# The Current Status and Prospect of Hydrogen Economy in China

Dr. Kun YUAN

Tsinghua University, P.R. China

kyuan@tsinghua.edu.cn

International Seminar on the Hydrogen Economy for Sustainable Development

Reykjavik, Iceland

28 – 29 September 2006

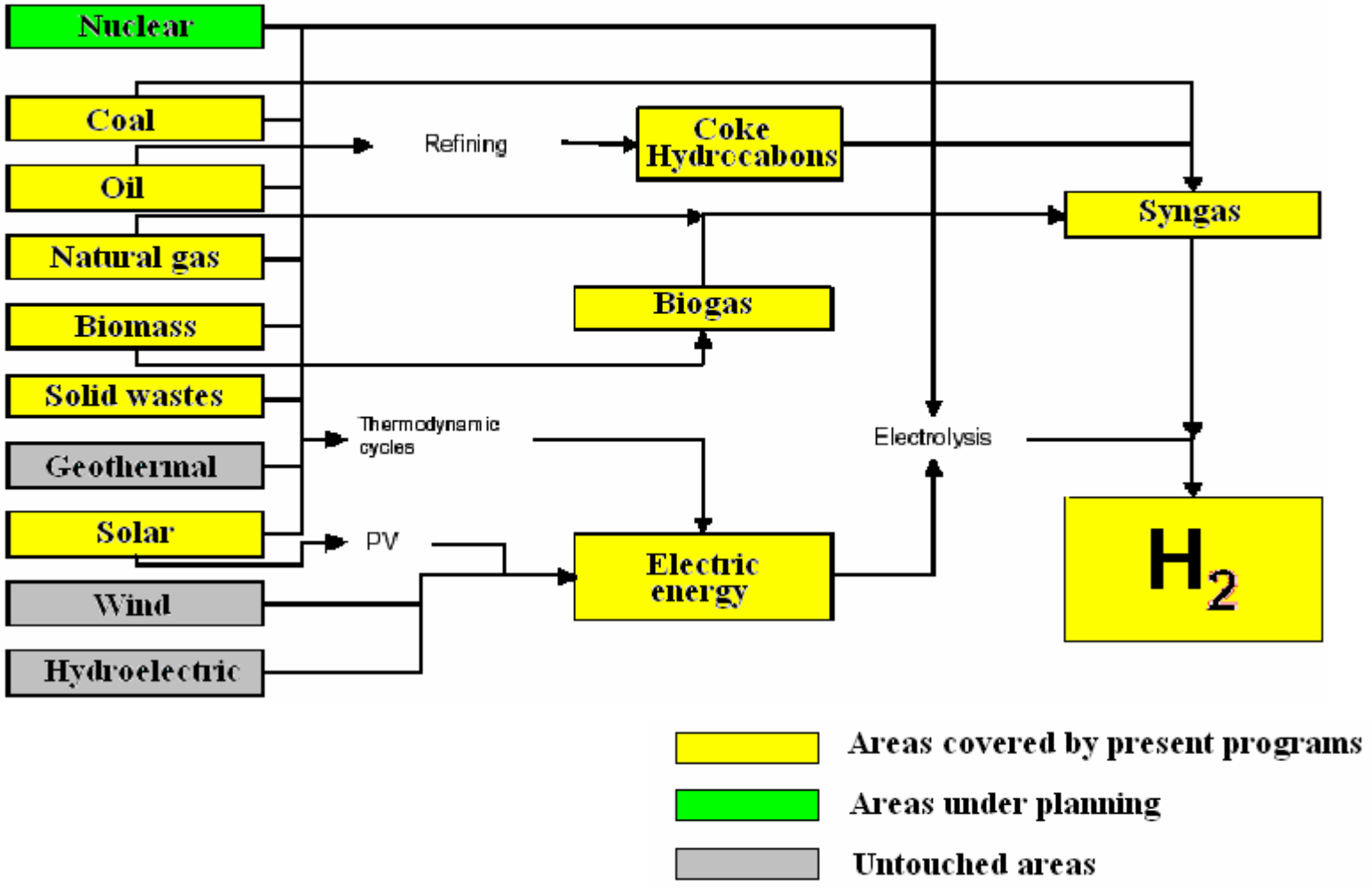
# Outline

- Current hydrogen-related activities in China
  - Research and development
  - Demonstration and pilot test
- Prospect of hydrogen economy in China
  - Hydrogen economy vision
  - Hydrogen economy roadmap

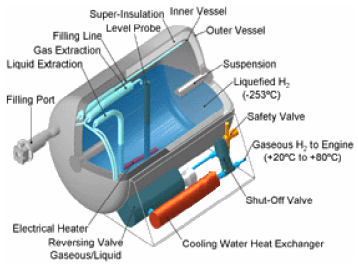
# Multi-dimensional RD&D framework

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | Government Appropriations |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fundamentals of Large-scale Production, Storage and Transportation of Hydrogen and the related Fuel Cells | | | | | | | | | 30 million RMB |
| | | | | Basic Research of Hydrogen Production in Scale Using Solar Energy | | | | | | 20 million RMB |
| | | Post-Fossil Thematic Project on Hydrogen Technology | | | | | | | | 10 million RMB |
| | | Post-Fossil Thematic Project on High-Temperature Fuel Cell Technology | | | | | | | | 20 million RMB |
| | | Target-Oriented Key Project on Electric Automobile | | | | | | | | 0.88billion RMB |
| | | Innovation project for hydrogen and fuel cell | | | | | | | | 57.75 million RMB |
| | 14 items | 12 items | 27 items | 27 items | 44 items | 39 items | | | | |

