

FCED_YFY_04_2010

**US-China Electric Vehicle & Battery Technology
Workshop**

Demonstration of fuel cell city bus in Beijing

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Brief introduction of myself



□ Major research area

- Engine Control & system Optimization

□ Objectives

- Phase 1 ('90~'98) : LPG/CNG
- Phase 2 ('99~'04) : Diesel engine
- Phase 3 (04~) : FC/Hybrid management

□ Projects in recent 5 years

- Plan 863: FCE performance evaluation technology ('07)
- Plan 863: the durability control of the FC city BUS ('07)
- Plan 863: R&D of a specific engine control system for diesel-electric hybrid bus ('08)
- Plan 973: HCCI engine control duration the transient process('02-'11)
- Plan 863: APU design for a HCNG-electric hybrid bus(06)



Outline



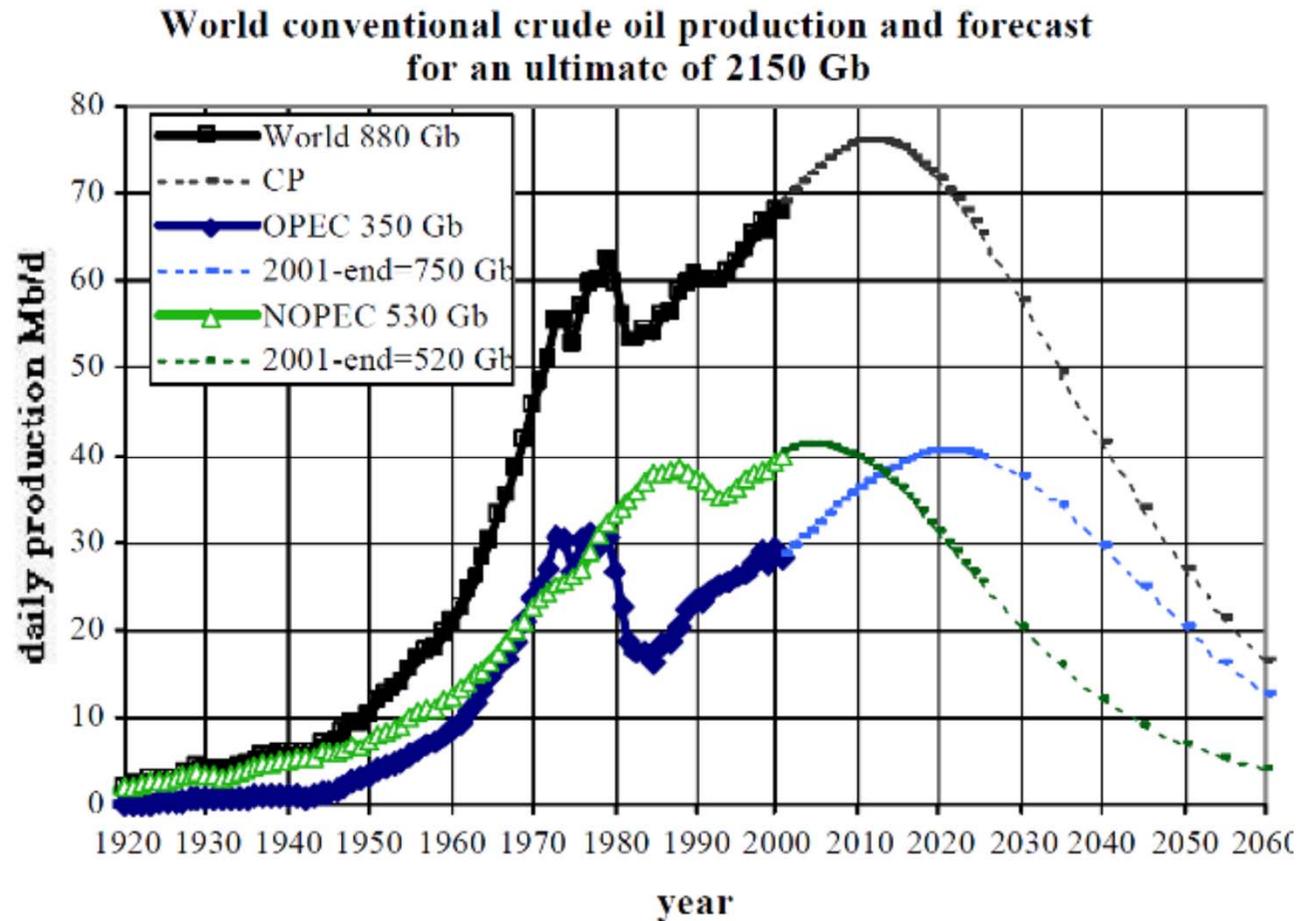
- Background
- Key Technologies
- Demonstration
- Summary



Background



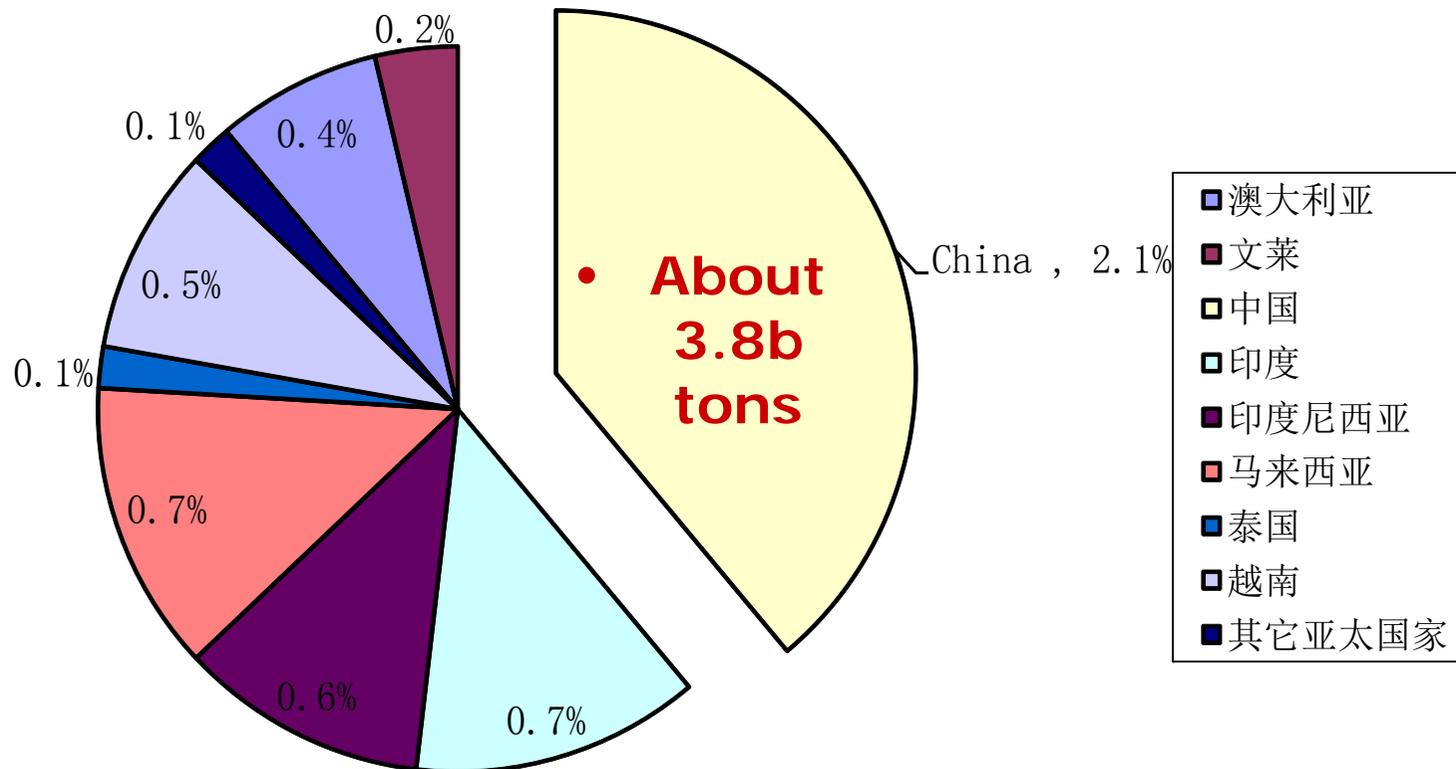
Post oil age is coming.....



