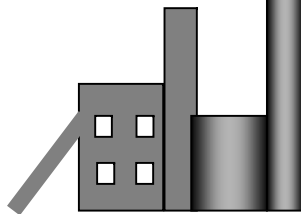
China's Main Sources of Oil Imports, 2003 (%)



# Challenges Confronting China's Energy System

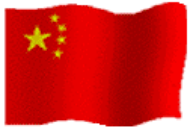
## Traditional utilization of coal leads to severe pollution

**Large Quantity  
Direct Using  
Low Efficiency  
High Emissions**



- Fly ash: 70%, SO<sub>2</sub>: 90%, NO<sub>x</sub>: 67%, acid rain: 82%
- SO<sub>2</sub> emission surpasses 20Mt, 1/3 land area is subjected to acid rain.



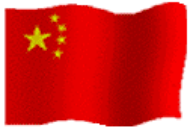


## Challenges Confronting China's Energy System

### **Responsibility for alleviation of greenhouse gas emission**

**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), participation in the Carbon Sequestration Leadership Forum (2003-2004), establishment of Provisional Management Method for CDM Project (2004), drafting of National Strategy for Climate Change (2005), et al.**

**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.**

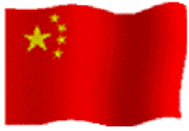


## Challenges Confronting China's Energy System

### **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, quadrupleness of GDP with doubled energy consumption.**

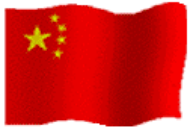


## Guideline for China's energy development



**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.**

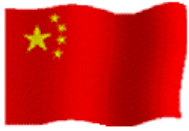
*China will depend primarily on domestic resources, and dramatically increase energy efficiency, to alleviate the conflict between energy and social-economical development. Both resources exploitation and energy saving will be addressed, with the later given top priority. New energy and renewable energy 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.**

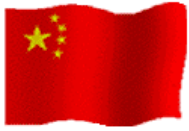
**In the about-to-end “Tenth Five-year Plan”(2001-2005), funding for energy research accounted for about 15% of total supporting effort for the national scientific R&D.**



## 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 top priority for innovation.**

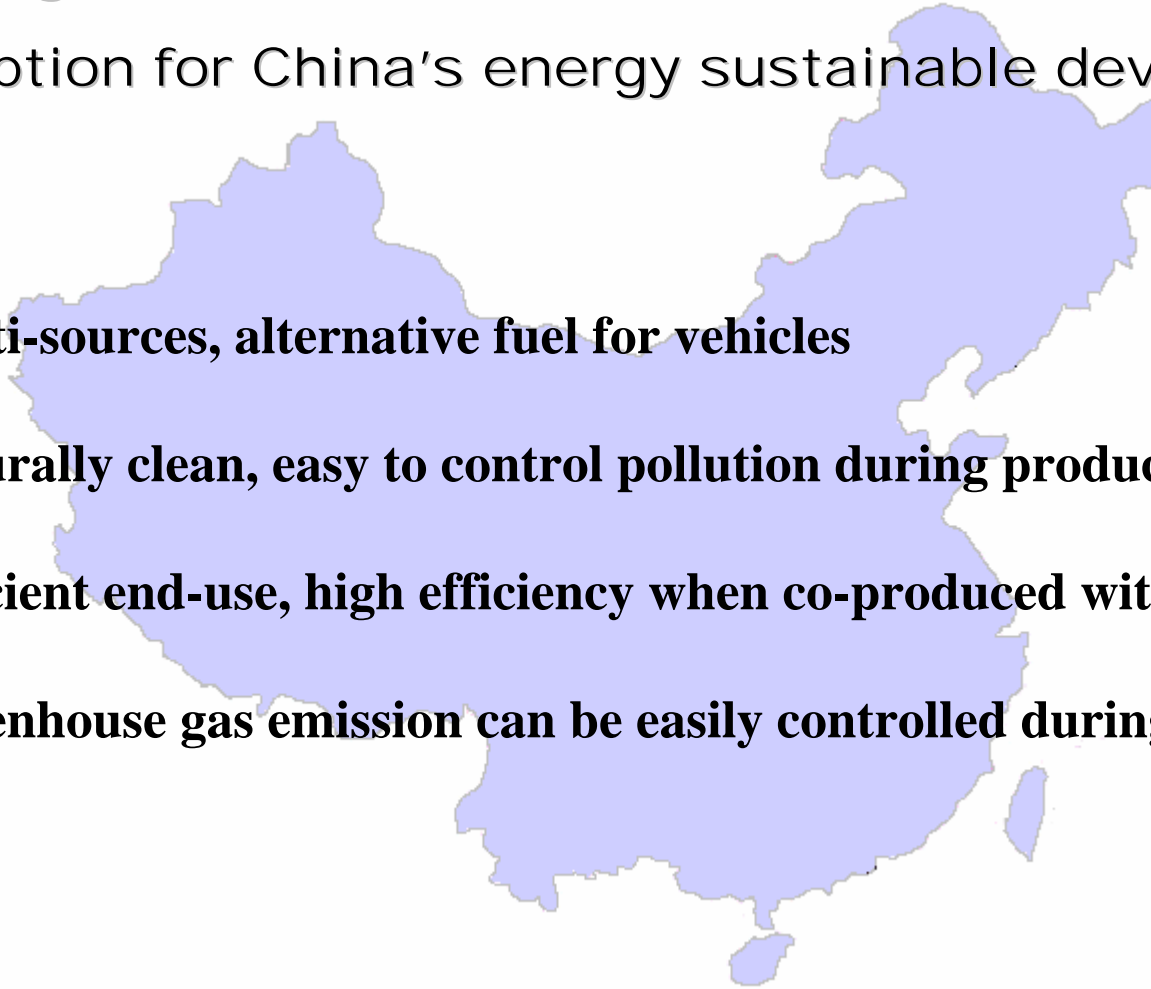
- **Technologies for energy saving and efficiency improvement;**
- **Reasonable, efficient, economic and clean utilization of coal;**
- **Technological supporting system for oil supply security;**
- **Advanced nuclear technologies;**
- **Advanced and reliable electricity transport and distribution system;**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

