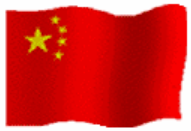


# China's Activities Related to Hydrogen Development


***Dinghuan SHI***

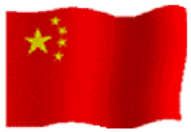
**Ministry of Science and Technology – China**


**IPHE – Steering Committee Meeting**
**Paris, France**
**January, 2005**

# China's Vision for Hydrogen Economy

## Transition to Hydrogen Economy

- **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.



# China Has Set $H_2$/FC as Technology Development Priority

**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.**

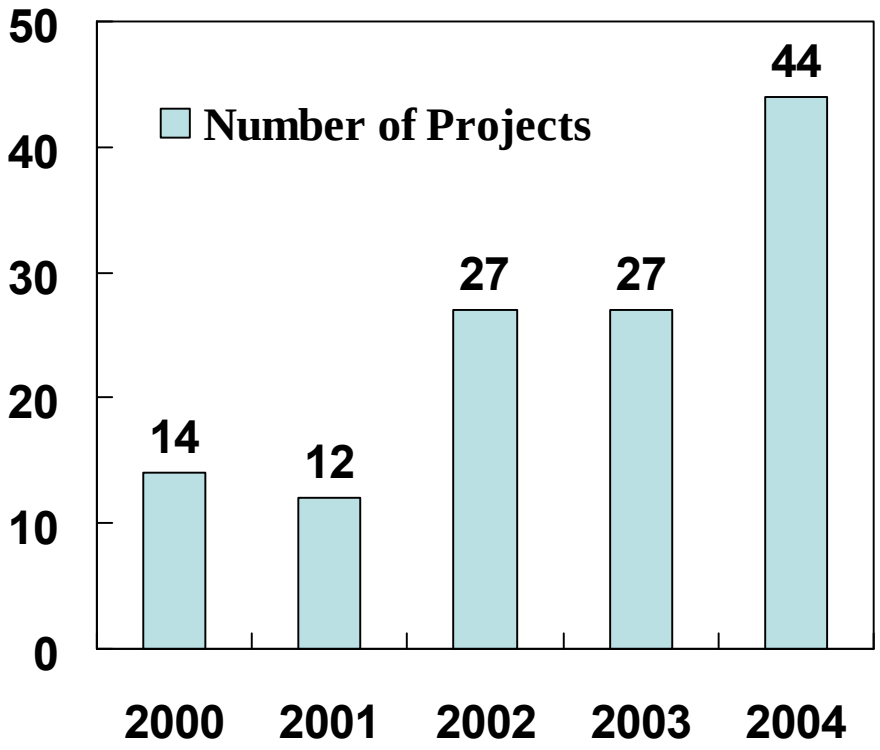
**Funding for EV&$H_2$/FC-related programs added up to 40% of total energy research budget.**

**Main focus includes both basic and technological aspects of fuel cell, hydrogen storage and generation.**

# $H_2$/FC-related Basic Research in 973 Program

- **Fundamentals of Large-scale Production, Storage and Transportation of hydrogen and the related Fuel Cells**
  - **2000-2005, 30million RMB**
- **Basic Research of Hydrogen Production in Scale Using Solar Energy**
  - **2003-2008, 22million RMB**

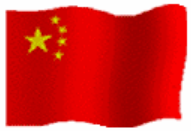
# Projects Supported by the NSFC




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

# 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 | | | | |



# China set highest priority on energy issues in the coming decades

**Energy and resources has been integrated into China's "Mid-to-long Term Sci-Tech Plan" as a premium topic, in which hydrogen and fuel cell is set as an area of priority;**

**"The Law for Renewable Energy" has been drafted and is being reviewed. The ratification and implementation of the law is expected to boost the RD&D and commercialization of hydrogen and renewable energy.**