resource : 「Forecasts of Oil and Gas Supply to 2050」 Jean Laherrere, Peterotech 2003 (New Delhi)



Oil share of China in the world



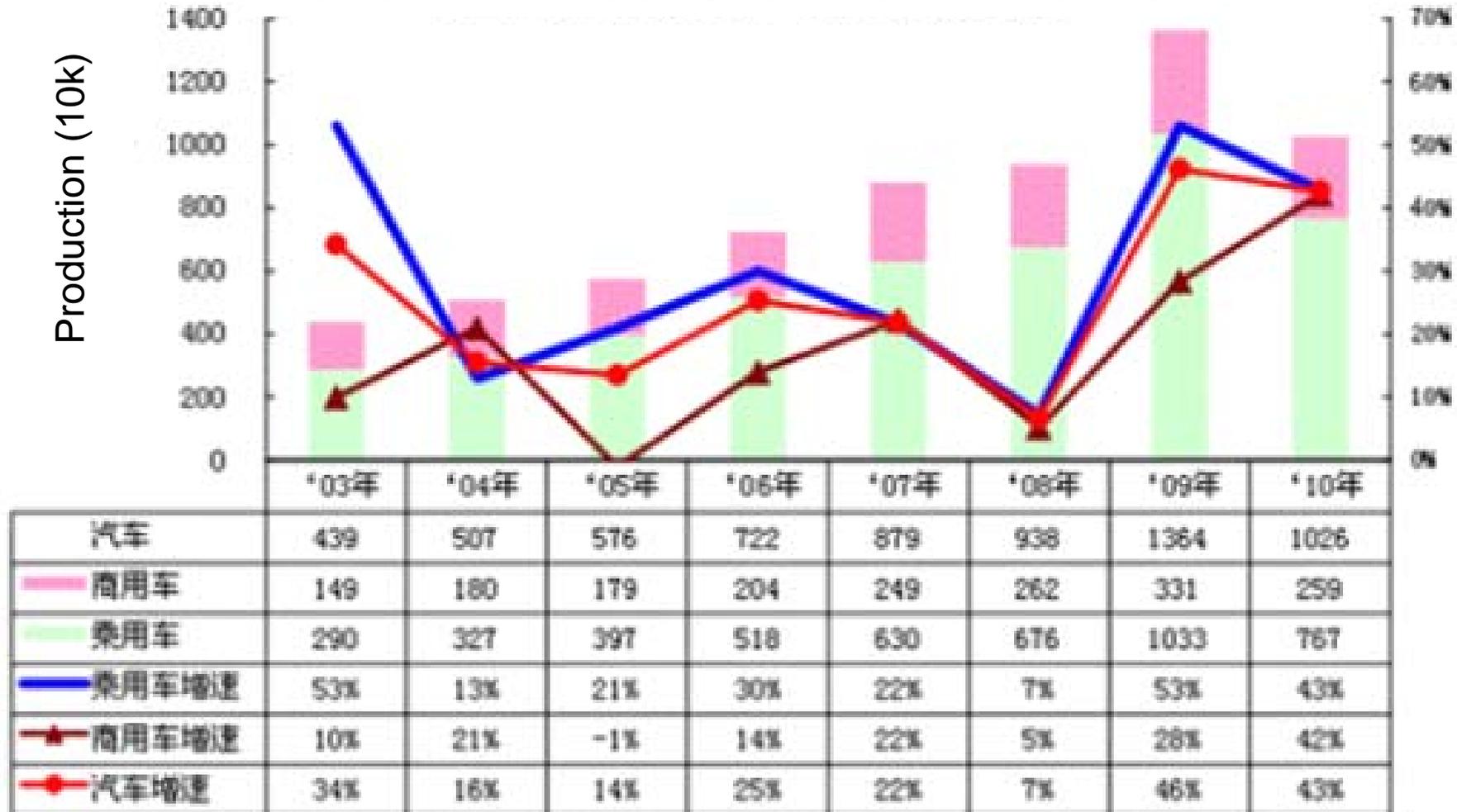
- The oil consumption of china in 2008 is about 0.38b ton, if without any import, it can be just used for 10 years. it means all the vehicles should end use 10years later, so it will be terrible for us and also for the world.



