

Electric Vehicles: A New Industry (slowly) Emerges

Electric vehicles have attracted substantial backing from both governments and private sector investors around the world. There has been something of an investment bubble – but we shouldn't ignore the fact that we are witnessing a revolution in transport.

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Fast cars tend to dominate the headlines in the automotive industry, so it is no surprise that the electric vehicle (EV) industry has its own 'poster child' in the form of Tesla Motors. Tesla received private funding of over US\$230 million from high profile venture investors, including PayPal founder Elon Musk, before listing on NASDAQ through an IPO. It introduced its first vehicle, the Tesla Roadster, in 2008 and its second, the Model S four-door sedan, has recently been the recipient of industry awards. Tesla is currently valued at US\$3.6 billion and is proof that it is possible to launch a new car company – indeed a new electric car company – in a large established marketplace. However, Tesla remains lossmaking and there is still a way to go before it can be held up as a true example of a successful new electric car company.

At the other end of the spectrum are two-wheel EVs. This market segment is growing rapidly, dominated by China and the Asia Pacific region which account for 95% of sales of electric bikes. The combined electric bike and electric motorbike market is growing at around 10% annually and approximately one in seven bikes sold in the world are battery assisted, according to Pike Research – which forecasts that there will be 466 million electric bikes and motorcycles on the road by 2016. A number of new top end electric motorbike manufacturers have emerged and are raising funds. Brammo of the US received funding from Polaris Industries earlier this year and Australia's Vmoto recently listed on the London Stock Exchange AIM market in conjunction with a fundraising round. However, the vast majority of electric bikes sold are basic battery assisted bikes: they mark the first step up from owning a push-bike in countries such as China. Although a far cry from a luxury sports car like the Tesla, they also represent a big business opportunity.

Tesla's original investors were from Silicon Valley, and California has been a hotbed of venture funding for new EV businesses, having spawned companies including CODA Automotive and Fisker Automotive. The EV industry is not predominantly comprised of start-ups however. Virtually all the major automotive companies around the world have been focusing on electric cars in one form or another.

Amongst the automotive OEMs there is something of a divide between those who have launched pure EV models and those who have focused on hybrids. The Renault/Nissan Alliance stands out as a pioneer with the launch of mainstream battery EVs, as does Mitsubishi. Others, such as Ford and GM (with the Chevy Volt in the US and the Ampera, under its Vauxhall and Opel brands, in Europe) have gone down the plug-in hybrid route. Cars such as the Volt/Ampera – battery EVs with range extenders – are designed to overcome the current lack of availability of EV infrastructure. The 'range anxiety' challenge (the fear of being stranded beyond the reach of a charging point infrastructure) is perceived as a significant barrier to adoption of EVs. Some investors are focusing on developments which can overcome this problem, such as innovative range extender technologies like the mini jet turbine being developed by Bladon Jets, in conjunction with Jaguar Land Rover/Tata.

Toyota, which led the way in terms of hybrid technology with the Prius, has launched plug-in hybrid versions of its vehicles. However, Toyota stated recently that it would also concentrate on fuel cell EVs – which we'll discuss later in this feature. (Hyundai and Honda also have a strong fuel cell focus.)

A couple of years ago the perceived wisdom was that 'range anxiety' wouldn't pose much of a problem in China. The argument was that most of China's car buyers over the next decade would be first time car owners, likely to be content with driving habits falling within the scope of what vehicles. China also has the advantage that it doesn't need to displace existing infrastructure. In a white paper published by the State Council Development Research Center Enterprise Institute, China has endorsed 'business model innovation' as the key to adoption of EVs. China's policy involves models to overcome slow charging and the high cost of EVs through battery exchange. The battery exchange model strategy involves allowing electric utilities to charge batteries centrally – and time their charging to help balance grid loads and provide stabilisation to the electric grid.

Substantial volumes of research and development have been pumped into EVs around the world. Large scale R&D support in Europe came from the EU Green Cars Initiative, part of the European Economic Recovery Plan. This offered €4 billion (US\$5.4 billion) in loans from the European Investment Bank plus a further €500 million (US\$678 million) via the Seventh Framework Programme, to be matched by an additional €500 million from public private partnerships with member states and industry.