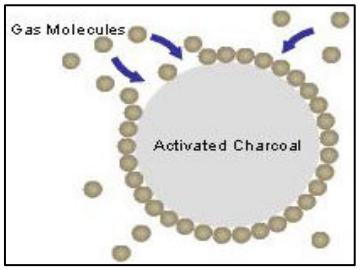
# Multi-source hydrogen production



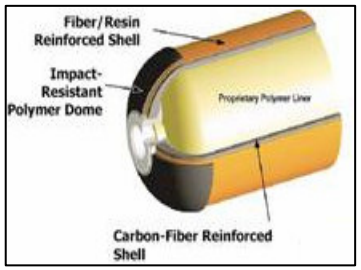
# Study on hydrogen storage



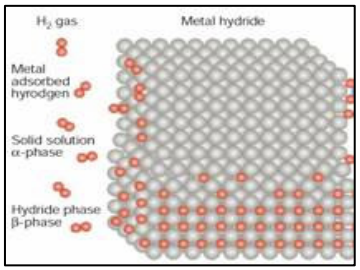

Hydrogen Liquefaction




Physical Adsorption




Compressed Hydrogen




Chemical Absorption

# Study on PEM fuel cell

100kW FC

70kW FC

30kW FC

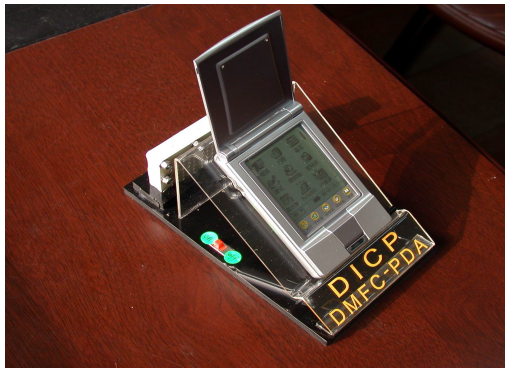
5kW FC

1999 2001 2002 2004 2006

# Study on DM fuel cell

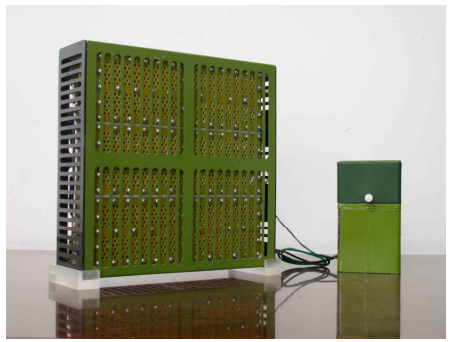
Mobile phone

**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:**



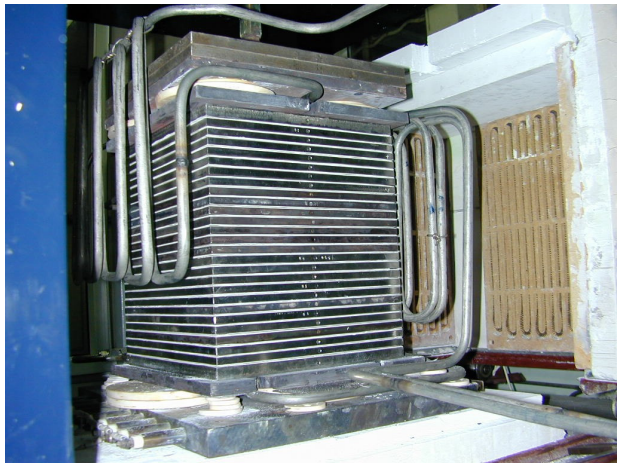

PDA

Notebook



50 W DMFC system

# Study on MC fuel cell



MCFC stack

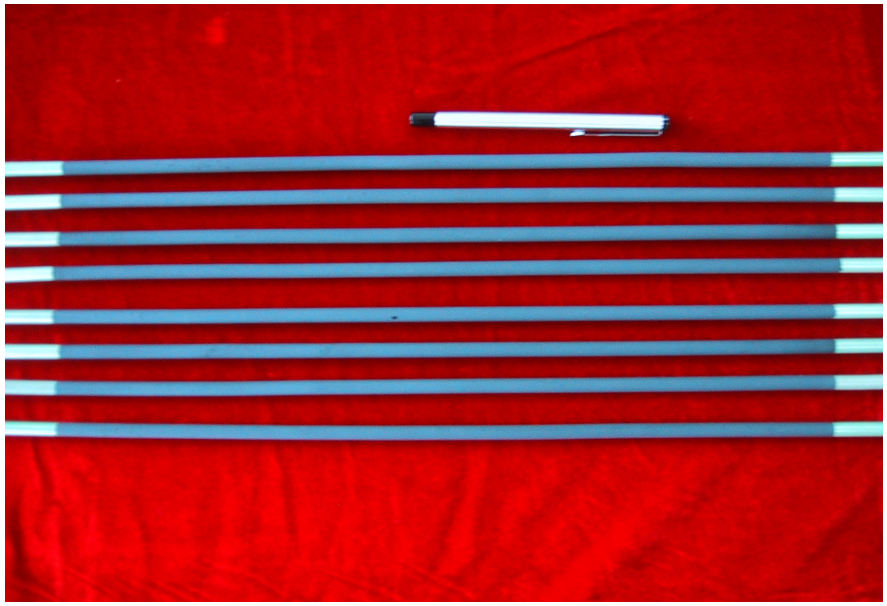
**Molten carbonate fuel cells and solid oxide fuel cells can extract hydrogen from a variety of fuels including coal-based fuels. They can achieve an efficiency of 60% stand-alone, or over 80% (net) if the waste heat is used for cogeneration.**