# Milestone of FCVs in China

100kW FC

70kW FC

30kW FC

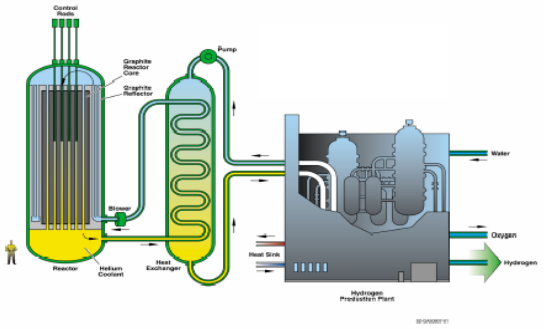
5kW FC

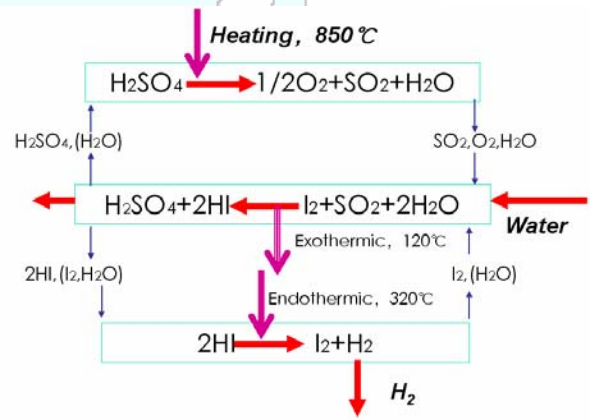
1999 2001 2002 2004

# Hydrogen from Nuclear Energy

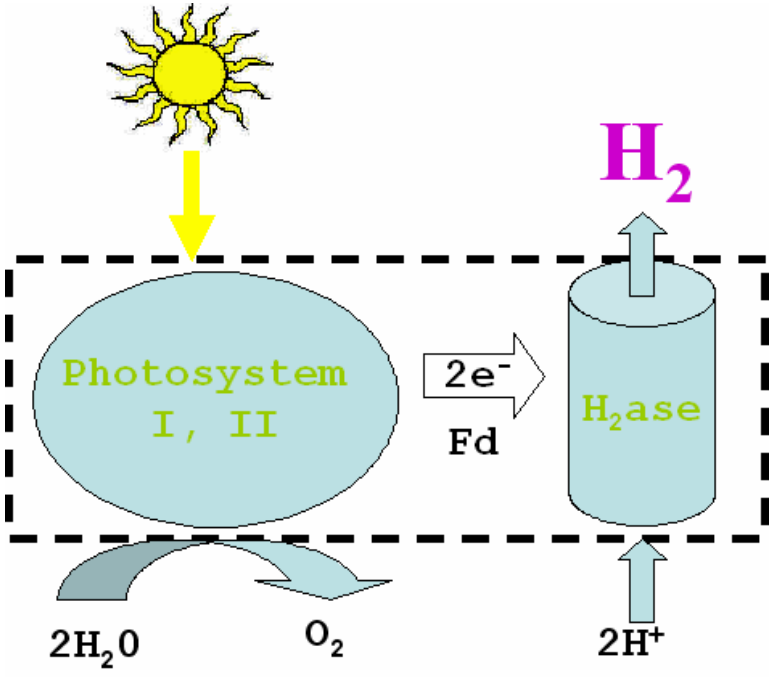
## *R&D Plan*

- **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$^3$/h)hydrogen production system**
- **Phase III (-2015): Establishment of a out-of-pile pilot demonstration plant (km$^3$/h□**

