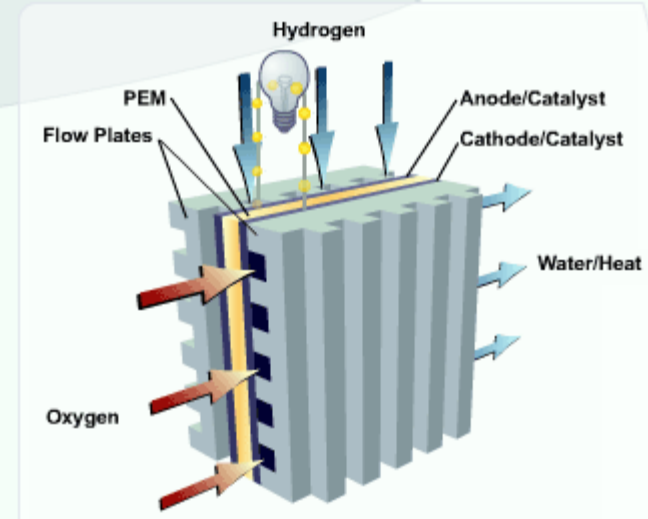
The China Fuel Cells Market

Economic renaissance may flower on technological advance, but it stems from the slow-growing seed of technological discovery. Ancient China's so-called Four Great Inventions bear testament to this. The science behind the compass, printing press, paper and gunpowder was known for centuries before Song Dynasty engineers put them to use; the vigor of the Middle Kingdom's first renaissance creating a need for navigation, mass communication, banknotes and defense. As with the rest of the world, the market in China hasn't found a profitable use for fuel cells yet. Current costs are too high, efficiencies too low, and the infrastructure needed to support its commercialization isn't in place. But within the scale and diversity of the demand for carbon energy there is an immense, latent need for alternatives. Should the price of hydrogen and fuel cell components approach parity, China's fuel cells market will become the world's largest.

A fuel cell is a generator of electrochemical energy. It consists of two reactant gasses (hydrogen and oxygen), conductors (anode, cathode and electrolyte), and a catalyst. Energy conversion starts when a hydrogen molecule at the anode comes into contact with the catalyst, splitting it into two hydrogen atoms which exothermically release their electrons that travel through a DC circuit. The now positively charged hydrogen is attracted to negatively charged oxygen molecules at the cathode. The electrons, having completed their journey are reunited with the reactant molecules at the cathode where a byproduct, water, is formed. The process is free of combustion and is several times more efficient than deriving energy from gasoline.

Figure 1: Workings of PEM Fuel Cell



Source: Department of Energy

And unlike gasoline, hydrogen is never going to run out. NASA estimates up to three-quarters of all matter, or nine out of every ten atoms, in the universe is the element known as H.[1] On Earth it exists in compounds with other elements like water (*hydro genes* means "born from water" in Greek), which means it must be isolated for fuel cell use. Thus fuel cells have three product categories. The first uses pre-isolated hydrogen, the second cracks hydrogen from methanol and ethanol, and the third reforms hydrogen-rich fossil fuel compounds such as coal and natural gas. Currently there are multiple fuel cell types for each of the three categories. These are used in stationary applications such as residential and industrial power generation; portable applications such as transport; and mobile applications such as cell-phones and notebooks.

The Market-at-a-Glance

Chinese interest in fuel cells can be traced back to programs by the Dalian Institute of Chemical Physics and the Chinese Academy of Sciences (CAS) in the 1960s. Research efforts at the time focused on alkaline fuel cells (AFC), which uses purified hydrogen and an electrolyte made of a potassium hydroxide solution (still used in alkaline batteries). It is unclear how productive this initiative was, but given the country's academic hiatus in the 1960s and

[1] http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/971113i.html

70s and the lag behind Western fuel cell technology, it is reasonable to assume that progress was halting and reverse engineering high on the agenda.

China's industrialization in 1980s was fueled by, and created for, the wider availability of technology. In March 1986, Deng Xiaopeng instigated the 863 program (named after its inception date), an initiative to stimulate high-tech industries. Money was later made available from the program to fund fuel cell research and development in universities in Dalian, Wuhan, Shanghai and Beijing. Development continued incrementally through the 1990s when the spate of fuel cell IPOs in North America and Europe raised the prospect that a fuel cells company could profit. Around that time, fuel cell companies were created by the CAS, universities, the Ministry of Science and Technology and other state entities. Private funding followed soon after and the twelve or so Chinese fuel cell suppliers today range from a professor's part-time project to a foreign-invested concern, focused on competing with the likes of Ballard and Toshiba.