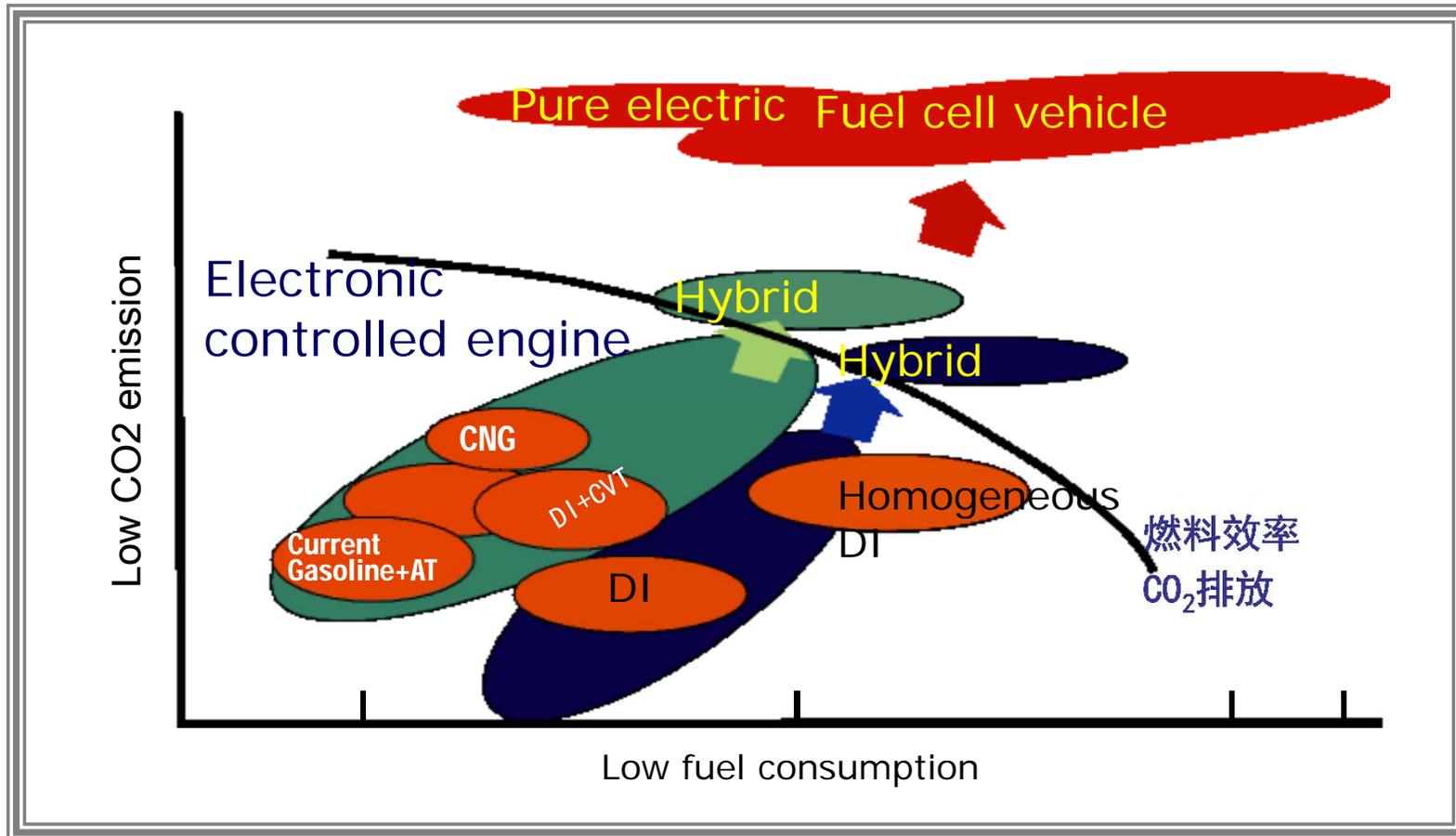
China: a fast growing market of vehicle



Vehicle Production & its Growth in China



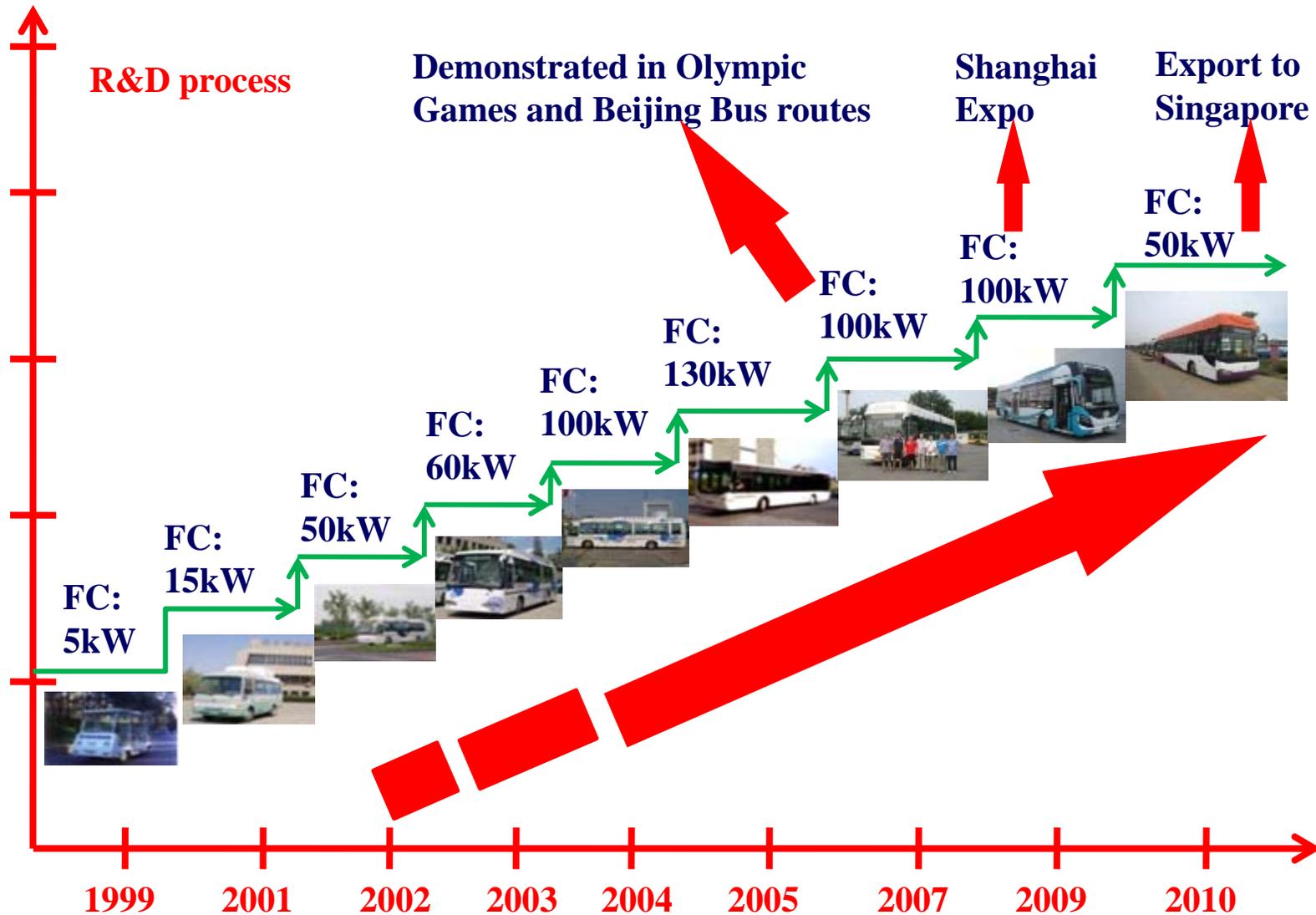
Global automobile industrial revolution



➤ New automobile powertrain technology is the only way to cope with energy crisis and environmental pollution.



