China's Fuel Cell Vehicles Technology Roadmap[1]

Source: 1. China Automotive Engineering Institute, <Energy Saving and New Energy Vehicle Technology Roadmap>, Oct. 2016

Fuel Cell Vehicles _Overall Goals

In Five Years

- Technical Features: Deep dynamic power hybrid with a medium power fuel cell and a large-capacity dynamic cell
- Targets: Large-scale demonstration run of fuel cell vehicles for public service in certain areas

In Ten Years

- Technical Features: Electric-electric hybrid with a large power fuel cell and a medium-capacity dynamic cell
- Targets: Large-scale commercial applications of fuel cell vehicles

In Fifteen Years

- Technical Features: Using full-power fuel cell
- Targets: 1. Commercial promotion for millions of fuel cell vehicles in private passenger vehicles and large commercial vehicles; 2. Building hydrogen supply system mainly using renewable energy ; 3.Suppoting scale development of fuel cell vehicles

Fuel Cell Vehicles _ Development Targets, Technology Routes and Priorities

Development Targets

It is supposed that fuel cell vehicles will develop from demonstration run to large scale applications gradually in 2020 to 2030

Scale of Fuel Cell Vehicles(Units)

2020	2025	2030
5,000	50,000	Billions

Power of Fuel Cell Vehicles(kW/kg)

2020	2025	2030
2	2.5	2.5

Durability of Fuel Cell(Hours)

2020	2025	2030
5,000	6,000	8,000

Technology Routes

- **Key Material Technology of Fuel Cell**
- **Fuel Cell Pack Technology**
- **System Integration and Control**
- **Dynamic System Development**
- **Design and Integration of Fuel Cell Vehicles**
- **Improving Power Density**
- **Improving Durability**
- **Lowering Cost**
- **Improving Safety for Hydrogen Loaded**

Development Priorities

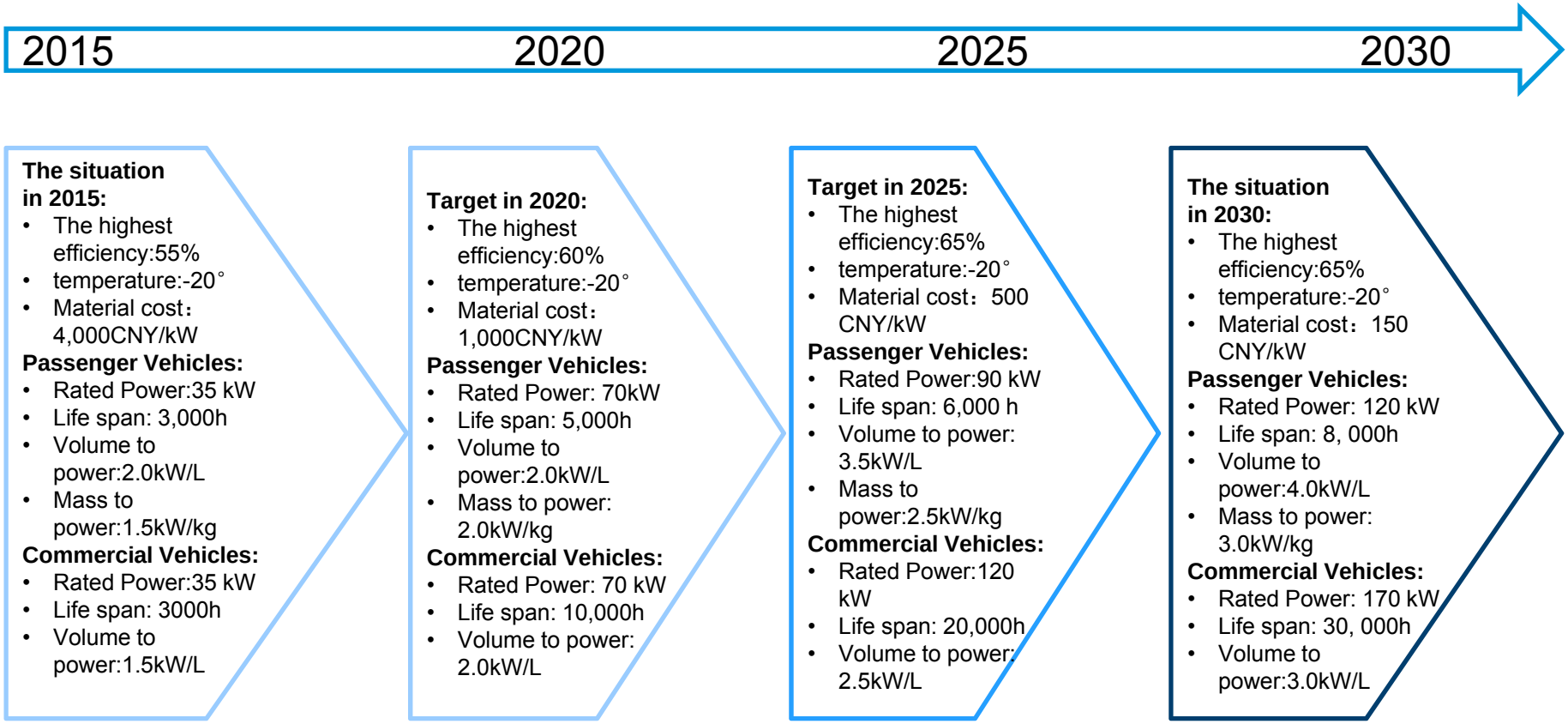
- ✓ **New core materials for fuel cell**
- ✓ **Advance fuel cell pack**
- ✓ **Key technology for auxiliary system parts**
- ✓ **High-performance of fuel cell system**
- ✓ **Hybrid fuel cell power system**
- ✓ **Basic facilities for making hydrogen , carrying hydrogen, storing hydrogen and adding hydrogen**