Currently, the only commercially available fuel cell in China is the proton exchange membrane fuel cell (PEMFC). This uses pre-isolated hydrogen and is most suited to portable applications such as road transport. Other types of fuel cells see little light outside of the laboratories of academia and government. These include solid oxide fuel cells (SOFC), suited to stationary applications, and AFC, which is used in China's nascent space program. Other types of fuel cells such as direct methanol, regenerative, and molten carbonate exist as showpieces only.

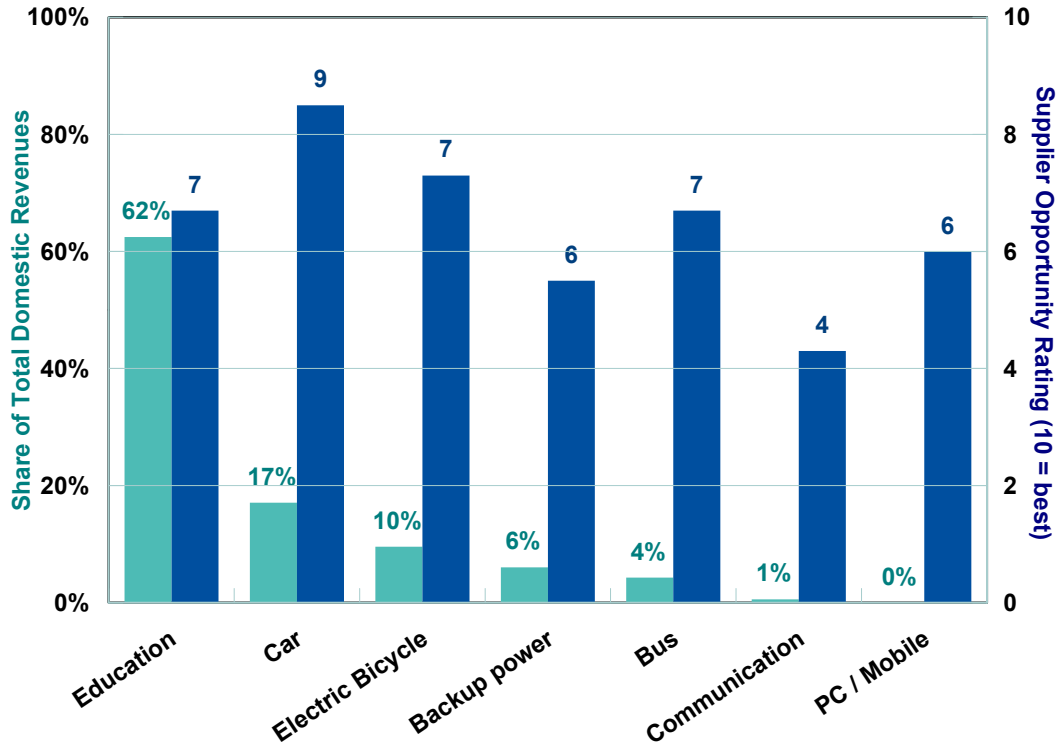
There are no major foreign suppliers selling into the China market. Companies like Ballard have worked on local fuel cells projects and others such as Hydrogenics supply hydrogen production equipment. But the selling of fuel cells to the Chinese market is the domain of domestic suppliers. Intellectual property protection is a likely reason for this, so too is the size of the domestic market, valued at around USD 3.2 million.

Of those that sell to the domestic market, Dalian Xinyuan Dongli reported the highest revenues. Jiangsu Huayuan, Shanghai Shenli and Shanghai Boneng also report revenues in excess of USD 150,000 (RMB 1m).

PEMFC sales last year generated an estimated USD 16 million for Chinese fuel cell suppliers, of which 80% came from exports to the U.S. and Japan. Educators are the market's biggest customers; buying upwards of two thirds of all China's fuel cells for classroom demonstrations and science projects. The auto industry, tipped as the brightest hope for fuel cells in years to come, is a smaller customer in the China market. Despite a conceptual interest from most major car manufacturers and a race by Chinese manufacturers to get an electric car on the market, fuel cells are either being developed in-house or abroad.

Another seemingly promising industry is electric bikes. Around 15 million battery powered bikes were sold in China last year, creating a total market size of 75 million; the world's largest by a long stretch. Forklift trucks also present an opportunity. Like electric bikes, they require a long steady discharge form their batteries (as opposed to the short burst of energy from a car's starter battery), which makes them naturally suitable for fuel cells. Other markets for fuel cells in China include back-up power (which has a wide range of applications from ATMs to hospitals, mines, and communications) and consumer products. Although these are small markets at present, suppliers think that in the future, opportunities may equal or exceed those of education (see figure 2).