R&D of fuel cell city bus technology in Tsinghua



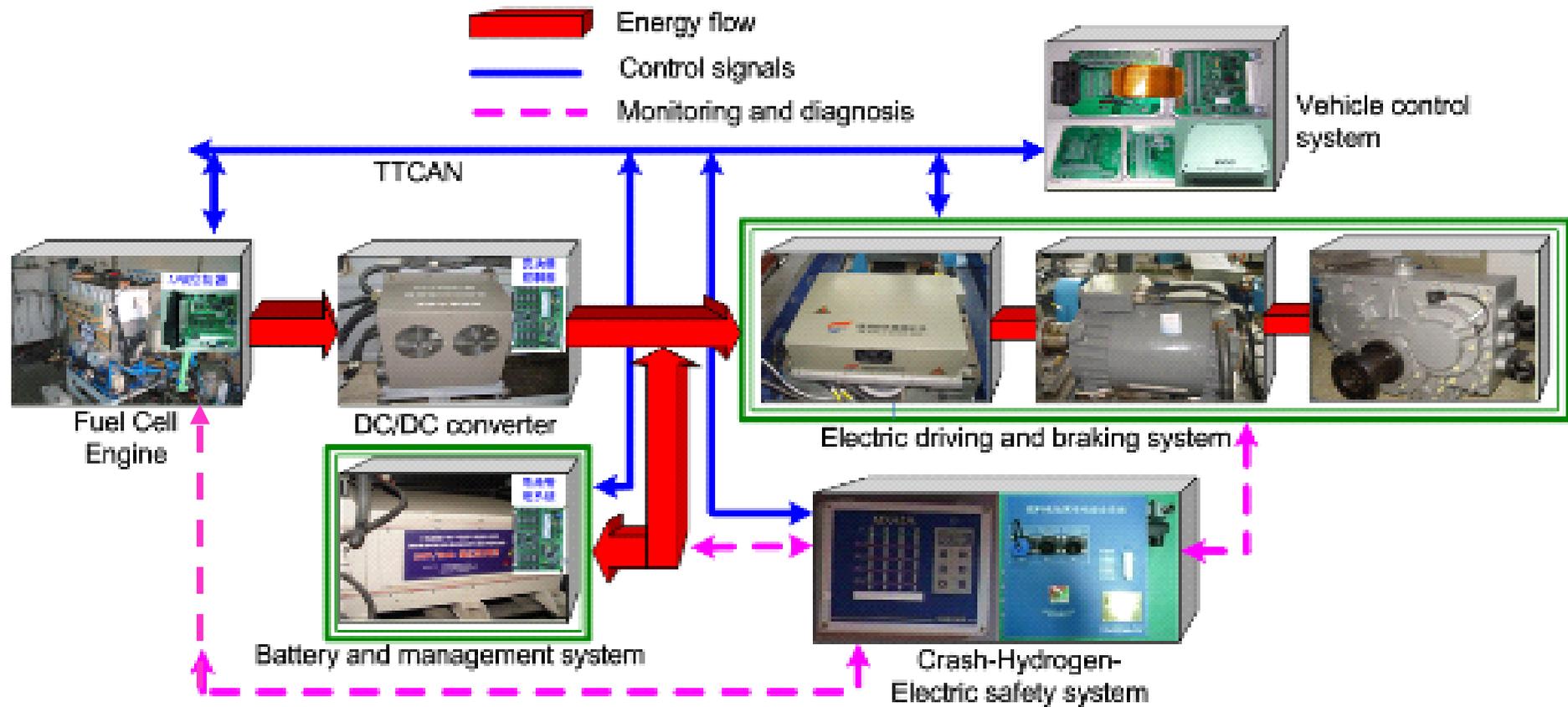
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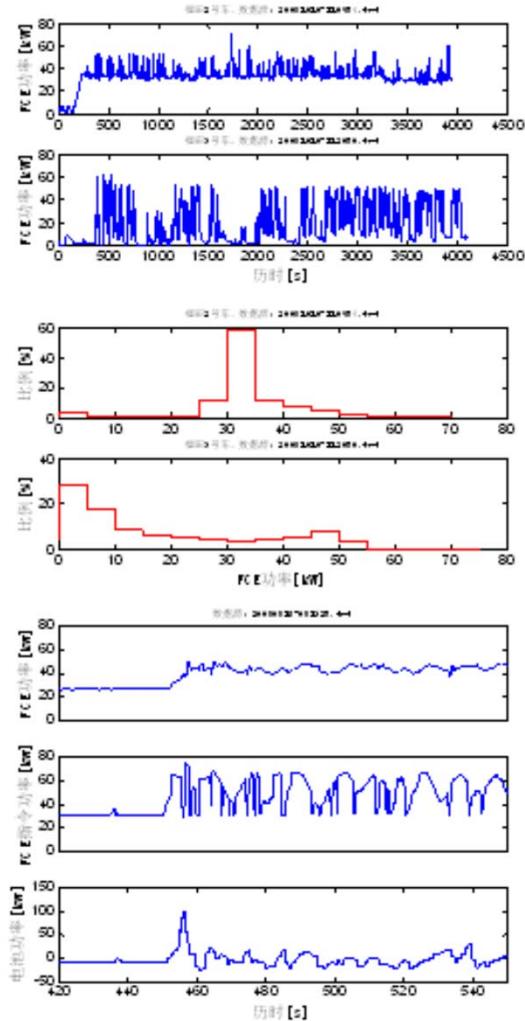
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1 Fuel cell Hybrid System Control



Soft-Run Concept



Operating Condition analysis

To get the driving requirement para :

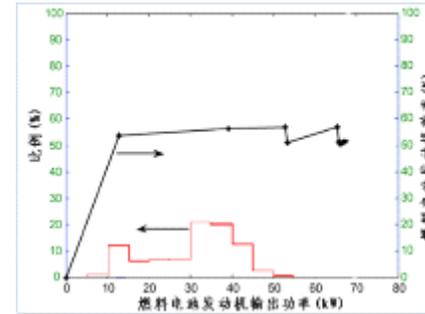
- Traction Power
- FCE power distribution
- Continuous Speedup time & power
- Dischrg & chrg of Batt.
- SOC
-

To get typical operating para :

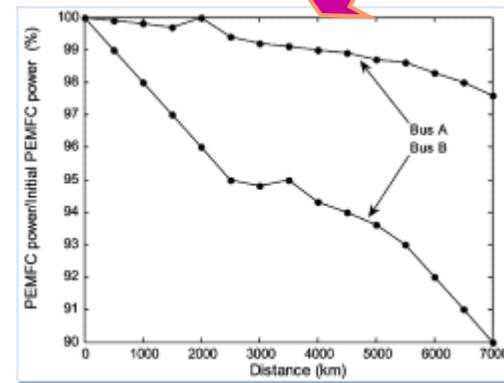
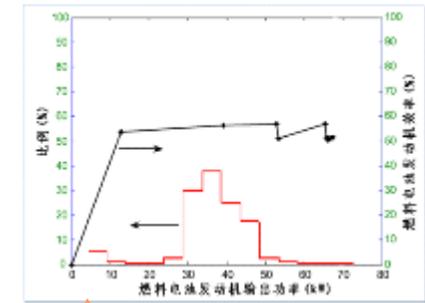
- Load varying speed
- Loading numbers
- Percent of idle time
- Number of start



1.1 Soft-Run control of fuel cell system



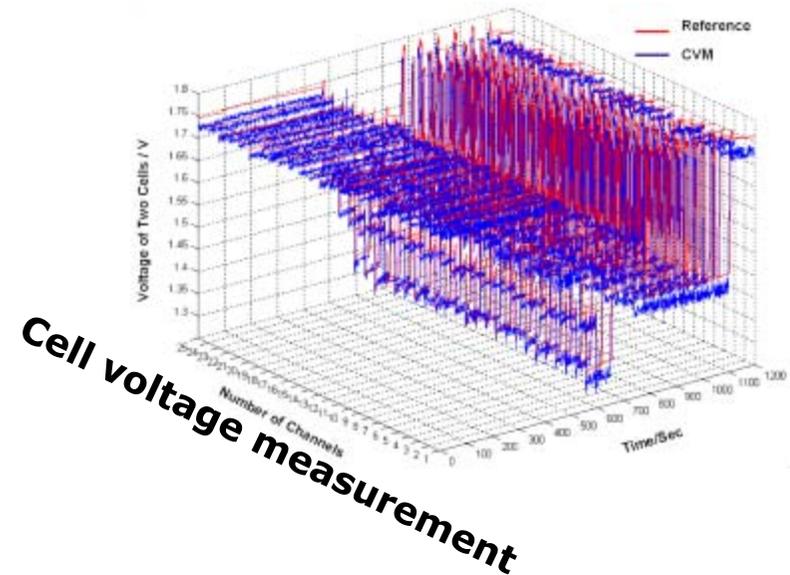
soft-run:
Higher efficiency;
Longer working
life time