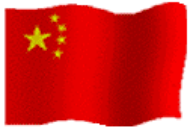


## Hydrogen

- An option for China's energy sustainable development

- ✓ **Multi-sources, alternative fuel for vehicles**
- ✓ **Naturally clean, easy to control pollution during production**
- ✓ **Efficient end-use, high efficiency when co-produced with power**
- ✓ **Greenhouse gas emission can be easily controlled during production**



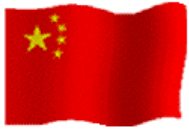


# Transition to Hydrogen Economy - Vision

## 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.**

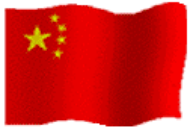


# Transition to Hydrogen Economy - Roadmap

## January 2005 Roadmap Meeting

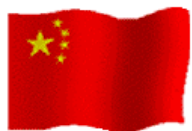


**A workshop for China's Roadmap hydrogen economy was held in January, 2005. More than 90 domestic senior executives from industry, government, environmental organizations, and research institutions participated the workshop.**









## Transition to Hydrogen Economy - timetable

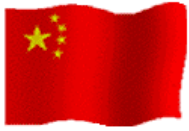
- **By 2020 - Technology Development Phase:** Research to meet customer requirements and establish business case lead to commercialization decision.
- **By 2050 - Market Penetration Phase:** Electric power and transport market begin to develop, infrastructure investment begins with government policies.
- **Beyond 2050 - Fully Developed Market and Infrastructure Phase:** The hydrogen economy is realized.



