

## Fuel Cell Vehicle Development in China

### China's energy needs and the growing role of transport

With rapid industrialization, urbanization and growth since the 1990s, China has become the world's largest producer and consumer of energy, and the largest emitter of greenhouse gases (GHGs).<sup>i</sup> These GHG emissions contribute to climate change, as well as severe air pollution that causes health problems around the country.<sup>ii</sup>

China is taking actions to address this. In the China-USA joint announcement on climate change in November 2014, China pledged to reach its emissions peak around 2030. As the world's largest investor in clean energy technologies, China also set a target for non-fossil fuels consumption to account for 15 percent of primary energy consumption by 2020 and 20 percent by 2030.

However, forecasts indicate that China's oil consumption will grow substantially over the next 20 years, from roughly 6 million barrels per day in 2013 to 13 million in 2035. This will cement China as the world's largest oil importer.<sup>iii</sup> By 2035, 75 percent of the oil China consumes will be imported. Much of this will be due to the energy consumed by the transport sector.

Rapid growth in China's auto market – as shown below – has made the country number one in annual auto sales globally since 2009.

2006	2007	2008	2009	2010	2011	2012	2013	2014	2020 (e)
7.1	8.3	8.9	13.3	17.3	18.0	19.3	22	23.5	31.0
<b>Growth</b>		2005-2012 CAGR: <sup>iv</sup> 18%    2012-2020 forecast CAGR: 6%							

Table 1: China's Annual Sales of Auto Vehicles (millions of units)<sup>v</sup>

That said, China's vehicle ownership rates are still a fraction of those in some other countries. For instance, in 2010 China's rate was 58 vehicles per 1,000 people compared to the US's 804 per 1,000 per people.<sup>vi</sup> However, growth to date indicates that the transport sector now accounts for 10 to 15 percent of China's total energy consumption,<sup>vii</sup> and 7 percent of China's CO<sub>2</sub> emissions. Although further growth of auto sales in China is projected to slow down compared to the past 10 years, such growth could create real challenges for China in meeting its climate change targets, and therefore has great implications domestically and for the rest of the world, especially for the poorest countries and ones that are most vulnerable to climate change.

### Fuel cell vehicles – are they the answer?

For China to reach its climate change goals while allowing vehicle sales to continue to increase, estimates suggest that it will not be enough to simply improve the energy performance of traditional internal combustion engine (ICE) vehicles. It will also be critical to develop new energy vehicles (NEVs), namely, vehicles that can be recharged from non-fossil fuels such as electricity, natural gas and hydrogen. NEVs include electric vehicles (EVs), hybrid-powered vehicles as well as fuel cell vehicles (FCVs). In particular, FCVs are vehicles powered by fuel cells that convert chemical energy from

hydrogen into electricity to power the car and emit nothing but water.

The NEV sector has the potential to improve energy efficiency by 30 percent on average by 2020.<sup>viii</sup> This is important, as further improvement on ICE vehicle efficiency requires advancing the development of hybridization technologies and materials, which may be costly.

However, NEVs come with their own costs. The 2007 *IPCC Mitigation Report* predicted that by 2030, without major breakthroughs, EVs will still be relatively costly.<sup>ix</sup> On the other hand, the cost of fuel cell systems is expected to decrease by 90 percent by 2020, as a result of economies of scale and incremental improvements in technology.<sup>x</sup> In addition, NEVs are not all the same. It is expected that by 2030, the overall cost of large FCVs will be lower than other types of NEVs, and significantly lower than ICE vehicles by 2050.

Indeed, China conducted its first research on fuel cells in the 1950s, and since the 1990s has been undertaking R&D and demonstration work on NEVs. However, while China now leads the world in annual deployment of new energy buses, figures show that NEV sales have been lagging in China compared to other countries.<sup>xi</sup>

This is not just coincidence. Countries like Japan, the US, Germany and South Korea have launched ambitious FCV development programmes and made marked progress in expanding a hydrogen fuel infrastructure, enabling industry leaders such as Toyota and Honda to begin commercial production.