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

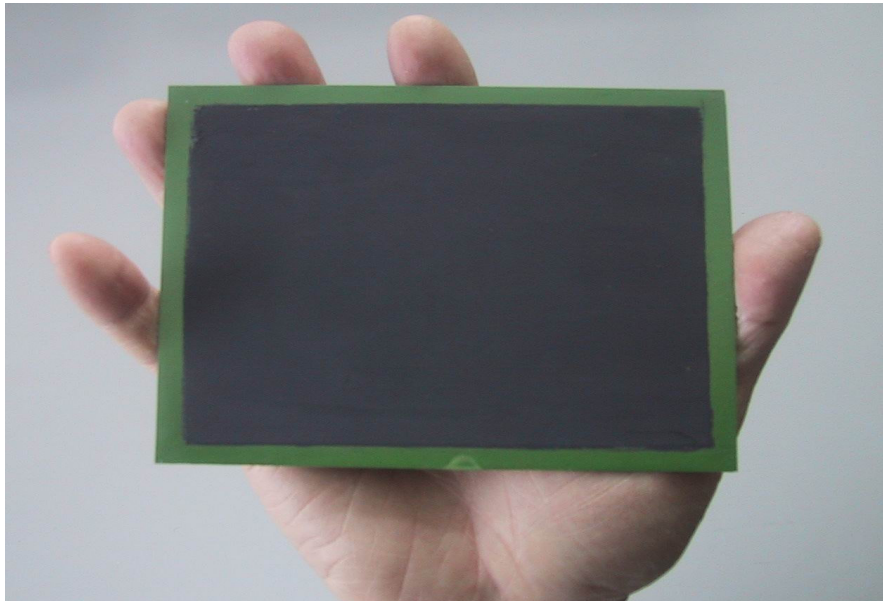
10-100 kW MCFC system

# Study on SO fuel cell

**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.**

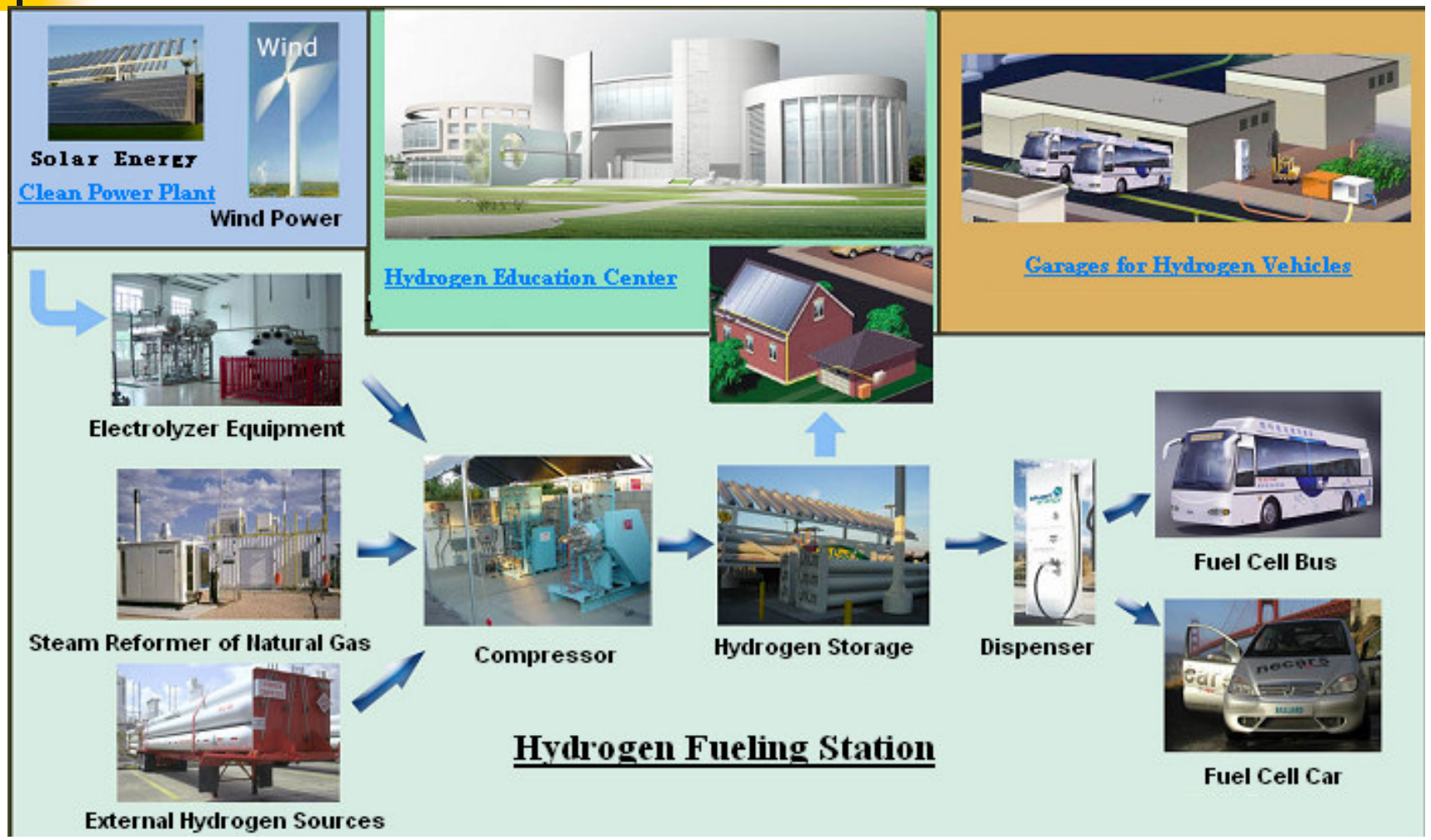


Tubular Cells
Length: 500 mm
Cell power: >25 W at 0.7V

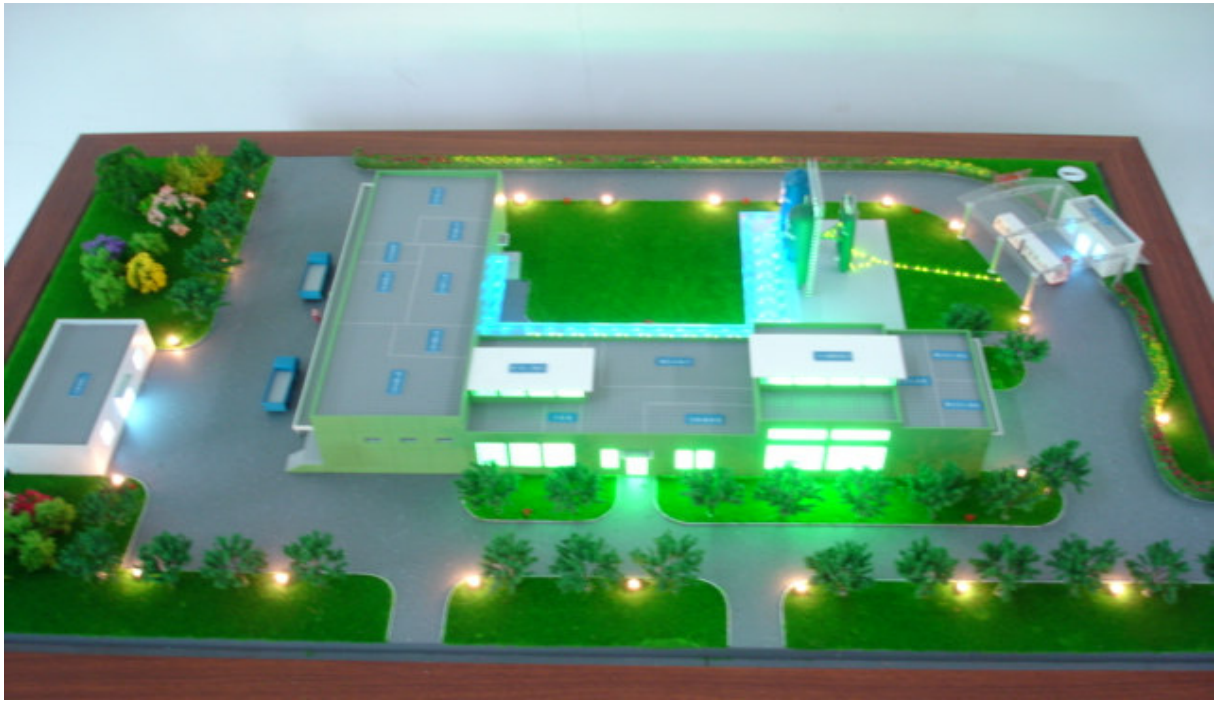