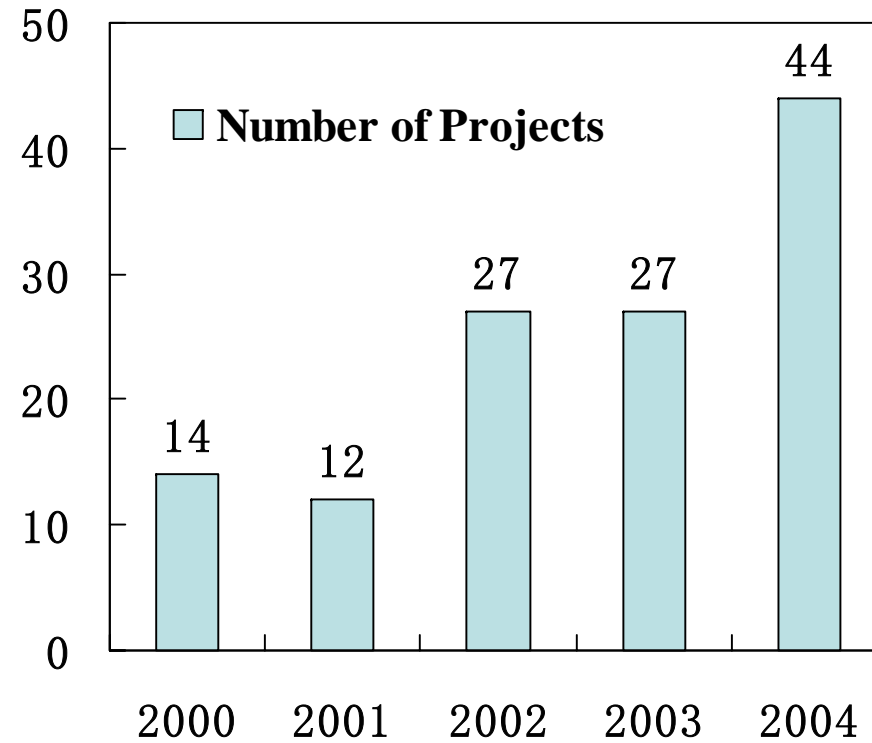
## Ongoing Projects Supported by the MOST

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

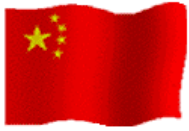
**During the past 5 years, funding for EV&H<sub>2</sub>/FC-related programs added up to 40% of total energy research budget.**