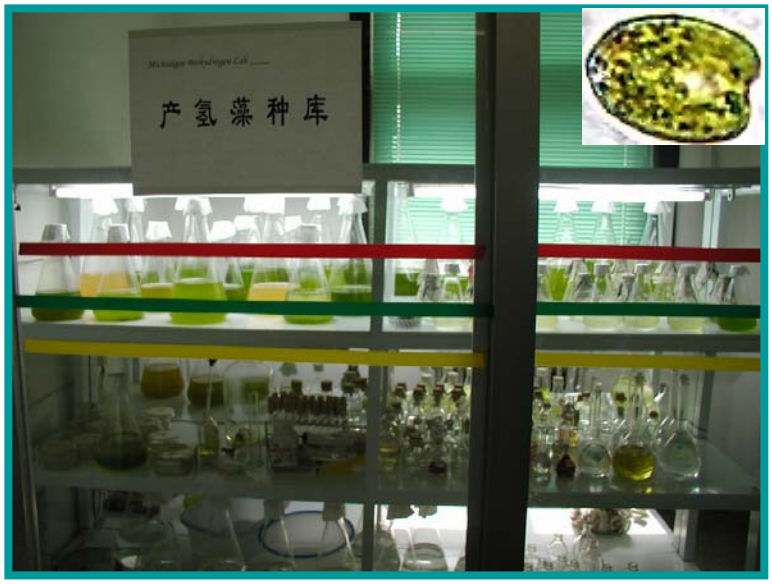


# Achievements in Hydrogen Production

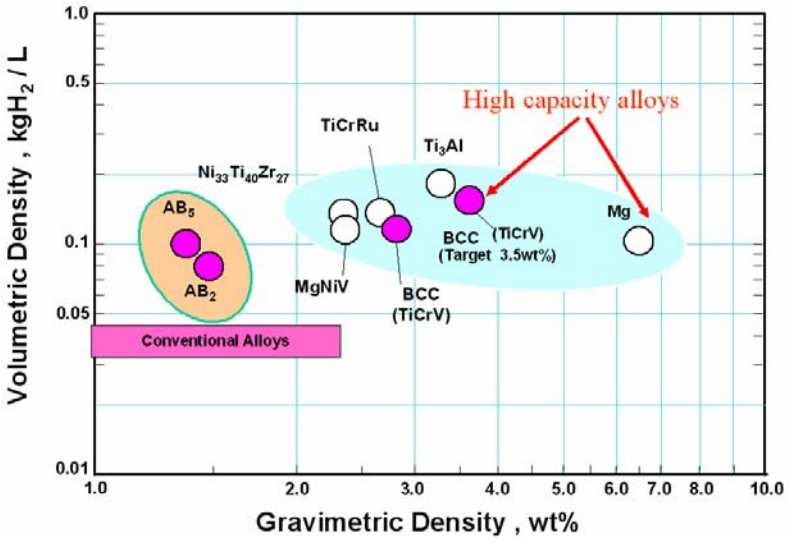



Photobiological Hydrogen Production




Marine Green Algae Bank

# Hydrogen Storage




## Characteristics of Mg Alloy

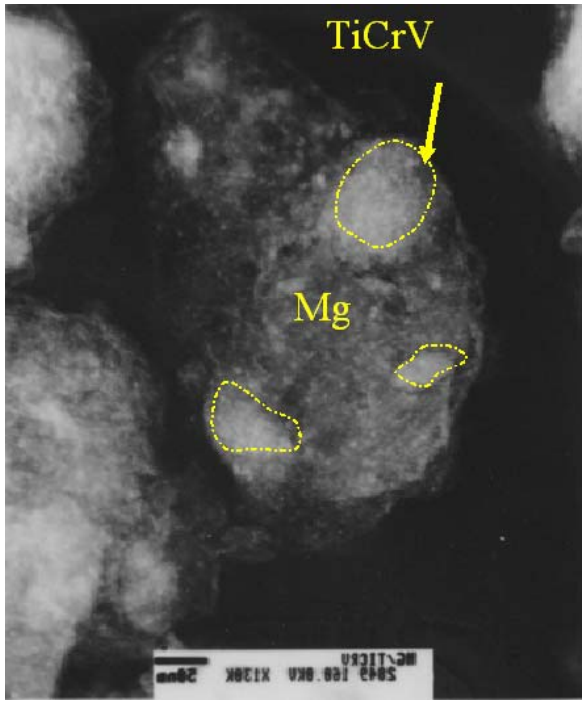
- High Storage Capacity (Maximum□□7.6wt%)
- lower sorption kinetic
- high reaction temperature