Planar Cells
Effective area: 100 $cm^2$
Cell power: > 50 W at 0.7V

# Beijing Hydrogen Demonstration Park



# Beijing Hydrogen Demonstration Park

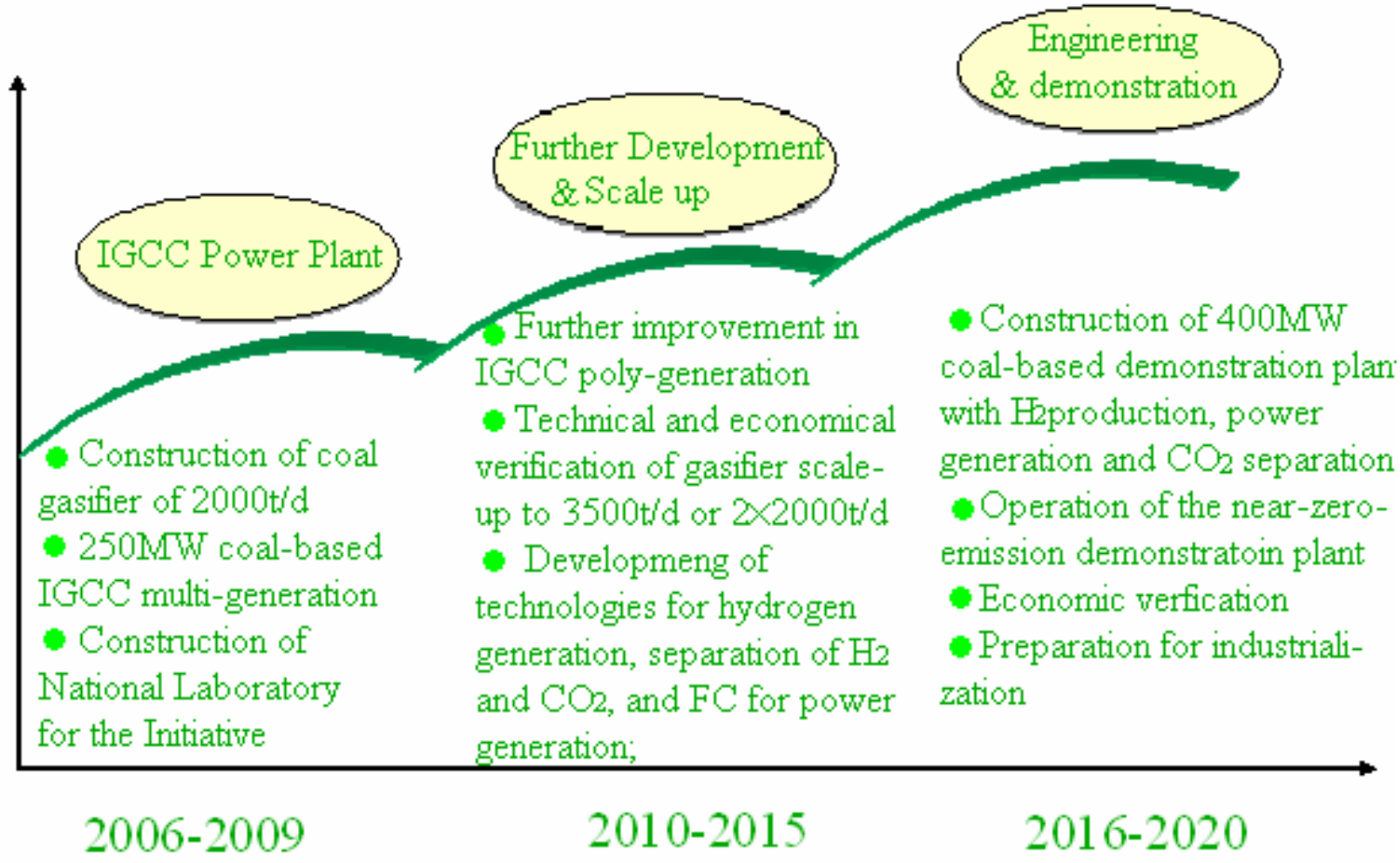


**Beijing Lnpower Sources Co., Ltd filling station - capability of hydrogen Supply 7200 Nm3/day, was finished on June.29, 2006.**