Fuel Cell Vehicles_ Overall Technology Routes

Overall Technology Route

		2020	2025	2030
Overall Targets		Demonstration run scale of 5,000 units fuel cell vehicles for public service in certain areas	50,000 units fuel cell vehicles for private and public service	Commercial promotion up to millions units of fuel cell vehicles for private and public service
		Per company produce more than 1,000 fuel cell vehicles	Per company produce more than 10,000 fuel cell vehicles	Per company produce more than 100,000 fuel cell vehicles
Fuel cell vehicles using hydrogen power	Performance Requirements	Optimizing dynamic system design, the same cost as the electrical vehicles, cold start temperature -30°	Cold start temperature -40° , lower purchasing cost, the same as the hybrid energy vehicles	The same performances of fuel cell vehicles as traditional vehicles, having compared advantages
	Commercial Vehicles	Durability: 400,000 km Cost≤ 1.5 million CNY	Durability: 800,000 km Cost≤1 million CNY	Durability: 1 million Cost≤ 0.6 million CNY
	Passenger Vehicles	Life span: 200,000 km Cost ≤ 300,000 CNY	Life span: 250,000 km Cost ≤ 200,000 CNY	Life span: 300,000 km Cost ≤ 180,000 CNY
Key parts technology		Key auxiliary parts meeting the standard like oil-free air compressor, hydrogen circulatory system, 70MPa storage bottle		System cost lower than 200CNY/kW
Hydrogen Infrastructure	Hydrogen Supply	Hydrogen production from renewable energy; Hydrogen desperation using low cost and high efficiency approach; Hydrogen production using subsidiary from coke oven gas		Producing hydrogen using renewable energy
	Hydrogen Transportation	Storage and transportation of high pressure gaseous hydrogen	Transportation of low temperature liquid hydrogen	Storage and transportation of high density organic liquid in the normal pressure
	Hydrogen Station	More than 100 units	More than 300 units	More than 1,000 units

Fuel Cell Vehicles _Technology Routes of Fuel Cell Pack



Fuel Cell Vehicles _ Improvement of Fuel Cell Pack

Performance Improvement

- Optimizing membrane electrode structure and the structure of metal and graphite bipolar plate based on existing materials
- Using electrode material and cell pack structure
- Intensifying verification of new materials and structure

Life Span Improvement

- Optimizing cell pack design and improving consistency of key parts in the cell pack
- Developing efficient water management technology and applying new materials
- Optimizing water management technology of cell pack and intensifying new material application

Environmental Adaption

- Research on low temperature performance of key materials and parts
- Developing cell pack technology in cold temperature
- Developing thermal management technology of dynamic system

Cost Control

- Reducing the quantity of key parts and lowering material cost
- Developing key material like compound proton exchange membrane, new catalyst; Developing volume production technology of material and graphite bipolar plate
- Using key materials and parts with low cost and lowering manufacturing cost

Fuel Cell Vehicles_ Future Forecast

Project Type	Demand for Technical Innovation	Prior Actions
Technology Foresight	• Research on core materials of new fuel cell • Research on fuel cell mechanism	• **Dynamic system of fuel cell system and integration technology in commercial vehicles** • **Dynamic system of fuel cell system and integration technology in passenger vehicles**
Applied Technology	• Technology for improving performance of the fuel cell pack • Key auxiliary parts like hydrogen circulation pump, air compressor parts • Research on fuel cell system (Engine) • Research on life span of fuel cell system(Engine) • Dynamic system of fuel cell system and integration technology in commercial vehicles • Dynamic system of fuel cell system and integration technology in passenger vehicles	
Demonstration And Industrialization	• Demonstration run for commercialization of fuel cell vehicles in some cities • International technology cooperation for fuel cell vehicles	
Common Platform	• Test and evaluation platform for dynamic system of fuel cell • Innovation platform for hydrogen energy system	