## Characteristics of BCC (TiCrV)

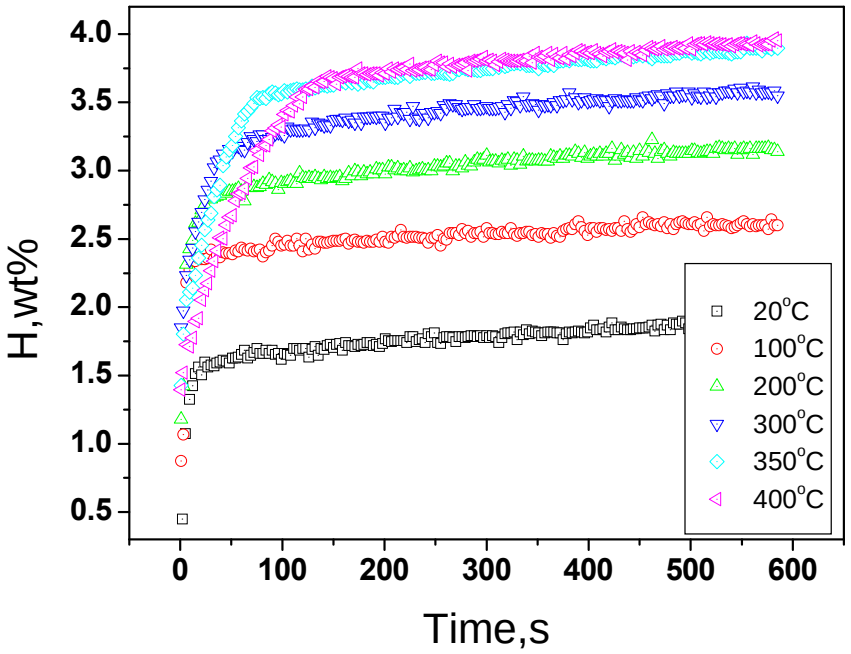
- Favorable Sorption Kinetic
- Lower Reaction Temperature
- relatively low storage capacity (Maximum: □□4.0wt%)