# Green Coal-Based Power Generation

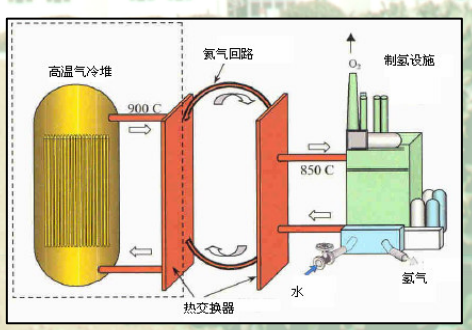

**Near-zero-emission coal-based H2/power co-generation demonstration**

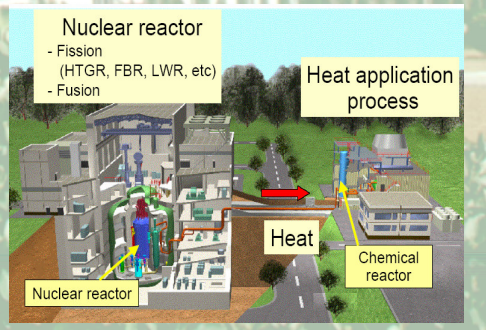
# Green Coal-Based Power Generation



# Nuclear Hydrogen Production Pilot

- **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）**

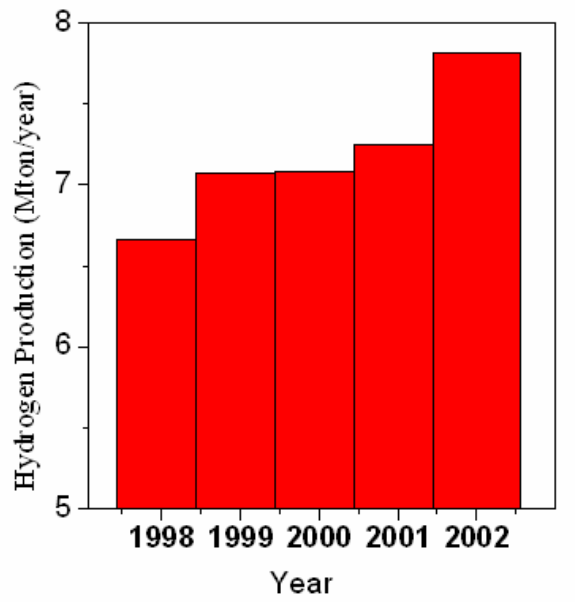



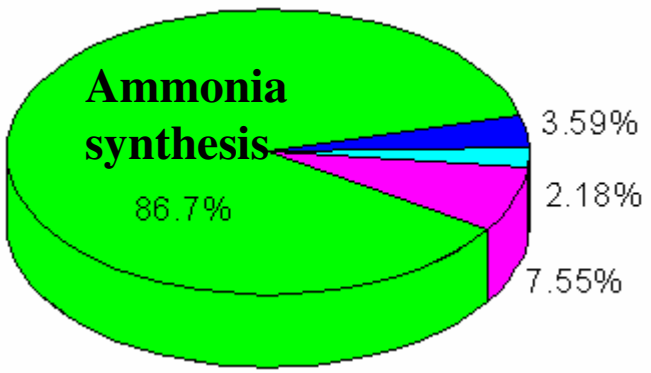
# Outline

- Current hydrogen-related activities in China
  - Research and development
  - Demonstration and pilot test
- Prospect of hydrogen economy in China
  - Hydrogen economy vision
  - Hydrogen economy roadmap