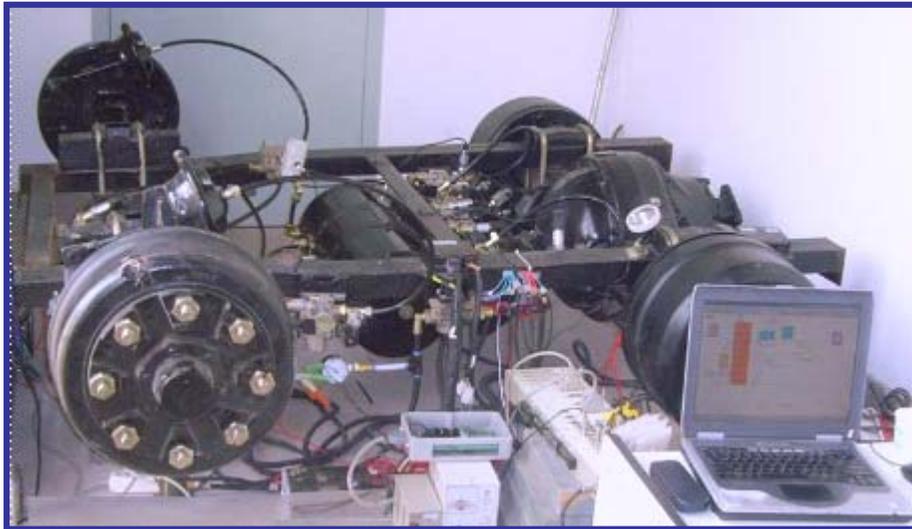
1.2 Battery management system



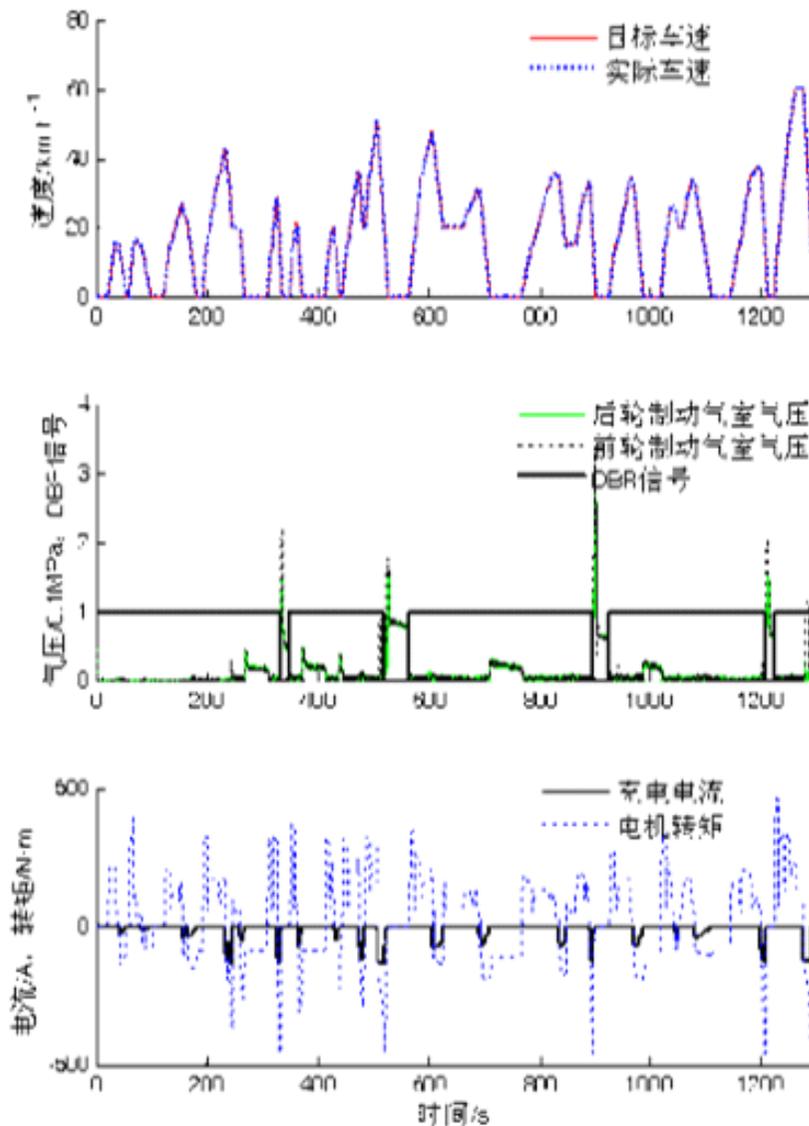
SOC Estimation



1.3 Serial braking energy recycling system



The entire fuel consumption can be Lowered by 15% with serial braking recycling system in “China typical city bus cycle”.