**INNOVATION: Mechanical Alloying for Synergy**

# Hydrogen Storage

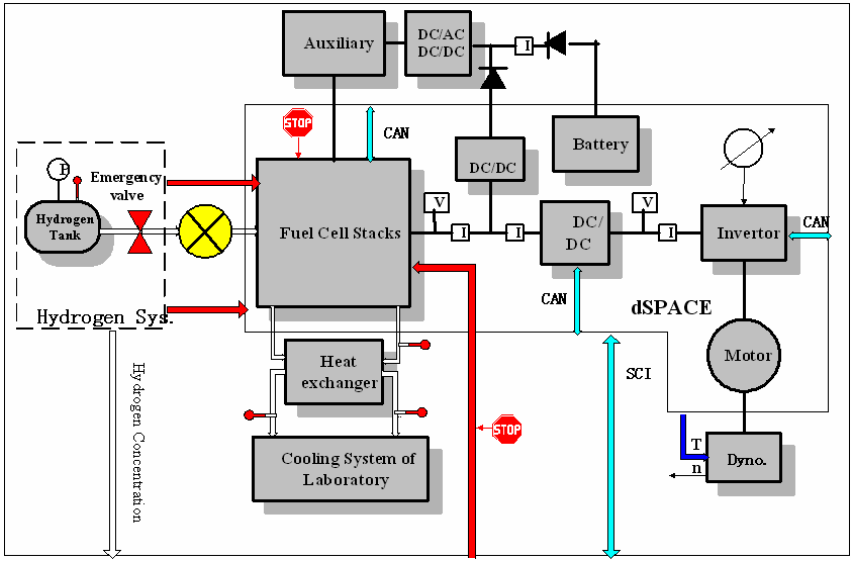



TEM micrograph for Mg/TiCrV (6:4wt%) nano-composite after mechanical alloying

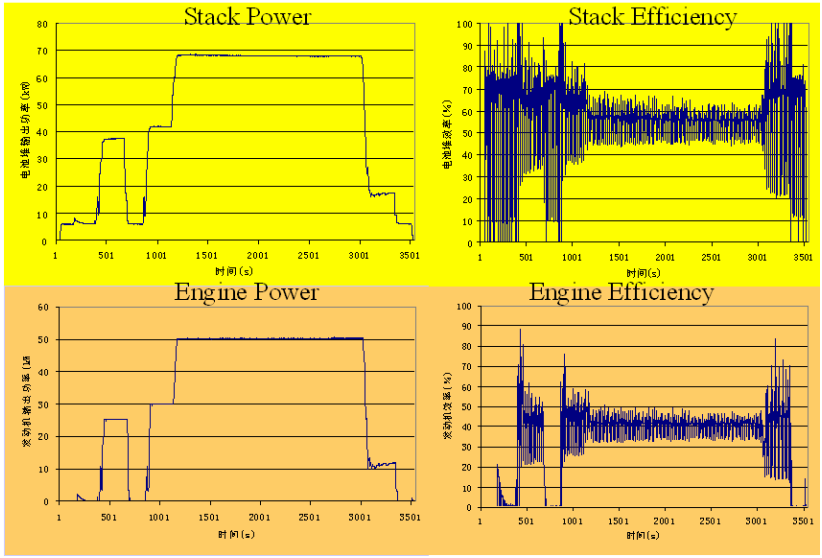



Absorption kinetic curves of $MgH_2$/TiCrV hydrogen storage composite at different temperature (P=2.0MPa)

# 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

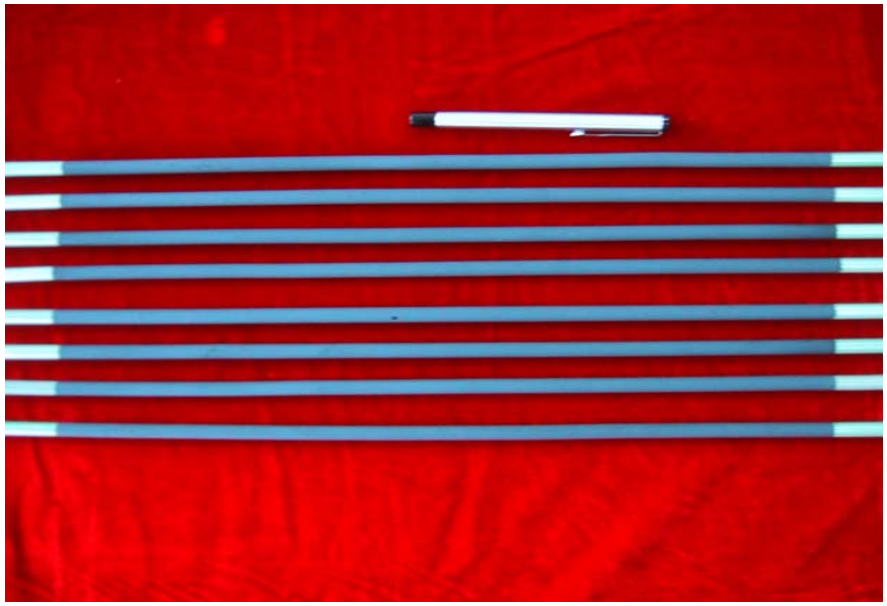
**Molten carbonate fuel cells and solid oxide fuel cells can extract hydrogen from a variety of fuels including coal-based fuels. They can achieve an efficiency of 60% stand-alone, or over 80% (net) if the waste heat is used for cogeneration.**

