

BALLARD™



CASE STUDY

Fuel Cell Zero-Emission Buses for Foshan and Yunfu, China

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Situation

With China’s growing need for clean urban mass transit and to improve air quality, fuel cell electric powered transportation is one of the zero emission technologies poised to deliver a solution to the air quality problem. Foshan and Yunfu, two cities in central Guangdong Province in southeastern China, were the first to commercially operate hydrogen powered bus lines. The



development of fuel cell buses and the hydrogen industry is integral to the strategy to promote the economic development of both locations, addressing air quality and emission reduction issues through zero tailpipe emission mass transit solutions.

Solution

The planned deployment of 300 fuel cell-powered buses in Foshan/Yunfu was first announced in 2015. The consortium made exceptional progress, including localization of Ballard-designed fuel cell systems, establishment of a fuel cell bus manufacturing facility, local procurement activities, development of systems integration capabilities, national permitting of a fuel cell bus platform, preparation for hydrogen refueling infrastructure and development of the China service

team. 2016 marked the announcement by Ballard of the commissioning of an initial 12 fuel cell-powered buses in Foshan. Later that year, another 10 fuel cell powered buses were commissioned in Yunfu City. The hydrogen fuel cell buses are jointly developed by Synergy, Foshan Feichi Automobile Manufacturing Co. Ltd. Ltd., Ballard Power Systems, Tsinghua University Energy-Saving and New Energy Vehicle Engineering Center. Buses in Foshan were integrated by Re-fire and in Yunfu City by Sinohytech. These buses comprise the first hydrogen fuel cell buses in Guangdong province.

The new fuel cell buses have an anticipated driving range in excess of 300 kilometers, and an expected hydrogen gas consumption of less than 8.5 kilograms per 100 kilometers and zero tailpipe emissions. The transit route in Yunfu and Foshan will not require any catenary wires or on-route recharging.

Site	Foshan/Yunfu, Guangdong, China
System	FCveloCity®-HD85 power modules integrated on Feichi Chassis
Fuel	Hydrogen provided by Linkye Gas
Size	10.96m in length/ 78 person capacity
Bus Range	>250-300km
Objectives	Reduce urban air pollution

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Refueling

Nation-Synergy built the first commercial hydrogen refueling station in Silao, Yunfu city. Covered by 6465.3 square meters, this station has a daily hydrogen supply capacity of 500 kg and a storage capacity of 665 kg. It only takes 5-7 minutes to refuel a bus. Each refueling volume per bus is about 22kg of hydrogen and the average hydrogen consumption per bus is about 8.5kg/100km.

Foshan and Yunfu municipal governments made great efforts in accelerating the deployment of hydrogen refueling stations (HRS). In August 2018, Foshan has launched construction of another 8 HRS and set the target of construction of 28 HRS in 2019 to support the vehicle deployment. So far, 4 HRS in Foshan and 2 HRS in Yunfu are in service.

Result

The first installment of zero-emission fuel cell buses has now hit the road in both Foshan and Yunfu, with 16 buses in current passenger service. This was the first deployment of fuel cell buses in China's history. Another 80 fuel cell buses, powered by Ballard technology, as part of the 300 fuel cell buses plan, are also in service in these two cities.

Each bus in Foshan city runs about 120-140 km per day. Buses in Yunfu city run approximately 140-150 km (two round trips) per day. Community members can enjoy the green travel experience of zero pollution and the comfortable ride provided by these fuel cell buses. Since operation in 2016, Ballard powered heavy duty buses have gone through a few iterations of component improvements and software optimization. As a result, these buses have accumulated valuable technical on-site data and demonstrated proven durability and reliability through exceptional bus availability. As of now, Ballard-powered heavy duty applications are continuing to serve the public in China and contributing to the commercialization of fuel cell technology.

Given its scale and importance, this deployment in Foshan and Yunfu will serve as a major competitive advantage for Ballard and our local partners as we seek to bring additional Chinese cities on board. China's new energy program enlists 48 cities that are focused on addressing severe air quality issues, in part through expansion of public transit, with one thousand clean energy buses to be deployed in each participating city.