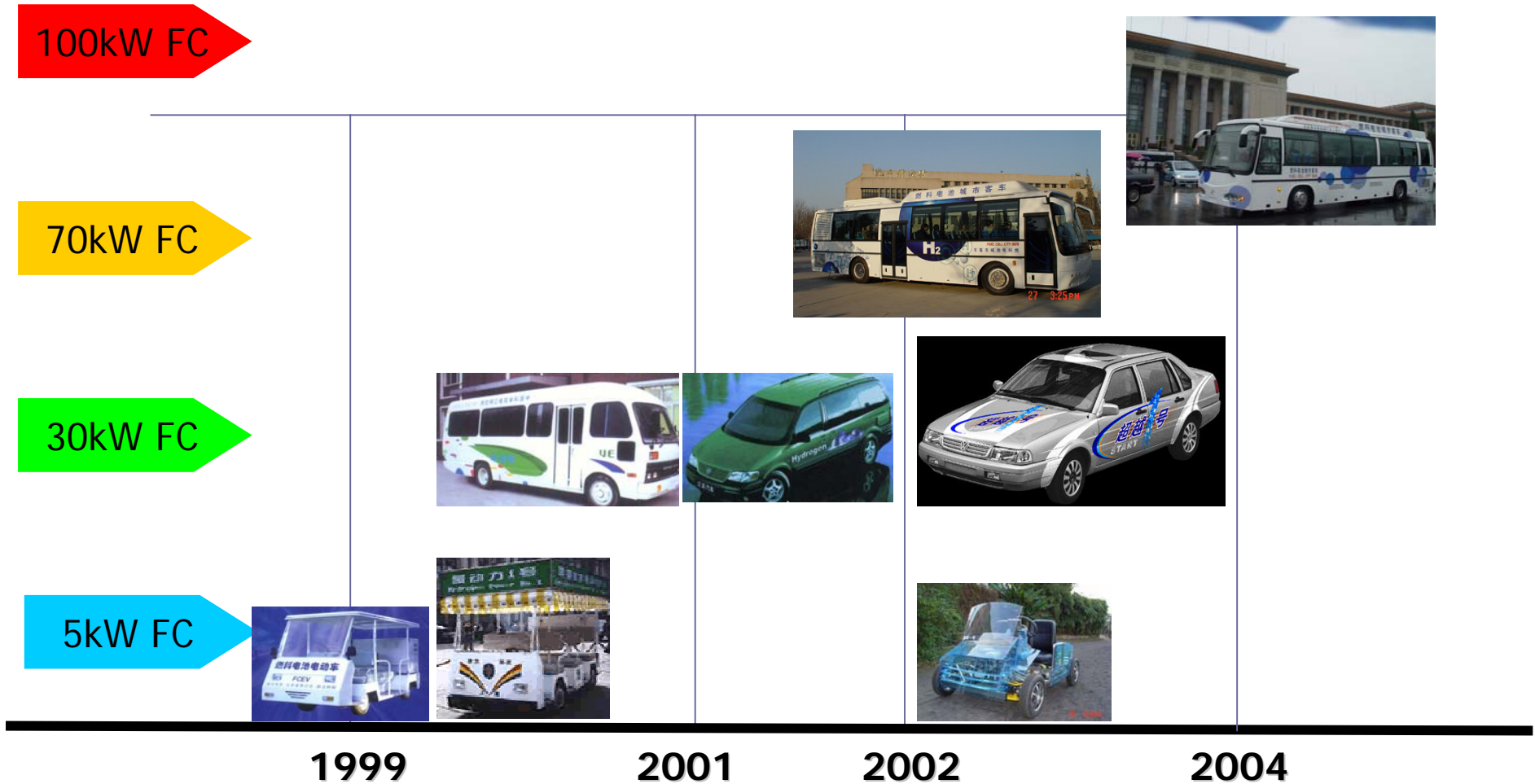
## Projects Supported by the NSFC

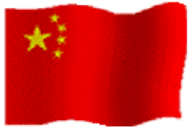


**Priority areas: Mechanism and materials in hydrogen storage, production and fuel cell.**



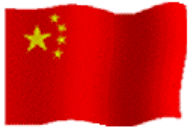
# Milestone of FCVs in China





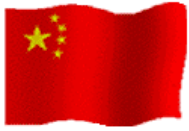
## Fuel Cell Car—Chaoyue III





# Fuel Cell Bus





## Hybrid Car



DFM hybrid car



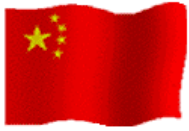