Figure 2: Perceived Opportunities and Revenue Breakdown – China Fuel Cells



Source: GCiS

Adam Smith's Objections

As with other countries, the cost of fuel cells in China is too high to be considered a serious substitute for conventional power sources. The issue is all the more acute in a country where fuel is subsidized by the government and sufficient deposits of lead, lithium and coal exist. Consider the difference in price between a conventional lead-acid bike battery and its fuel cell equivalent. The 240 watt lead-acid cell costs around USD 300 or around USD 1.20 per watt. A 25-stack PEMFC that produces 220 watts costs ten times this amount. The price difference for other applications is similarly high, ranging from six to ten times more for customers wanting hydrogen power. A fuel cell car, according to PEMFC supplier Beijing Speed Eco-power, can be yours for USD 2.2 million, the cost of an executive helicopter.

Fuel cell costs are not just a reflection of the tiny scale on which they are produced but of inherently high raw material costs, namely the platinum catalyst and carbon electrodes. Platinum is twice as expensive as gold and

rarer still in China. Currently only a handful of western companies can refine this precious metal and build a catalyst. Carbon electrodes also require a high degree of precision engineering to ready them for use. As such, most fuel cell electrodes and all platinum components must be imported.

High costs extend beyond that of raw materials. Hydrogen, for all its abundance and eco-amiability, is expensive to isolate and store and the amount of fossil fuel it takes to produce would have most environmentalists running for the nearest Hummer. Industrial production is typically achieved by way of steam reforming natural gas, which results in significant amounts of waste carbon monoxide and dioxide. Furthermore, being the least dense substance in the universe, it cannot efficiently be captured, transported and stored.

Case Study: China's Fuel Cell Bus Service

China's only fuel cell powered commercial bus service is run from Hydrogen Park, located a few miles north of Tsinghua University's campus in Beijing, consists of a fueling station and fuel cell bus depot. The first stop on the journey is at the park's forecourt, where an ordinary looking dispenser stands a short distance from a moon-base of intertwining pipes, compressors, filter tubes and several giant tanks marked with the Chinese character "爆", meaning explosive. Fueling takes 20 minutes, thereafter an engineer gingerly drives the half a million USD vehicle from Tsinghua University to Renmin University, five miles south and back. A ticket costs one Yuan, the same as its carboniferous counterpart, though the bus itself costs six times more.

But the biggest impediment to the fuel cell industry isn't the cost of new technology. These can, and likely will, be incrementally brought down as we find cheaper ways to produce hydrogen and part it with its electrons. Nor is it with the fuel itself. It is the sunken costs that are in the current energy industry,

particularly at the consumer level, that are too large to allow Hydrogen's easy passage.

China will not see a hydrogen dispenser at the forecourt anytime soon. According to the China president of a U.S. multinational leading the market in gas dispenser equipment, the majority of China's gas stations were built less than a decade ago, so the investment that has gone into them has yet to be recouped. Hydrogen, which is more susceptible to ignition than gasoline, would need a specialized storage facility at each station. Each station would also require specialized pumps and dispensing equipment, costing up to USD 5 million a pop. Add to that the delivery vehicles, storage silos and all the equipment related to them needed to keep hydrogen pure and safe right up to the production plant and it becomes clear that for now, fuel cells have no place in cars in China.

Investors and parent companies have recognized that 2009 and 2010 will be particularly cruel to cash burning companies in this industry. Like their publicly listed counterparts abroad, China's fuel cell suppliers all reported losses in 2008 and are scaling back. Some, like Zhongshan, a Chinese producer of motorcycles and ATVs, have pulled out of the fuel cells business to focus on refining battery power vehicles. Other companies such as Ford are "suspending" fuel cells development programs as they battle the recession. Most domestic Chinese companies are seeking loans or investment, while some are hoping to refinance on their losses. Repayment periods are an unappetizing ten to 15 years hence.

Despite the high cost hurdles the industry must overcome, there are long term opportunities in the market. Firstly, China is committed out of necessity to finding and using alternative energy sources. Electric vehicles, once banned for encroaching on the turf of the automobile, are now encouraged in cities. There are plans to roll out charging stations in 15 major Chinese cities soon, where drivers could swap old cells for new in the time it takes to fill a car today. BYD Auto, noted for its investment by Berkshire Hathaway, is commercializing an affordable electric car. If this catches on in China, there will certainly be

enough demand for the electron to warrant an automotive power grid. Could fuel cells stay upstream powering the charging stations?

Like its Song forbears, modern China is enjoying the fruits of mature technology while exploring creative solutions to environmental problems. The 10th Century renaissance produced history's first green initiative: a reforestation program on the state's northern boarders. But it didn't last, because despite its appealing aesthetics and prospect of military advantage, it didn't make sense economically. True, the modern day cost per mile driven, hour online, and kilowatt generated is rising while that of the fuel cell is falling. But the gap between the two is so wide that the time taken to reach parity could be measured by the coming and going of dynasties.