2 Vehicle control system



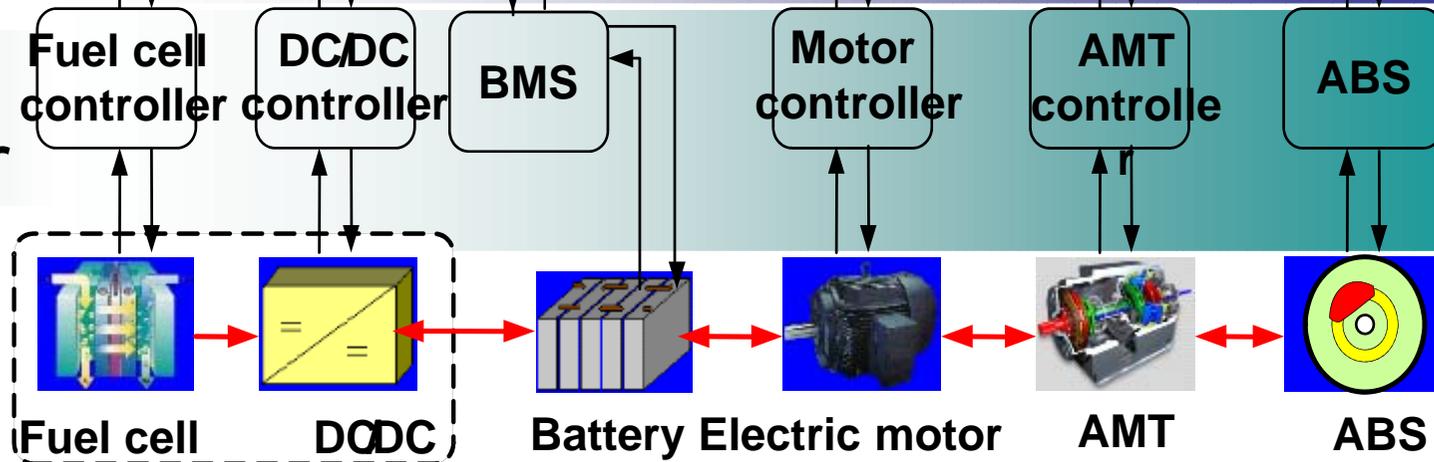
Energy management



Communication



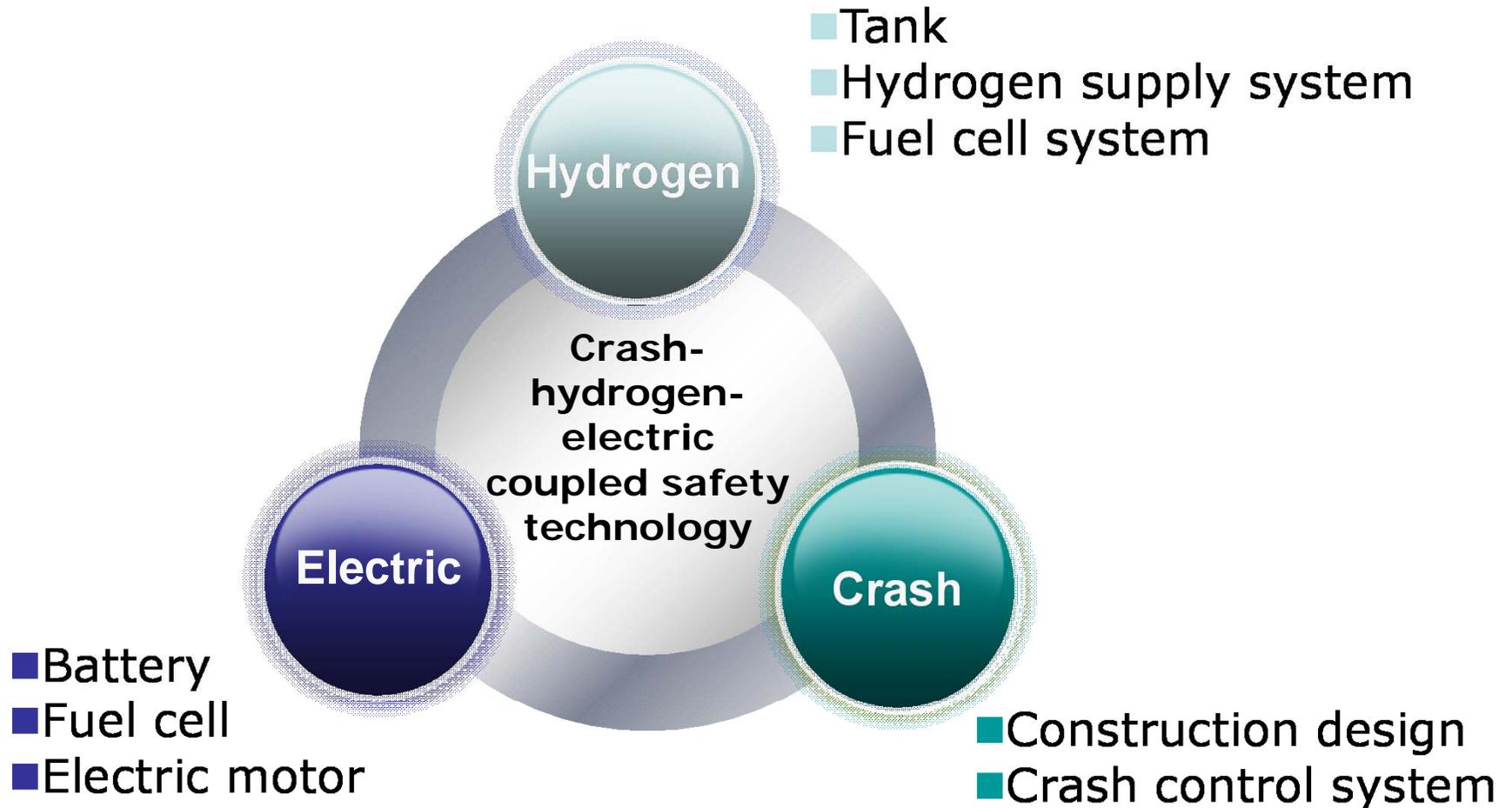
Electric Controller



→ Power flow → Signal flow



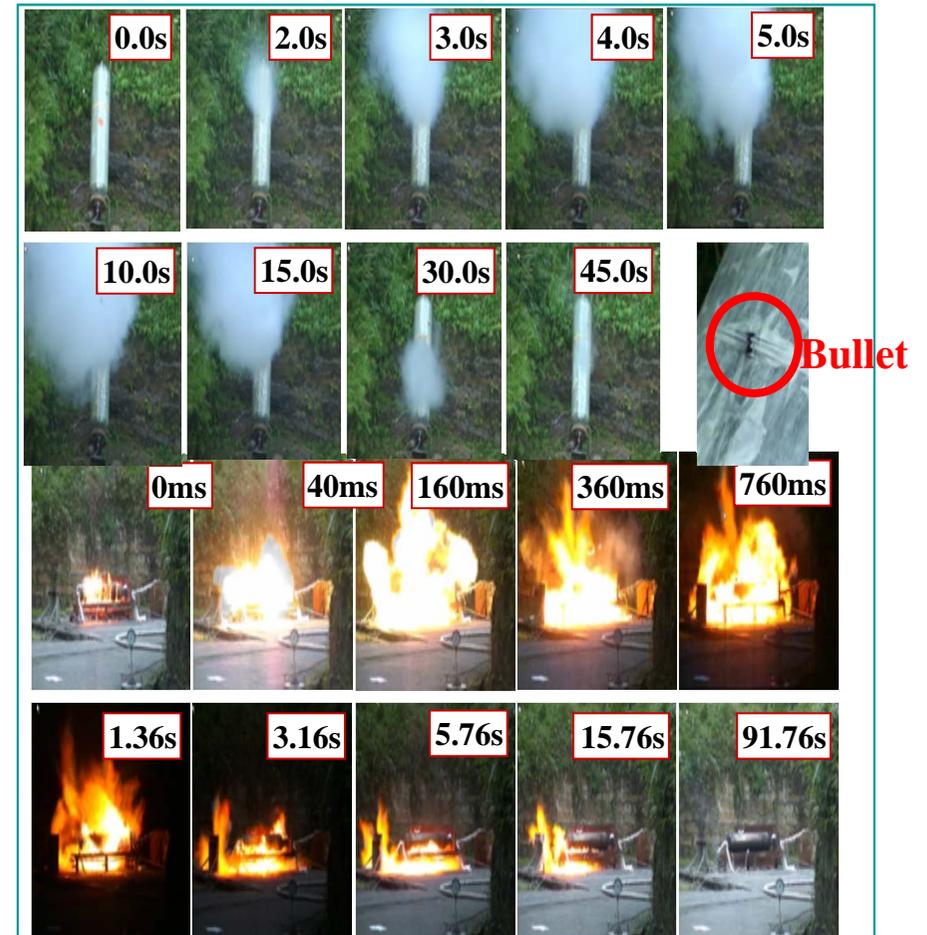
3 Safety technology



3 Tests and experiments



High pressure hydrogen storage system crash testing



Gunshot and firing testing of a 35MPa hydrogen tank



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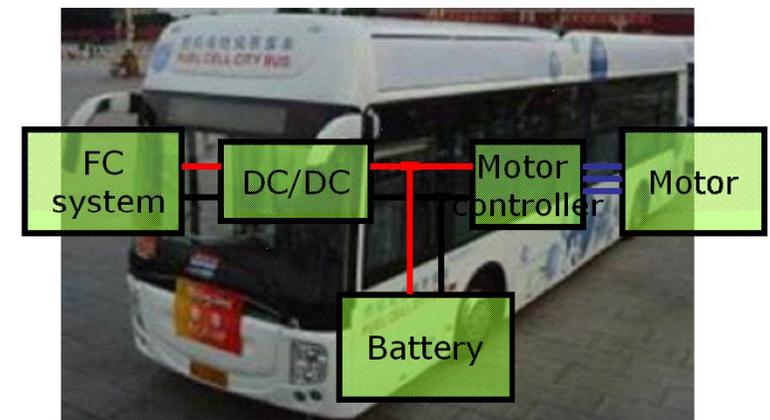


Specifications of the demonstrated bus in Beijing



Maximal speed: 80km/h
Accelerating time of 0-50kmph: 20s
Hydrogen storage pressure: 20Mpa
Continuous driving range: 200km

Parameter (unit)	Value
Vehicle mass, m (kg)	1.4672×10^4
Frontal area, A (m^2)	7.5
Drag coefficient, C_D	0.7
Rolling resistance coefficient	1.8×10^{-2}
Mechanical efficiency, η_T (%)	95
Mass factor	1.1
PEM fuel cell rated power (kW)	80
DC/DC rated power (kW)	80
Ni-MH battery rated capacity (A h)	80
Electric motor peak power (kW)	150
Electric motor peak torque (Nm)	1.121×10^3
Electric motor rated power (kW)	100
Electric motor maximal rotational speed ($r \text{ min}^{-1}$)	6×10^3



Demonstration route



- Quantity of buses: 3
