



China Electric Vehicles BEV/FCV

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Battery Electric Vehicles and related technology were first defined within China's 12th Five Year Plan (2011 -2015)

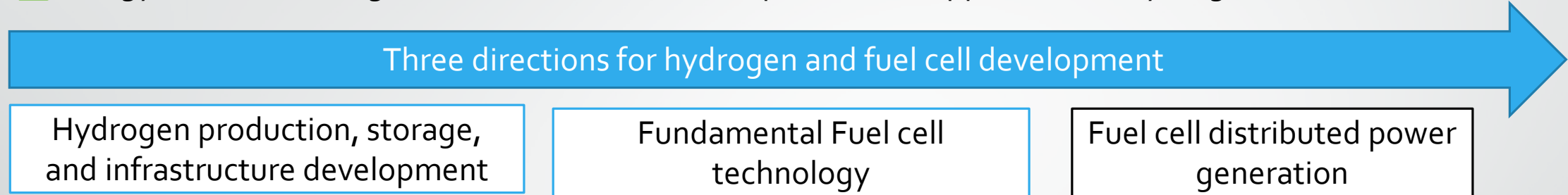
Battery electric vehicles in China

- During the 12th five year plan, China made large incentives available to many Chinese companies to acquire technology, establish engineer capabilities, and build Battery Electric Vehicles (BEV)
 - Today China operates more BEV's than the rest of the world combined
 - The core technologies are now Chinese owned; technology & manufacturing
- The technology and Manufacturing for BEV in China is now 100% Chinese supply
 - Only Chinese OEM Companies can get the defined Chinese Subsidies
 - EV's in China have unrestricted access permits to operate inside Cities.
 - There is ongoing growth of electric charging infrastructure
- While the market for BEV's in China is continuing to grow rapidly, they now look to Fuel Cell Electric Vehicles (FCV) as next logical step
 - In 2016 Global sales of BEV's was 549K vehicles, in China it was 331K (60%)
 - In 2017 Global sales of BEV's was 1.42M, in China it was 777K (55%).

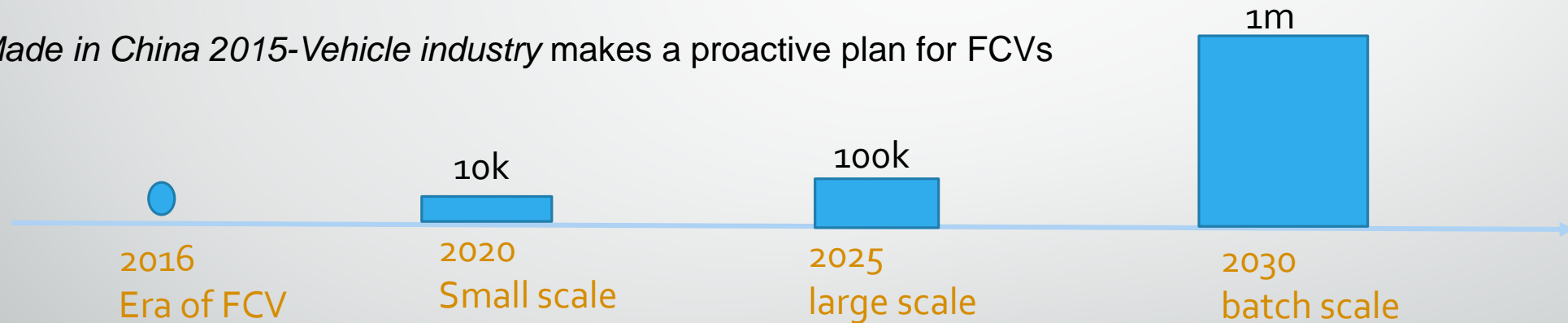
**Fuel Cells are a defined technology in
China's 13th Five Year Plan (2016 -2020)**

China's Hydrogen & FCV Development Plan

1 Energy Revolution Program 2016-2030 defines the plan for the application of hydrogen and fuel cells



2 *Made in China 2015-Vehicle industry* makes a proactive plan for FCVs



3 **13th Five Year Plan in 2016** – *alternative energy and hydrogen technology program*

Encouraging local companies to acquire the technologies for hydrogen production, storage, and fuel cell systems, in order to achieve large-scale deployment of hydrogen infrastructures and fuel cell applications

Chinese Subsidies for Hydrogen and Fuel Cell Vehicles

Key Point: Fuel cell subsidies at the state and local level proposed to be unchanged thru 2020