Chana hybrid car



Chery hybrid car



FAW hybrid car



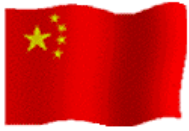
## Hybrid Bus



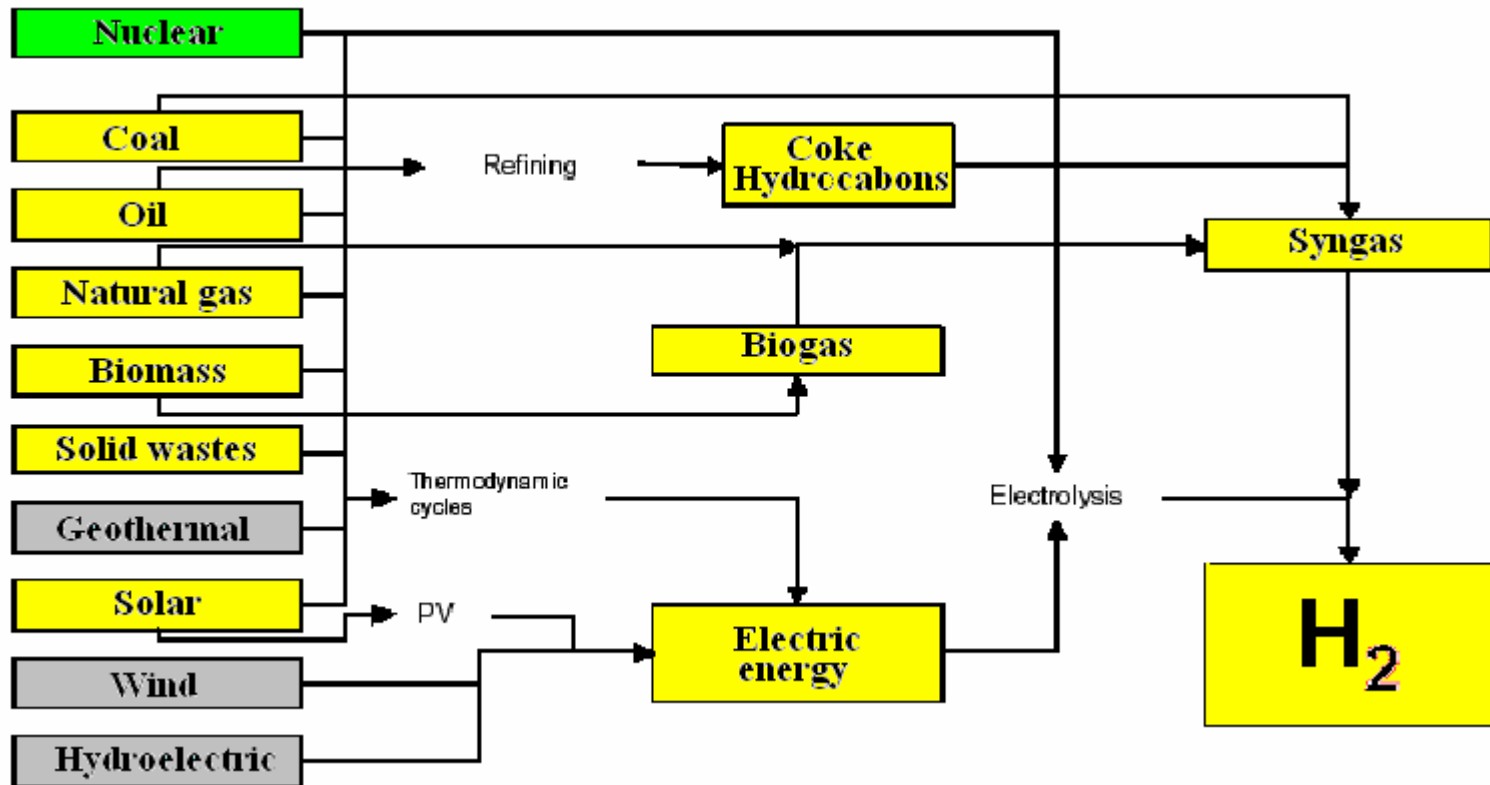
FAW hybrid bus






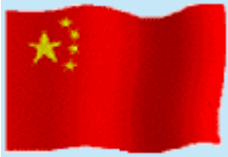
DFM hybrid bus



# Hydrogen Production from Primary Energies



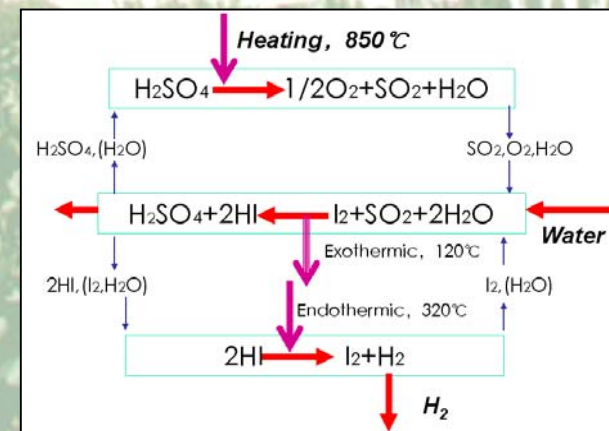
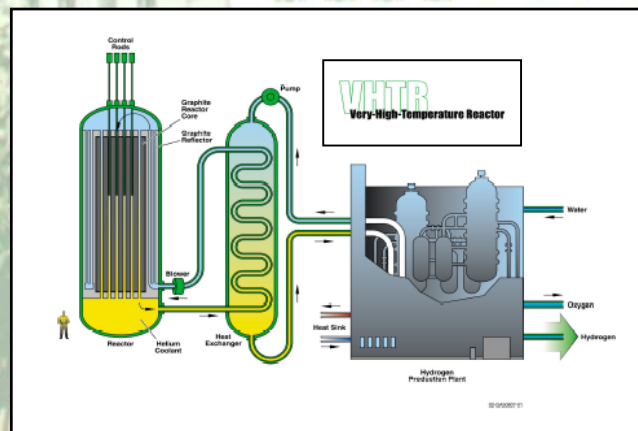
-  Areas covered by present programs
-  Areas under planning
-  Untouched areas