- Duration: Started from August 1st, 2008, Ended in July 31th, 2009.
- Route: Run on the same routes as the former demonstration from 2006 to 2007
- One trip: 18km



Hydrogen production and refueling station



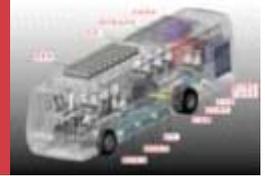
- Supply 20 MPa and 35 MPa refueling service since 2005
- Large scale application of hydrogen as vehicle fuel, more than 23 tons hydrogen refueled to fuel cell cars and buses up to the end of 2008
- Hydrogen fuel price has been reduced to 4RMB per cubic meter, thus total fuel cost of FC bus per 100km is almost equal to that of diesel bus.



The first comprehensive hydrogen production and refueling station in China



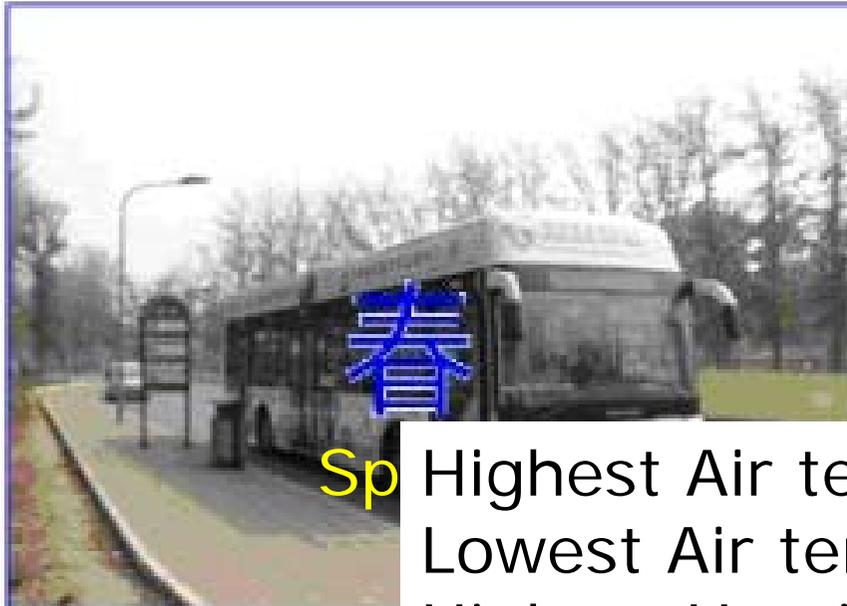
Pictures in Olympic Games, Beijing, 2008



Aug. 17 Woman Marathon Race
Aug. 24 Man Marathon Race



Climate adaptability



Sp

Highest Air temp. : 40°C

Lowest Air temp. : -10°C

Highest Humidity: >95%

Lowest humidity: <10%



夏

Summer



秋

Autumn



冬

Winter



Compared with the former demonstration FCB



Vehicle	the former demonstration Bus	BJ6123-12m Bus
Operating time	2006,8-2007,8	2008,7-2009,6
Bus route	Beijing 801 bus route	
Total mileage	54832km	47152km
Total passengers	21000	32000
Hydrogen consumption	18.0kg/100km	10.8kg/100km