**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.**

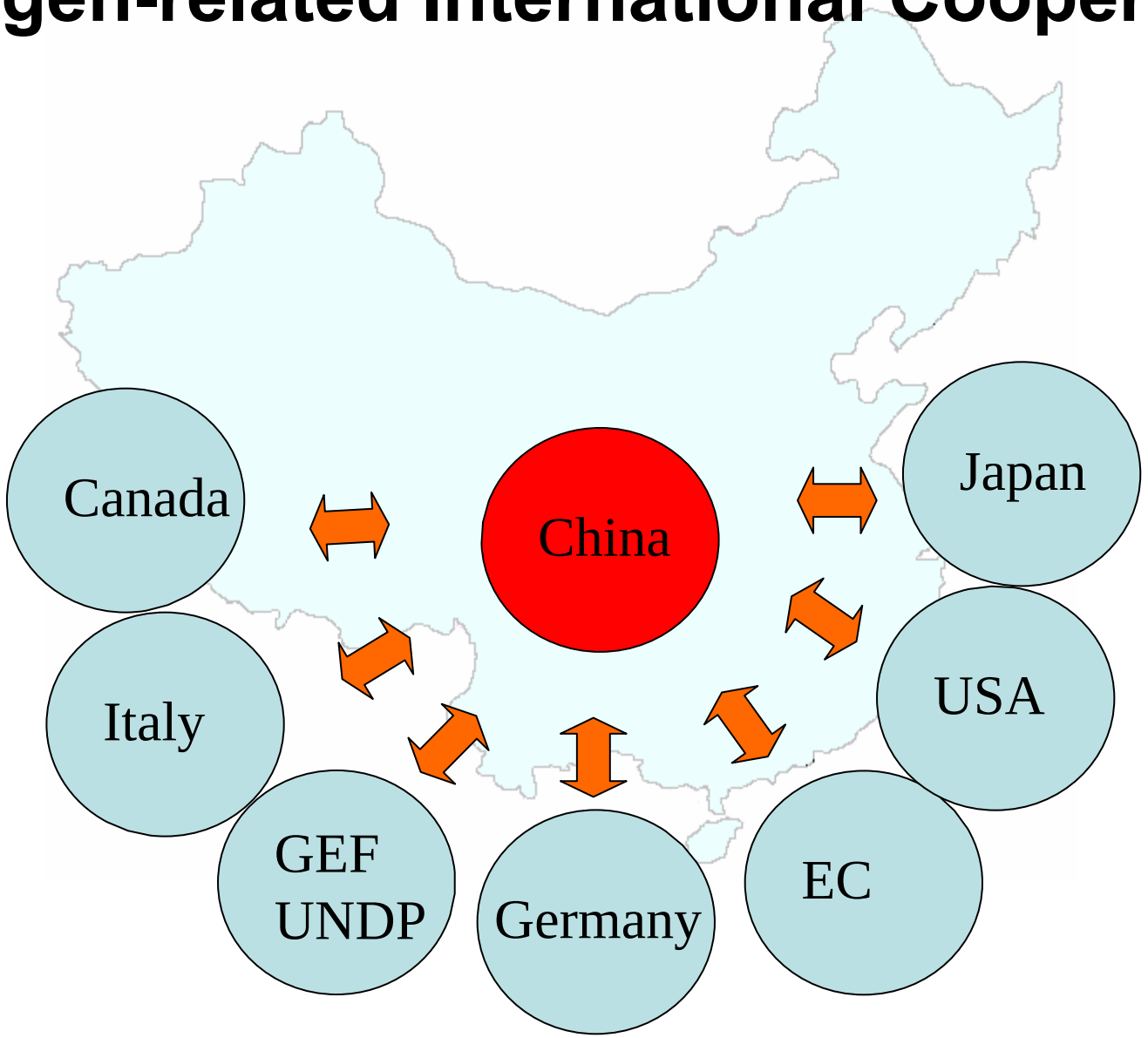


Tubular Cells
Length: 500 mm
Cell power: >25 W at 0.7V

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

# Monographs on Hydrogen Energy


# Hydrogen-related International Cooperation



# 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 Events

## 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.**

# Roadmap toward Hydrogen Economy

**January 2005 Roadmap Meeting, Beijing**


**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.**


Thanks for your Attention