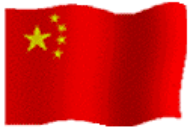


# Hydrogen from Nuclear Energy

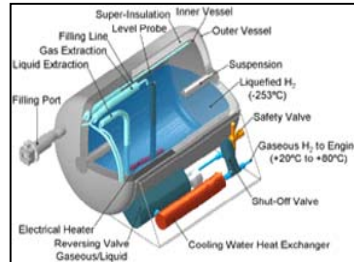
## R&D Plan

- **Phase I (~2006) : Establish a laboratory-scale thermo-chemical water-splitting hydrogen production cycle system (nL/h); demonstrate the feasibility of the process.**
- **Phase II (~2010) : Establishment of a bench-scale (1m<sup>3</sup>/h)hydrogen production system**
- **Phase III (-2015): Establishment of a out-of-pile pilot demonstration plant (km<sup>3</sup>/h )**

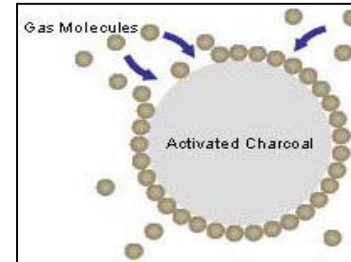




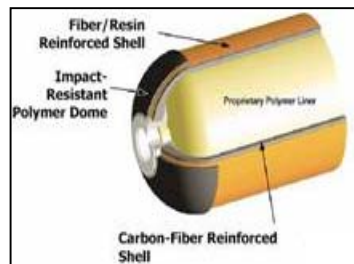
# Key areas of Study on Hydrogen Storage