Hydrogen Refueling Station Subsidy (from State Government)					
\$60K per Site for Hydrogen Stations with Refueling Capacity of 200 kg/day or More					
Fuel Cell Vehicle Subsidy (2016-2020)					
	State	Local Subsidy			
Passenger Car	\$ 29,800	\$ 32,750	\$ 29,800	\$ 21,000	\$ 15,000
Light duty trucks					
6-8 meter buses	\$ 44,650	\$ 49,000	\$ 44,650	\$ 31,000	\$ 22,000
Mid-sized trucks					
> 8 meter buses	\$ 74,400	\$ 89,300	\$ 74,400	\$ 52,000	\$ 37,000
Heavy duty trucks					
Source of Sibsidy		Shanghai	Beijing, Shenzhen Shanxi, Xi'an, Hebei Changchun, Haerbin	Shenyang	Qinghai

Sources: gov. policy [2015] 134、 159 and local policies

Status of FCV Deployments

- **China is at the very beginning of developing fuel cell vehicles**
 - It is currently estimate there are <40 licensed fuel cell vehicles on the road in China
 - Primarily these are buses or light duty commercial trucks very few if any are currently in commercial service
 - Light duty trucks (7.5T & 4.5T) are currently in certification process, and perhaps up to 500 units are in construction based on confirmed orders from end users
 - **China's objectives are that there will be a total of 10,000 Hydrogen fuel cell vehicles (FCV) by 2020 and 2,000,000 by 2030 and 1,000 refueling stations by 2030**
 - Current forecast of Hydrogen fueling stations construction is likely not enough to support the projections of vehicles according to the scheduled roll-outs
 - **Subsidies are provided by both local and national governments, these are critical to the development of hydrogen fuel cell vehicles and the necessary refueling infrastructure**
 - As a result of fraud issues associated with BEV electric vehicle subsidies, the requirements for fuel cell vehicle subsidies are more rigorous, and are now targeted to the end users instead of OEM manufacturers

China Market for Fuel Cell Vehicles

- China is aggressively promoting FCV applications
 - Large commitment by National and local governments for FCV subsidies
 - FCV subsidies are larger than those used to initially promote BEVs
 - First focus is on FCV fleet vehicle applications
 - Regional public and private bus projects
 - Light duty trucks
 - Subsidy for development of hydrogen infrastructure
 - Hydrogen fueling stations
 - Hydrogen production
- Key Goal is the localization of technologies for fuel cell and hydrogen applications
 - Investments by Chinese companies in non-Chinese fuel cell companies
US Fuel Cells (55%), Ballard (20%), Hydrogenics (18%), PowerCell, Horizon

Chinese & International Participants in China FCV

- Recent Fuel Cell Vehicle Expo Rugao China

FC Company

- Plug Power (USA)
- Ballard (Canada)
- Hydrogenics (Canada)
- ElringKlinger, Germany
- Sunrise Power (China)
- Re-fire (China)
- SinoHytec (China)
- Horizon (China)
- Bing energy (China)
- Zehe energy (China)
- PowerCell (Sweden)

FC Components

- WUT Wuhan
- ATM (China)
- Dongyue (China)
- The Gore company (USA)
- Tanaka Kikinzoku (Japan)
- 3M (USA)

Hydrogen Related

- Air Liquide
- Shell China
- McPhy (France)
- Furuiz (China)
- Nel Hydrogen (Norway)
- Hexagon (Norway)
- PDC Machines (USA)
- Hydrogenious Technologies GmbH (Germany)
- Shanghai HyFun (China)
- Furui (China)
- Nantong CIMC

Research Institute

- US DOE
- California Air Resources Board
- Tongji University (China)
- Zhejiang University (China)
- China Automotive Technology & Research Center (CATARC)
- New Energy and Industrial Technology Development Organization, Japan (NEDO)

OEM

- Hyundai Motor
- Great Wall Motor
- Honda
- Toyota
- SAIC
- Yutong bus
- Foton AUV bus
- First Automotive Works (FAW)
- Dongfeng Motors
- Yaxing bus
- Yangman bus

Current Fuel Cell Bus Programs

Multiple Cities have committed to Fuel Cell Bus Deployments

Fushan



Yunfu



Yaxing



- FC bus, range >300km
- Hydrogen system: 60KW, (35MPa)
- 6m, 8m & 11m bus platforms
- More than 5 major cities have a publicly stated commitment to deploy FC buses
- Orders announced for over 2000 buses in China

SAIC FCV

- Demonstrated 2 FCVs, right one is an FC SUV with initial planned annual production of around 2000 units



- While some cars have been built, these are generally prototypes and not meant for market introduction
- Generally speaking, Chinese auto makers are looking to partnerships for gaining FC technology

Dongfeng 7.5 Ton FCV Light Duty Truck

Total of Three a Different Cell System Manufacturers Participating in the Development Phase



It has been forecast by Dongfeng that as many as 1000 trucks could be produced in 2018

2018 China FCV Outlook

- Primary focus will continue to be fleet type vehicles
 - Bus Programs >200-300 units
 - 60Kw systems with >300km range
 - 8m & 10m platforms
 - Light Duty Trucks >500-1000 units
 - 30Kw systems with >300km range
 - 7.5 ton
 - 4.5 ton

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