These efforts are just the beginning of this important market adoption. With our strong local partners, we are well positioned to address this necessary, fast-growing and dynamic market opportunity in China with our unmatched global experience providing fuel cell engines for transit buses.



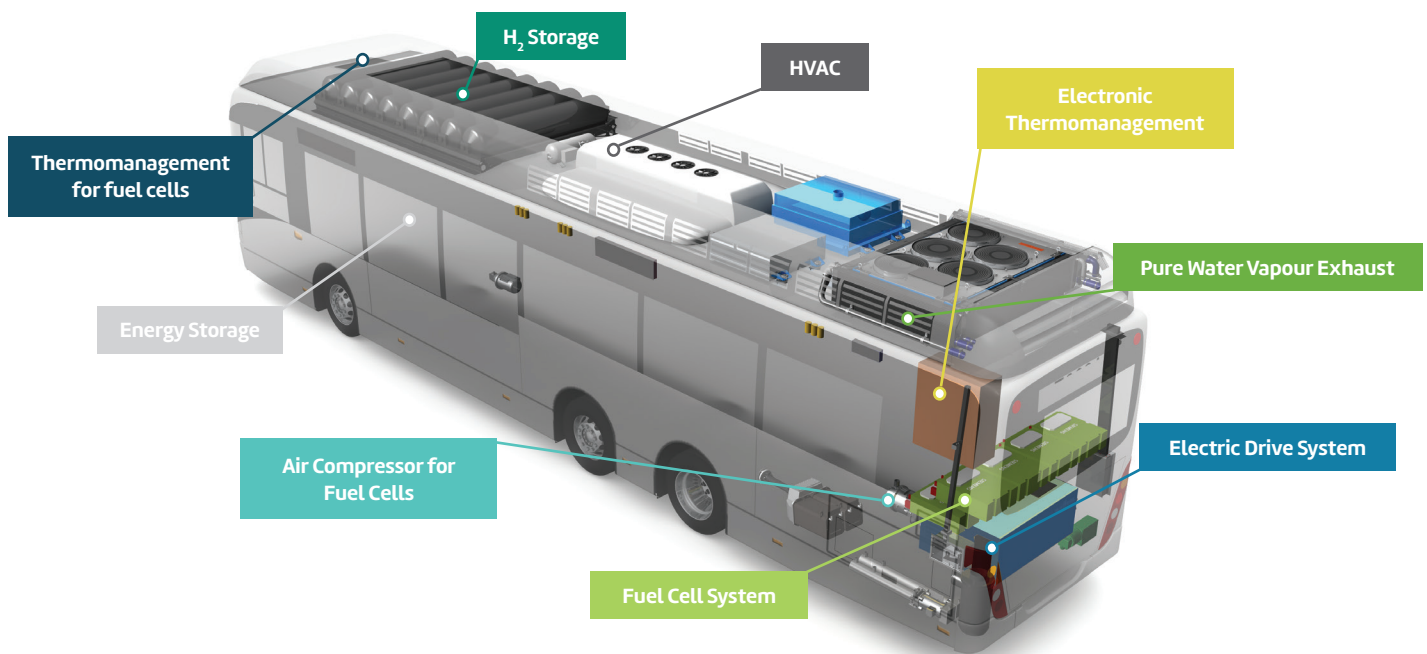
Refueling events	4,350
Refueling time	10 minutes
Availability	90%
Daily Operation	8 hours



Zero Emission Bus Technology

A fuel cell bus is an electric vehicle that uses compressed hydrogen as the fuel, rather than storing energy in large batteries. Fuel cell power modules onboard the bus generate electricity through an electro-chemical process, producing only water and heat as by-products. The electricity generated by the fuel cells powers the hybrid electric motors and charges the energy storage system. Regenerative braking on the buses increases the fuel economy. High pressure tanks located on the roof of the bus store hydrogen fuel, providing sufficient range for a full day of operation, over 16 to 18 hours.

Fuel cell power modules onboard the bus generate electricity through an electro-chemical process



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