### What prospects for FCVs in China?

A recent study comparing FCVs to other EVs found that FCVs are an effective low-carbon solution for a large proportion of China's transport fleet – but mainly buses, trucks and trains.<sup>xii</sup>

FCVs have a driving performance (similar acceleration), range (around 600 km) and recharging time (<5 minutes) comparable to those of ICE vehicles. They are feasible low-carbon substitutes for ICE vehicles for medium/larger cars and buses, especially for longer trips, potentially achieving an 80 percent CO<sub>2</sub> reduction by 2030 compared to today (when the source of hydrogen is non-fossil fuel-based).<sup>xiii</sup>

In addition, China has – in theory – two comparative advantages in FCV development. First, with the largest bus market and bus production capacity in the world, China's manufacturers have developed strong expertise in electric buses. There is an opportunity to bring in internationally advanced fuel cell stack technology and integrate it with Chinese electric bus technology in a series of hybrid fuel cell buses. Second, because of China's scale, it has the ability to reduce production costs. This may be of benefit to the industry both in China and internationally if the cost of certain components of FCVs can be reduced.

While China possesses these comparative advantages in FCV development, based on our analysis of the Chinese market and international experience, we believe there are five specific barriers that need to be overcome to make this a reality:

## 1. Technology

While it has already been noted that China's FCV manufacturers have many strengths, there is a general lack of access to quality FCV components and capability to increase the cost-effectiveness of producing components. Without this, it will be difficult for Chinese-made FCVs to cut costs while improving durability and performance.

## 2. Fuel infrastructure

Currently, China has only two hydrogen recharging stations (HRS) to support FCVs. This lack of HRS has arisen through a lack of reliability and financial viability of HRS and sustainable business models for HRS in China. There is also a lack of low-cost, low-carbon hydrogen, and a lack of HRS operations and management capacity. Expanded supporting infrastructure is badly needed.

## 3. Policy support

China has yet to develop supportive policy and regulatory frameworks for FCVs and HRS. While China has developed explicit plans and targets for other areas requiring technology development and demonstration roll-out (notably EVs), there is no such official plan for FCVs and HRS. In addition, the absence of clear and comprehensive standards and certification systems in China also poses challenges in the approval of FCVs and HRS at both national and local level. The government's mixed policy signals to date have made it difficult for the industry and markets to develop, lowering the confidence of local governments and potential investors in pursuing FCV development.

## 4. Awareness

As an awareness-raising strategy, in 2008, China demonstrated and operated fuel cell buses at the Beijing Olympics and the Shanghai Expo. In addition, in 2009, the Ministries of Finance and Ministry of Science & Technology launched a demonstration programme known as the "Thousands of Vehicles, Tens of Cities" ("Cities Programme") to promote NEVs in the public sector on a larger scale, maintaining its goal to have 5 million NEVs on the road by 2020.<sup>xiv</sup> However, beyond this, it is fair to say that in general, government officials and the general public know little about FCVs and their development. Nor do they have reliable information sources on the FCV market and technological developments. Yet, sales will not be possible without demand.

## 5. Operational and financial capacity

Last but not least, there is a lack of investor interest in this market, mainly because there is insufficient clarity about the market and its operational capacity. Although lack of clarity is not unique in China, ensuring reliable information about the FCV market and technological developments for investors in particular could make a major difference, enabling the operations and financial sector to better evaluate FCV-related investment opportunities.

## Suggestions for the way forward

The five barriers identified above are difficult, but possible to address. First, a national FCV roadmap could be developed to provide clear guidance, with associated financing for this industry. This could include policy and regulations at national and local level to facilitate the approval process of FCVs, issue license plates and pilot incentive policies.

To support local manufacturers in producing high quality products, domestic industrial standards and certification systems – that are ideally consistent with international standards – on FCV components, hydrogen storage and so on could also be created. Such manufacturers could also be exposed to leading international technologies and connected with top international component vendors. This would help reduce the cost of FCV production while improving the performance and durability of FCVs made in China.