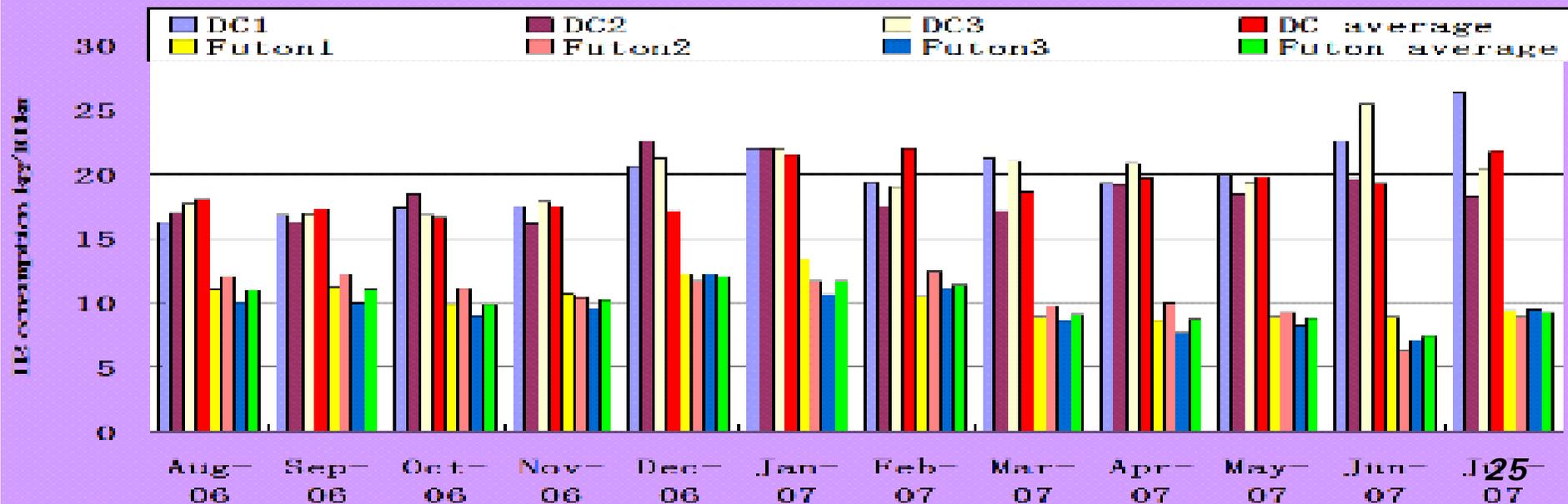


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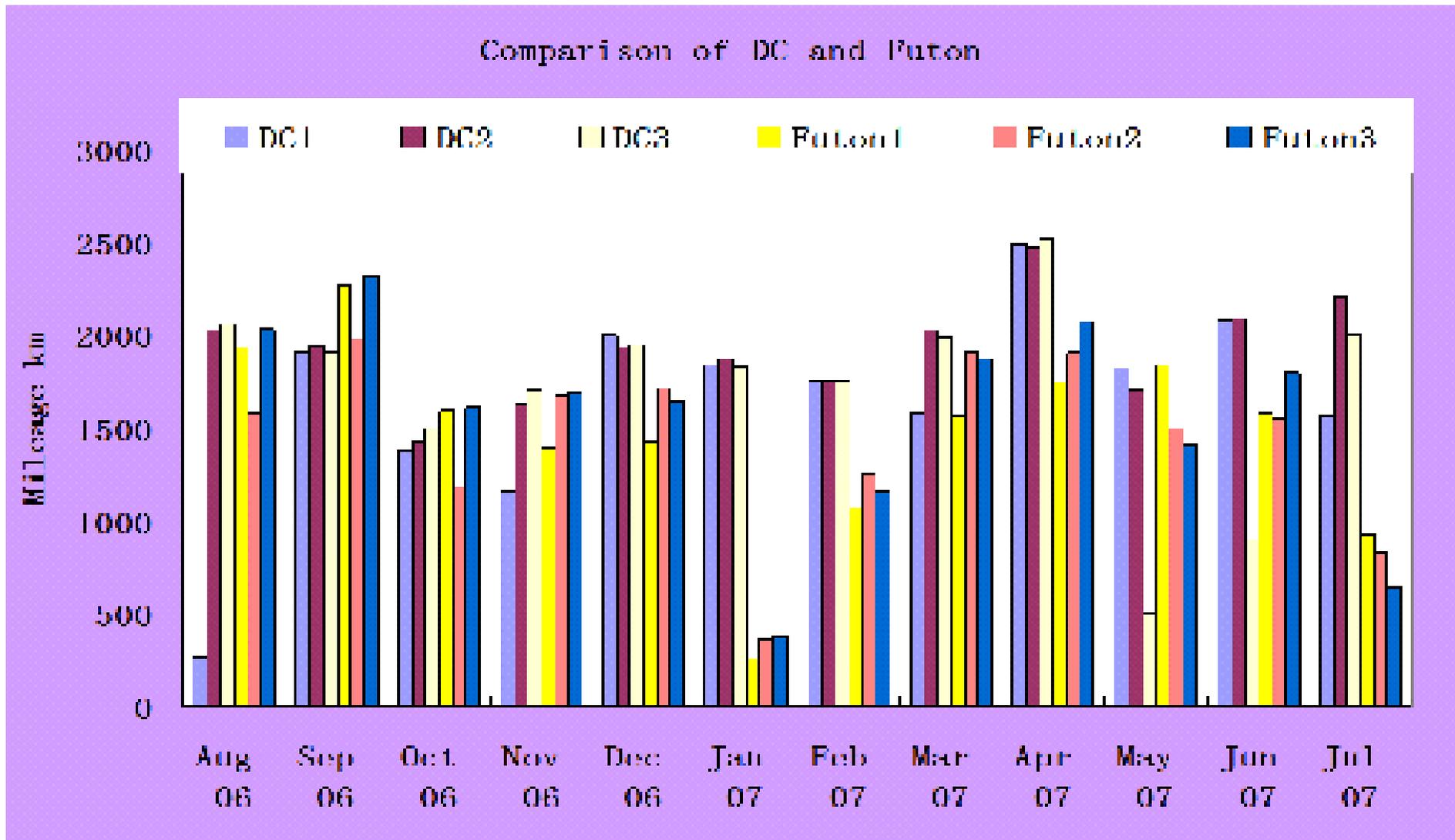


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Comparison of DC and Futon



Mileages month by month



International honor



The Hydrogen & Fuel Cell Letter
Alternative Energy News Since 1988

Recent News from the Hydrogen & Fuel Cell Letter
The Hydrogen & Fuel Cell Letter – June 2004 Issue

Provided by Fuel Cell Today. See the article on our website under:
[Knowledge Bank > Reviews & Reports > Hydrogen and Fuel Cell Letter](#)

China Report: HYFORUM Opens Window on China's Hydrogen/Fuel Cell Ambitions, Potential
BEIJING - The 2008 Olympics here are shaping up as a milestone test for Chinese hydrogen and fuel cell technologies, and judging by what Chinese scientists presented at HYFORUM 2004 here, China may emerge as a powerhouse, perhaps in the not too distant future - with some western help.

2004, the Hydrogen & Fuel Cell Letter : **“We’ll buy fuel cell buses from them 10 years from now.”**



2006 IPHE Annual Awards Program 5

IPHE Technical Achievement Award
**CUTE (Clean Urban Transport for Europe),
ECTOS (Ecological City Transport System),
STEP (Sustainable Transport Energy for Perth),
Beijing CUTE and HyFleet CUTE Projects**

The CUTE-ECTOS-STEP-BEIJING CUTE and HyFLEET:CUTE projects are joint selections to receive the inaugural 2006 IPHE Technical Achievement Award. Their selection by the IPHE Awards Committee recognizes the substantial role the projects play in advancing the global public and commercial acceptance of hydrogen fuel cell transportation systems.

The tremendous global impact of these projects directly corresponds with the mission of the IPHE to organize and implement effective, efficient, and focused international research, development, demonstration and commercial utilization activities that advance the transition to a global hydrogen economy.

- ◆ 2006, the first IPHE Technical Achievement Award
- ◆ 2010, IPHE Technical Achievement Award, Hydrogen Fuel Cell Bus Commercial-Demonstration for 2008 Beijing Olympic/Paralympics Games



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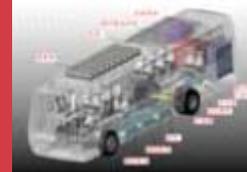


Summary



- “Fuel Cell + Battery” hybrid is a good choice for fuel cell bus in the near future
- At present, Fuel cell system is still a “noble” system, it need more cares and much money, so there is still a lot of works to do for the world, especially on its environment adaptability.





Thank you!