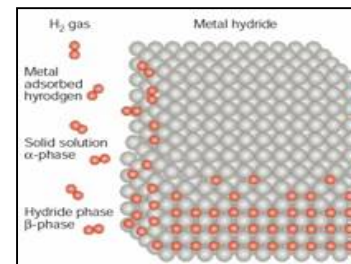
Hydrogen Liquefaction



Physical Adsorption

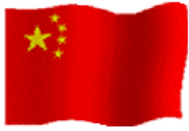


Compressed Hydrogen



Chemical Absorption





## 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**

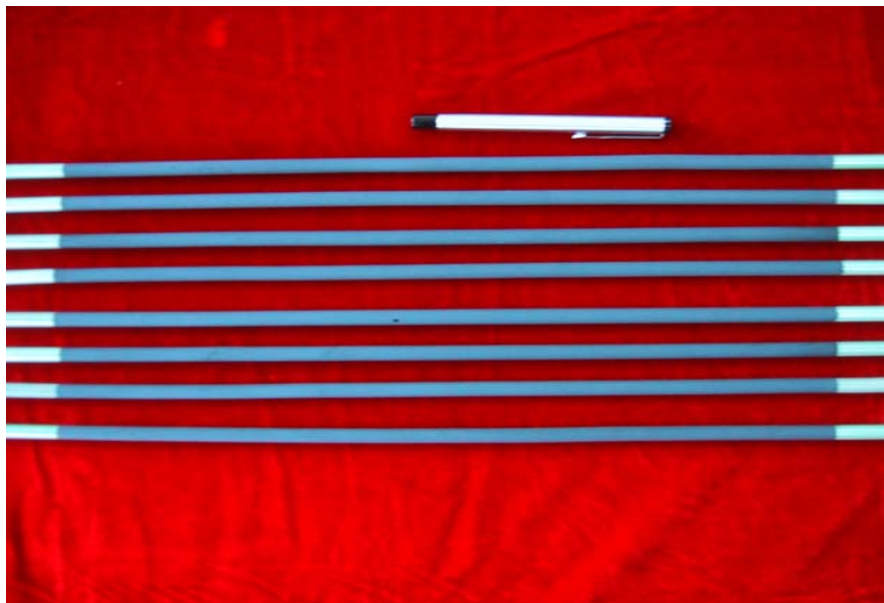


10-100 kW MCFC system



## 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<sup>2</sup>  
Cell power: > 50 W at 0.7V



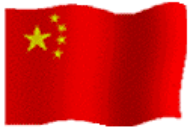
# Public Educations on Hydrogen Energy



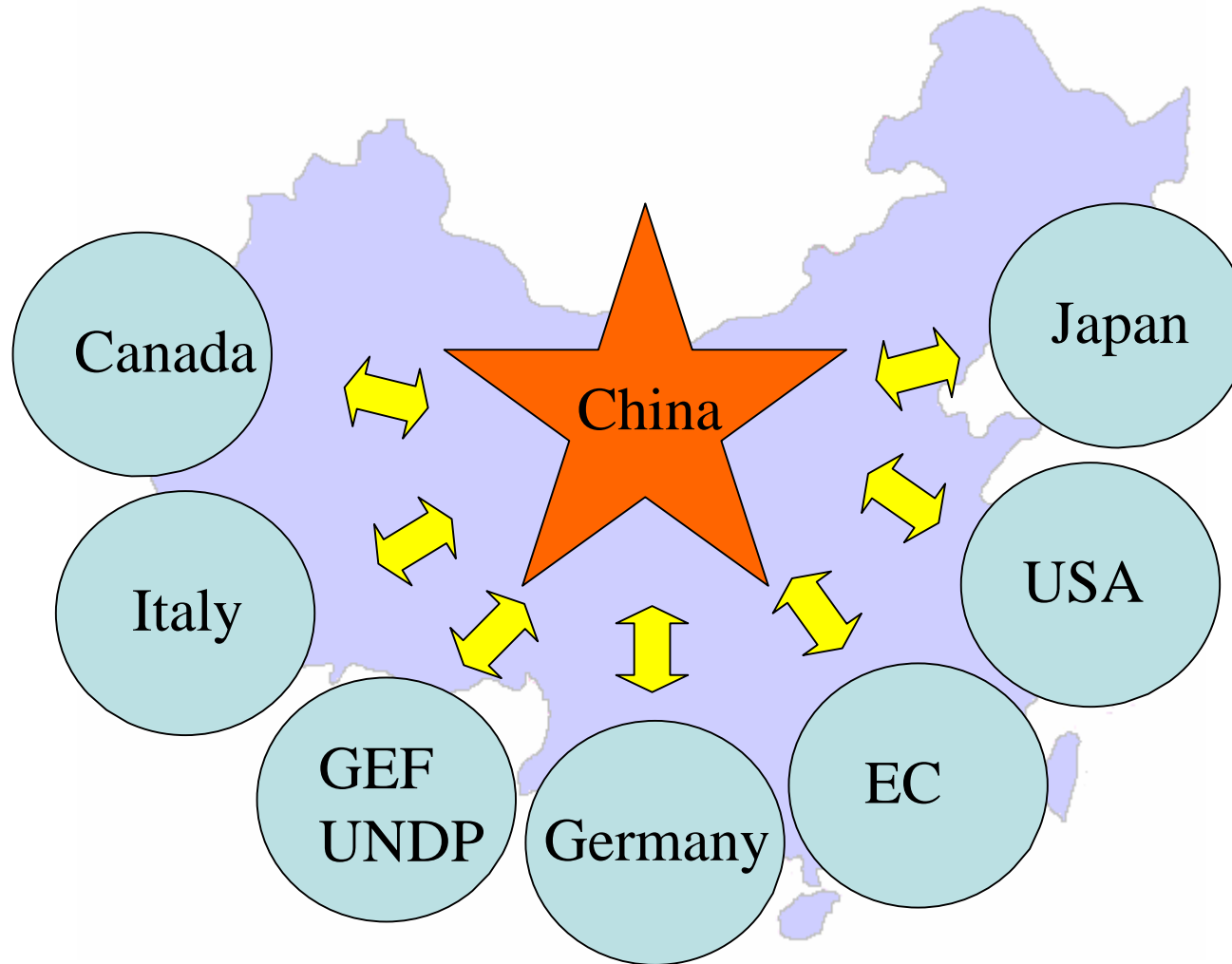
**Monographs**



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

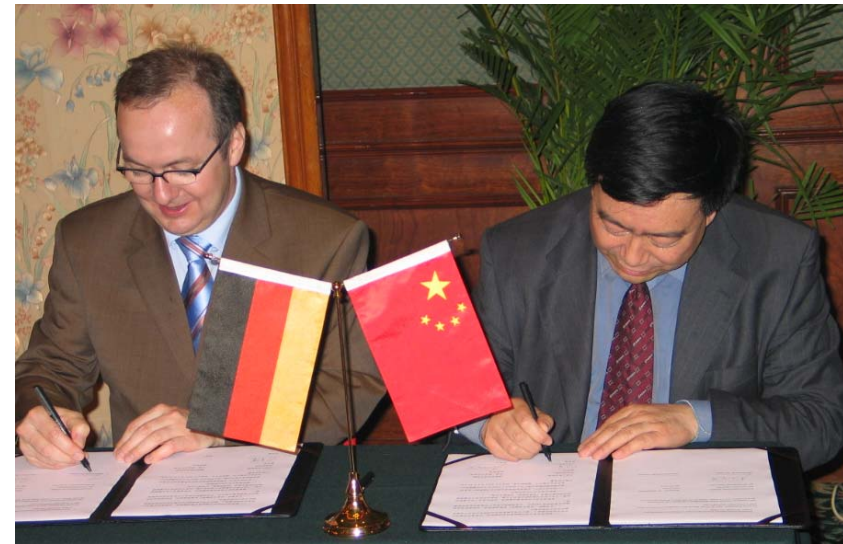


# Hydrogen-related International Cooperation

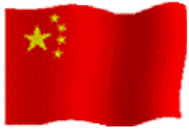





## Sino-Germany Cooperation on Renewable Transport



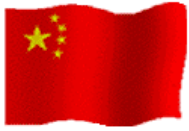
**The first working meeting of Steering Committee of “Sino-Germany cooperation on renewable transport energy” was held on May 24th, 2004. The meeting decided to carry out cooperative research on alternative transportation fuel in China, devised bilateral projects on production of different syn-fuels,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



# Hydrogen-related International Cooperation

<p style="text-align: center;"><b>TERMS OF REFERENCE FOR THE INTERNATIONAL PARTNERSHIP FOR THE HYDROGEN ECONOMY</b></p> <p>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.</p> <p><b>1. Purposes of the IPHE</b></p> <p>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.</p> <p><b>2. Functions of the IPHE</b></p> <p>The IPHE will seek to:</p> <ol style="list-style-type: none"><li>2.1 Identify and promote potential areas of bilateral and multilateral collaboration on hydrogen and fuel cell technologies;</li><li>2.2 Analyze and recommend priorities for