The cost and viability issues facing hydrogen production and HRS in China could be addressed by introducing international

experience and technologies from countries like the US, Japan and Germany. Increasing the number of hydrogen producers in China as well as helping them improve logistics would also bring down costs. In addition, a capacity building programme could be established to provide training, guidance and technical assistance for local HRS operators.

Finally, to enhance awareness, a public advocacy campaign is needed along with the establishment of knowledge programmes for policy makers and investors to gain more understanding about FCVs. In addition, an open platform could be established to provide up-to-date information on FCV development in China and worldwide, particularly for investors.

In sum, developing the NEV market in China will be key to helping its own population and other developing countries meet climate change goals while enabling economic growth. It will also contribute to China's domestic plans to shift towards a more innovation-based economy. Within this market, China's greatest potential lies in FCVs. But more work will be needed by the Chinese government to make this a reality, and UNDP is supporting this work to take place as soon as possible.

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<sup>i</sup> The International Energy Agency (IEA) indicated China surpassed the US as the world's top energy consumer in 2009. The US Energy Information Administration (EIA) indicated China became the world's largest producer of primary energy in 2009 and largest primary energy consumer in 2011. Some experts suggest that since 2006 or 2007, China has been the world's largest emitter of GHGs. In 2010, China acknowledged its role as the world's largest emitter of GHGs.

<sup>ii</sup> The "2010 Global Burden of Disease Study", published by the Lancet, a British medical journal, suggested that outdoor air pollution contributed to 1.2 million premature deaths in China in 2010.

<sup>iii</sup> Energy Information Administration (2014).

<http://www.eia.gov/todayinenergy/detail.cfm?id=15531>

<sup>iv</sup> CAGR: Compound Annual Growth Rate.

<sup>v</sup> Accenture. (2013). "China's Automotive Market".

<http://www.accenture.com/sitecollectiondocuments/pdf/chinas-automotive-market-consumer-digital-marketing-insights.pdf> and

Bloomberg Business News (various articles for 2013, 2014, and 2015).

<sup>vi</sup> Y. Wang, Teter, J. & Sperlin, D. (2012). "Will China's Vehicle Population Grow Even Faster than Forecasted?"

<http://www.uctc.net/access/41/access41-chinafleet.pdf>

<sup>vii</sup> Hailin Wang, Xi Yang, and Xunmin Ou (2014) "A Study on Future Energy Consumption and Carbon Emissions of China's Transportation Sector," *Low Carbon Economy*, 5, 133-138.

<sup>viii</sup> McKinsey & Company (2010). "A Portfolio of Power-Trains for Europe: A Fact-Based Analysis. The Role of Battery Electric Vehicles, Plug-in Hybrids and Fuel Cell Electric Vehicles".

[http://www.zeroemissionvehicles.eu/uploads/Power\\_trains\\_for\\_Europe.pdf](http://www.zeroemissionvehicles.eu/uploads/Power_trains_for_Europe.pdf).

<sup>ix</sup> South China Morning Post on July 15, 2014 offered the following comparative data for NEV sales for 2013: US 110,000, Japan 50,000, and China 17,600.

Celine Sun (2014). "Policy Shot in the Arm for New Energy Vehicles".

<http://www.scmp.com/business/china-business/article/1554316/policy-shot-arm-new-energy-vehicles>

<sup>x</sup> Kahn Ribeiro, S., S. Kobayashi, M. Beuthe, J. Gasca, D. Greene, D. S. Lee, Y. Muromachi, P. J. Newton, S. Plotkin, D. Sperling, R. Wit, P. J. Zhou (2007). Transport and its infrastructure. In *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, United Kingdom & New York, USA.

<sup>xi</sup> International Energy Agency (2009). *World Energy Outlook*.

<sup>xii</sup> Same as note viii.

<sup>xiii</sup> Same as note viii.

<sup>xiv</sup> From Ministry of Science and Technology, February 2015, "National Key R&D Plan for Key NEVs Project Implementation (for comments)".

[http://www.most.gov.cn/tztg/201502/t20150216\\_118251.htm](http://www.most.gov.cn/tztg/201502/t20150216_118251.htm)