# Hydrogen industry in China

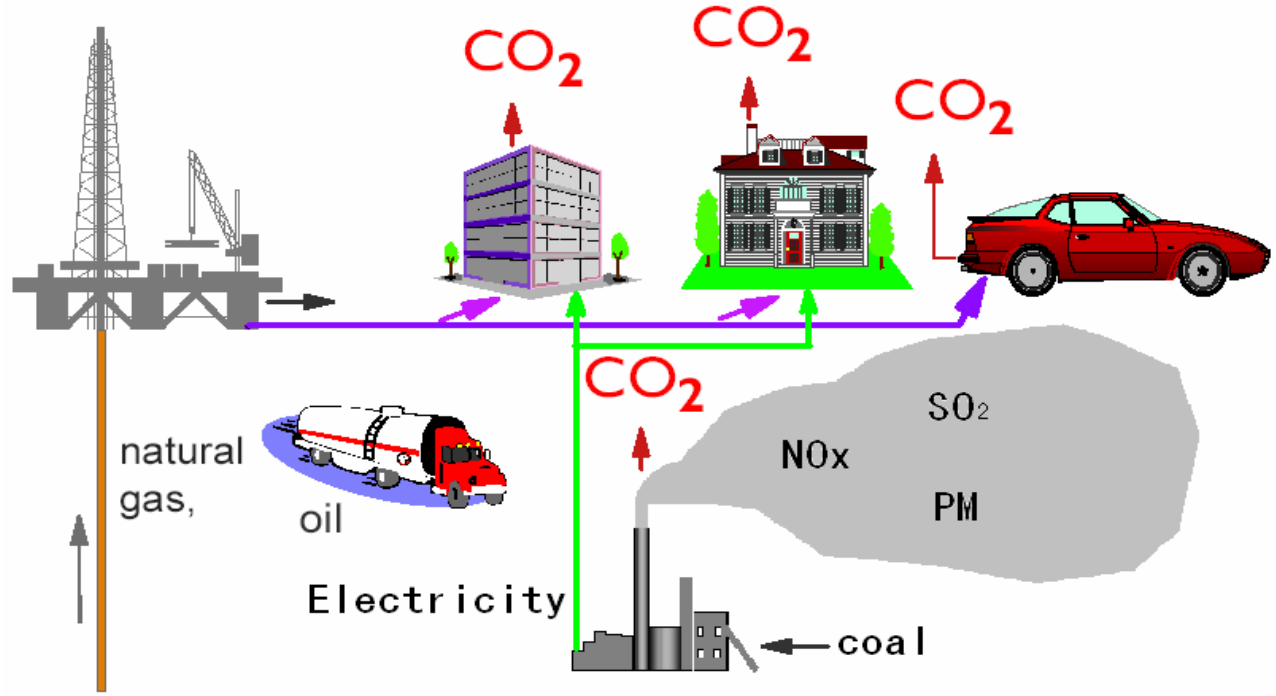



**Hydrogen production history**

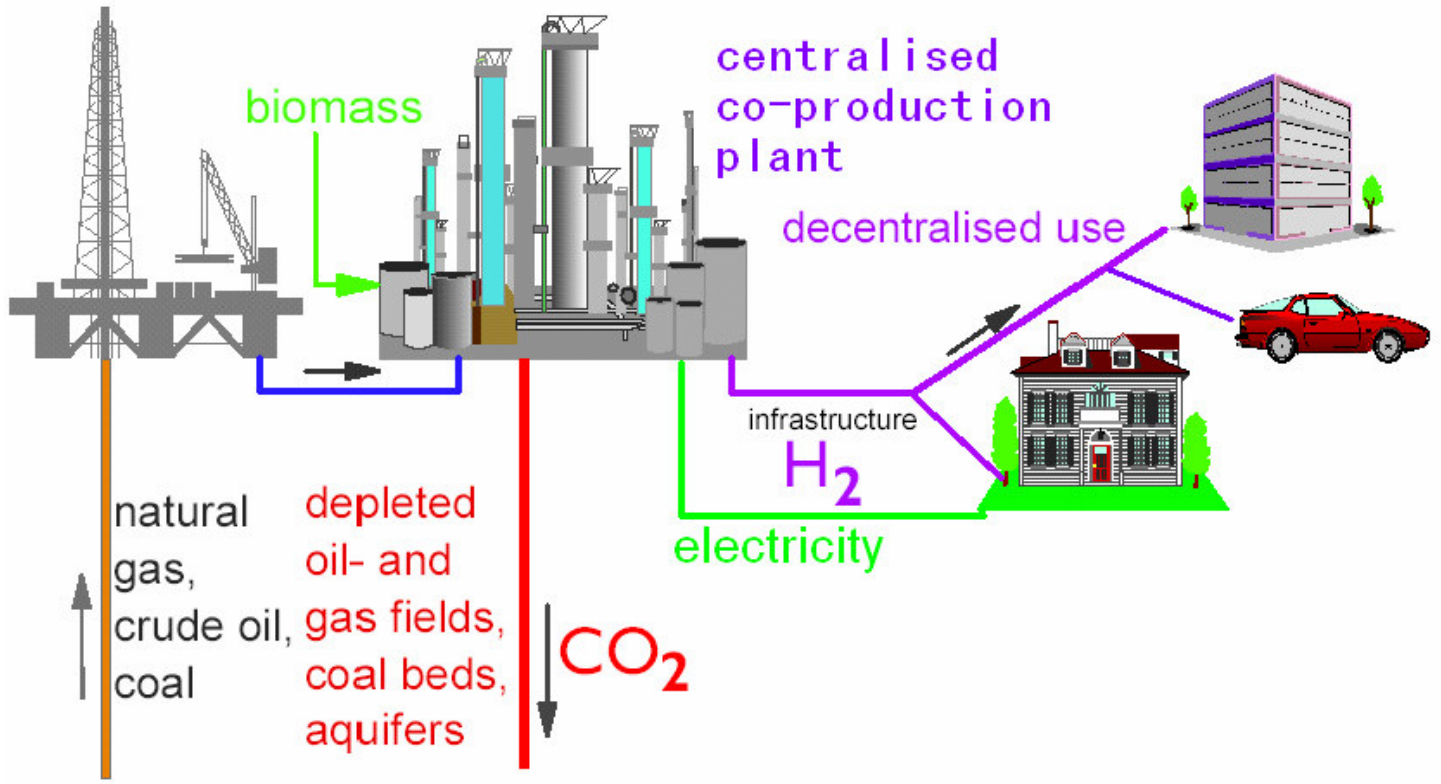



**Hydrogen production 2002： 7.81Mton**

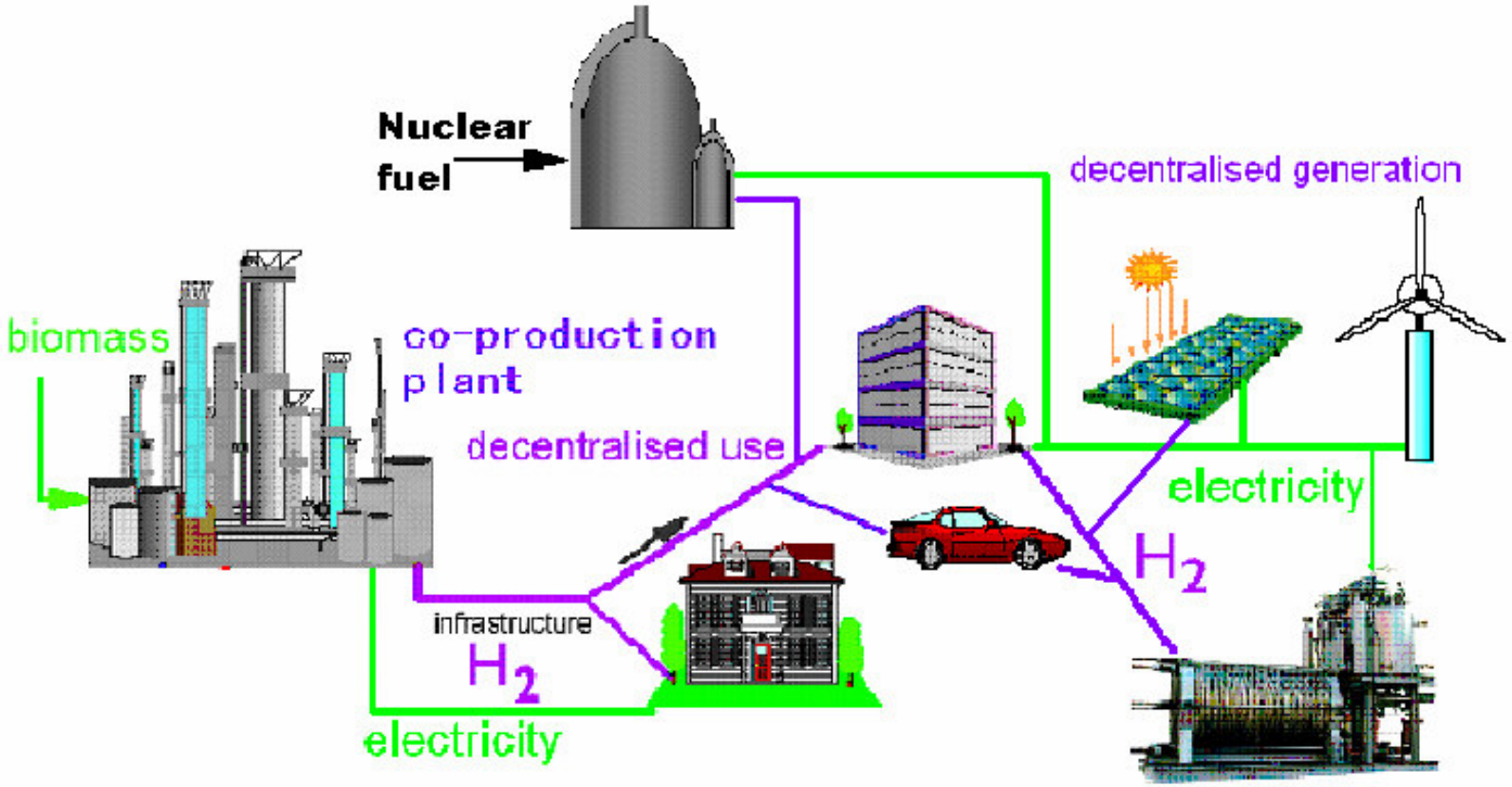
# Current energy status



# Fossil-based hydrogen economy



# Post-fossil hydrogen economy



# Transition to hydrogen economy

| | Phase 1 | Phase 2 | Phase 3 | Phase 4 |
|---|---|---|---|---|
| **Production** | Natural gas and oil as original hydrogen source | Coal-based hydrogen / power co-production demonstration | Coal-based FC / turbine hybrid cycle with carbon sequestration demonstration | Post-fossil based hydrogen generation demonstration and commercialization |
| **Delivery** | On-site hydrogen generation | Regional hydrogen infrastructure construction | Spreading of hydrogen delivery network | Construction of national hydrogen delivery network |
| **Utilization** | Hydrogen ICE and FCV demonstration | Distributed hydrogen-fueled power generation demonstration | Spreading of hydrogen-fueled vehicles and hydrogen fuel station | Hydrogen serves as complementary energy carrier as electricity |