research, development, demonstration, and commercial utilization of hydrogen technologies and equipment;</li><li>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;</li><li>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;</li><li>2.5 Coordinate and leverage resources to advance bilateral and multilateral cooperation in hydrogen and fuel cell technology research, development, demonstration and commercial utilization;</li><li>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.</li></ol>	<p style="text-align: center;"><i>Terms of Reference for the</i></p> <p style="text-align: center;"><b>INTERNATIONAL PARTNERSHIP FOR THE HYDROGEN ECONOMY</b></p> <p style="text-align: center;"> For the Ministry of Science and Technology of the People's Republic of China</p> <p style="text-align: center;">Date: November 20, 2003</p>
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**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.**

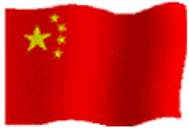


# Hydrogen-related International Events

## 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.**



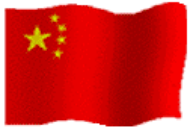
# Hydrogen-related International Events

## 2nd IPHE SC Meeting, May 2004, Beijing



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





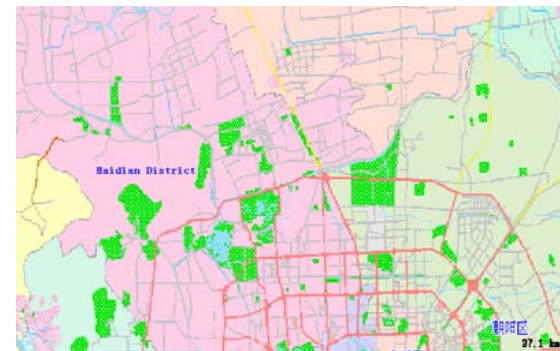
## Hydrogen-related International Projects

**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

An aerial photograph of a mountainous region. A winding road or path is visible, leading up a hillside. In the foreground, there is a large, multi-story building with a complex roof structure, possibly a traditional or historical structure. The terrain is rugged and mountainous, with some snow or light-colored patches on the slopes. The overall scene is a scenic view of a mountainous area.

Thanks for your Attention