# 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.**

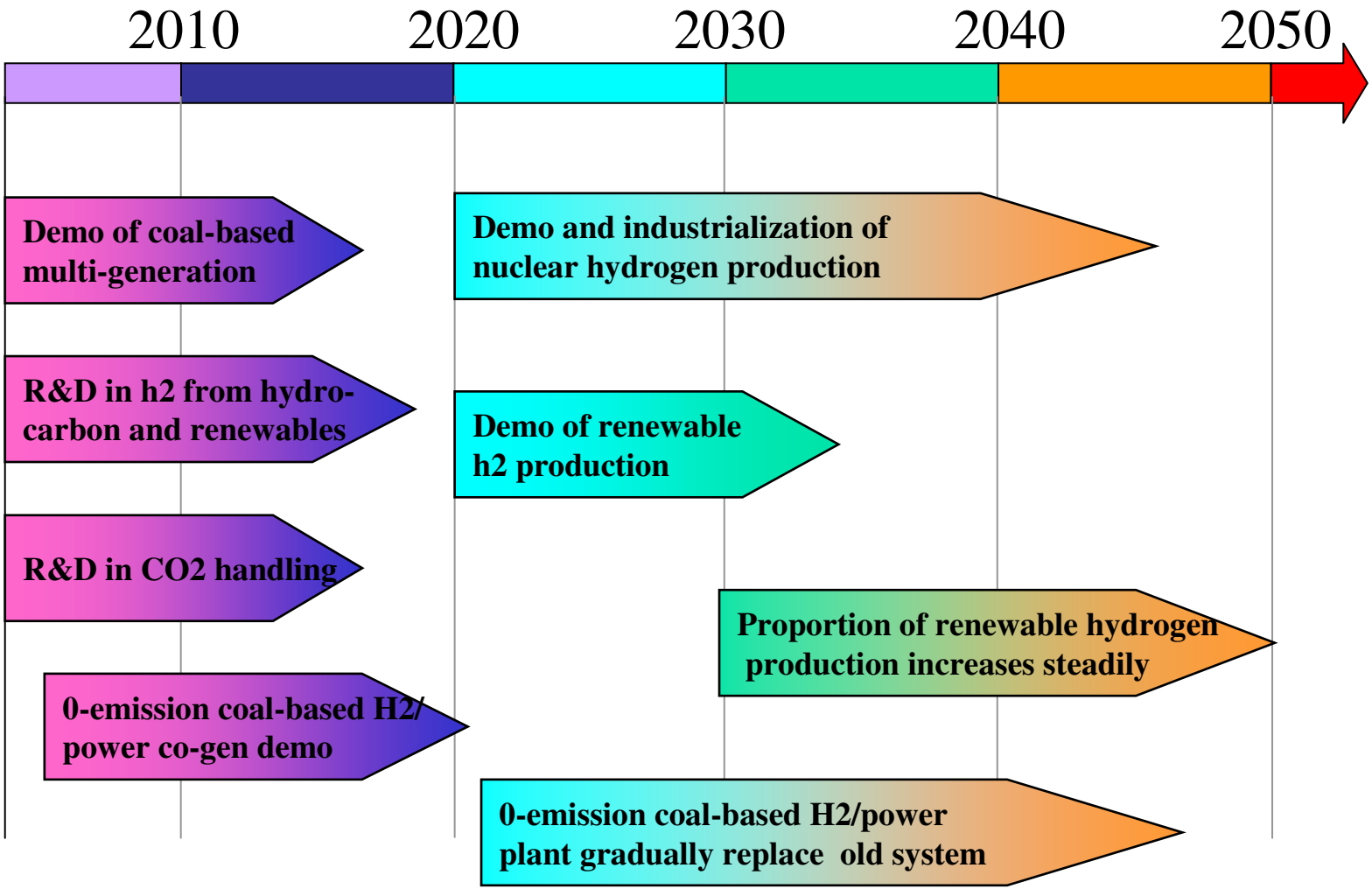
# January 2005 Roadmap Meeting


**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.**

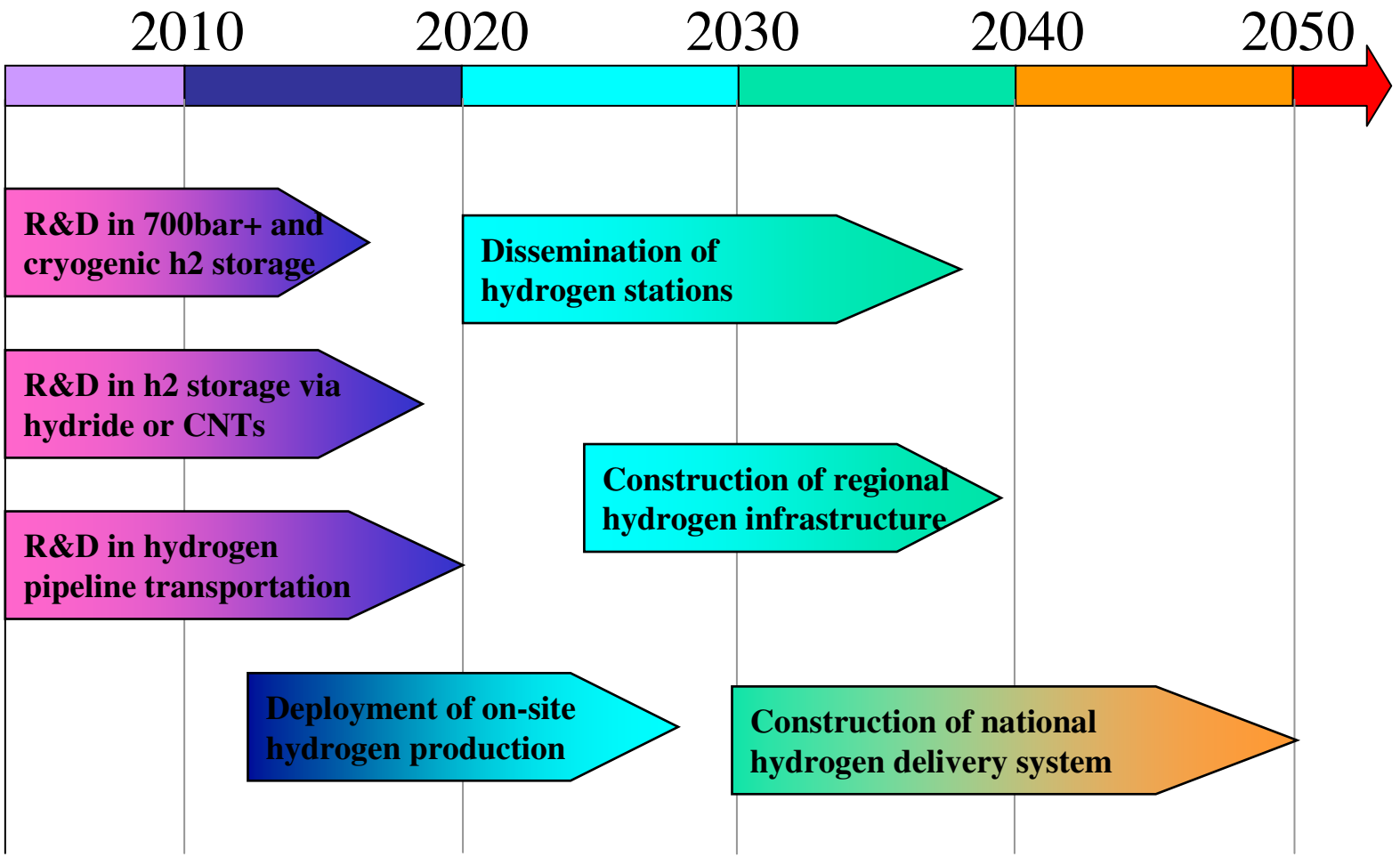
# Vision for hydrogen economy

- **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.**

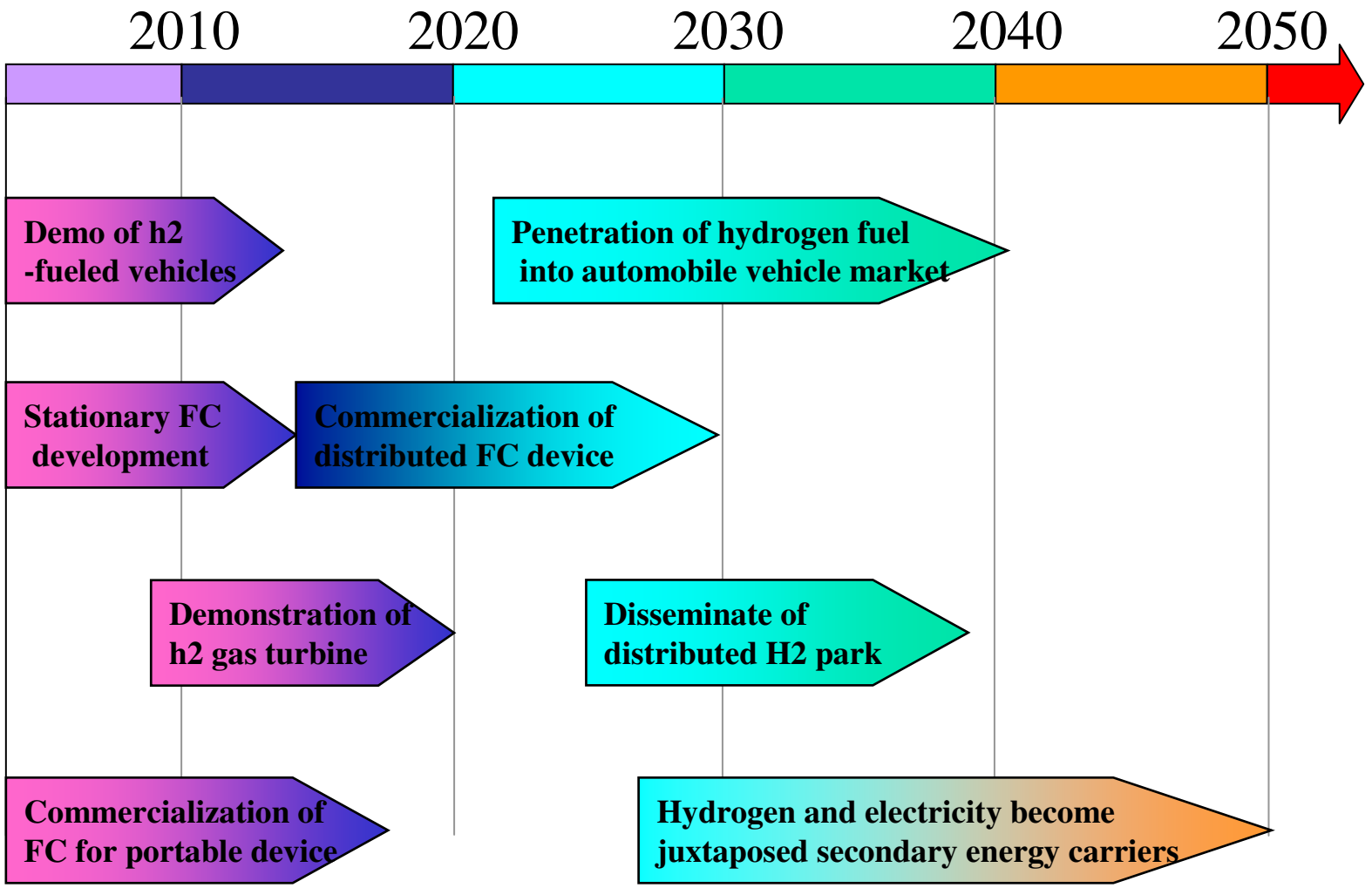
# Roadmap for hydrogen production



# Roadmap for hydrogen delivery



# Roadmap for hydrogen utilization



# Challenges

**Many challenges lie ahead in every phase to hydrogen economy, including:**

- **Institution,**
- **Policy,**
- **Technology,**
- **Economy,**
- **Human resource,**
- **Public reception,**
- **Regulation, code and standard,**
- **and so on.**

**A global collaboration is very needed.**


**Thank you very much**

**for your attention!**