The Chinese Government has a budget for investment of over RMB100 billion (US\$15 billion) over the ten years to 2020 to develop the entire plug-in vehicle (PEV) industrial chain. By 2010, five Chinese auto manufacturers had launched PEVs on the market. BYD, one of the best known Chinese EV companies in the West, was reported by Accenture to have invested RMB2 billion (US\$300 million) in PEV R&D. Shanghai Automotive Industry Corporation (SAIC) was reported to be investing RMB6 billion (US\$900 million), while Dongfeng Automobile Co. (DFAC) announced plans in 2011 to invest a massive RMB33 billion (US\$4.9 billion) in EV R&D over ten years.

In May 2012, China announced a US\$4.19 billion subsidy programme covering electric cars, plug-in hybrids and other vehicles with energy saving engines. China's target is to have 500,000 electric cars on the road by 2015 and a total of 5 million (cumulative) by 2020. So far, however, the take-up of electric cars has been slower than expected in China, and indeed early volume production of EVs has been lower than anticipated virtually everywhere. With overall automotive sales depressed in markets around the world, this is hardly surprising.

Battery Charging Infrastructure

Battery EVs need to be charged, and the chicken-and-egg deadlock of charging infrastructure can really only be broken by governments. Governments across the world have been working on this challenge. Countries of all sizes have deployed charging infrastructure, ranging from small countries like Denmark or Portugal to large nations like the US. In the UK, the Plugged in Places programme is building 11,000 vehicle charging points in streets, car parks, outside supermarkets and shopping centres. However, other nations have taken a different tack. Vancouver in Canada, for example, is prioritising the roll-out of private charging infrastructure in homes and made charge points compulsory in all new family homes and 20% of parking places in new apartment blocks.

Meanwhile, EV charging infrastructure has attracted much attention from investors. Amongst the most high profile fundraisings in the charging infrastructure space has been Better Place, the Israeli company with a business model based on its battery exchange mechanism (the battery is replaced entirely, avoiding the need for recharging).

Better Place was founded by former SAP executive Shai Agassi and has raised significant sums of private funding through a couple of investment rounds. The most recent, a Series C equity fundraising in November 2011, included new investors GE and UBS AG and valued Better Place at US\$2.25 billion, pushing it into the ranks of the best ever privately funded cleantech companies.

The battery exchange concept has been adopted by China. NASDAQ-listed Kandi Technologies Corp., a Chinese manufacturer and developer of pure EVs, is rolling out the country's largest pure EV programme – involving 20,000 vehicles – under a leasing programme in Hangzhou. Kandi awarded a contract to China Aviation Lithium Battery Co., Ltd, which is operating the Hangzhou project under a leading business model and supplying the batteries. Kandi's COCO EV is a mini-car designed for neighbourhood driving and commuting – and the Hangzhou project revolves around the Kandi battery swapping technology.

Meanwhile battery charging technology is moving ahead apace, with innovations such as inductive (wireless) charging and fast charging technologies grabbing the headlines. Qualcomm recently announced trials in London of its inductive charging technology after its 2011 acquisition of New Zealand university spinout HaloIPT. The technology enables batteries in EVs fitted with an integrated receiver pad to be charged automatically while the car is parked or when being driven over transmitter pads buried in the ground.

Elsewhere, charging infrastructure companies which have received funding include Coulomb Technologies, a California company that is developing a fast charging station in partnership with Aker Wade Power Technologies, which received financing from Voyager Capital and Rho Ventures .

The large multinational players are key in this space. ABB recently won the Cleantech Investor EV Investor Club Award for the deal of the year for the acquisition of Epyon BV, the developer of direct current (DC) fast charging stations and network charger software. Epyon, which was based in Rijswijk, the Netherlands, has developed software that reduces charging time to 15 minutes and enables charging to be tailored to different start conditions, power requirements and charging times. ABB has made a major commitment to fast charging technology and Epyon dovetails with its existing technology. Epyon had previously received funding from investors including SET Venture Partners, Chrysalix, LiteOn Technology Corp. from Taiwan, and the company has a partnership with LiteOn for the Chinese market.

ABB has also invested in Californian fast charging firm, ECOtality, which is deploying some 15,000 charging stations in 16 US cities. ECOtality had meanwhile entered China through a joint venture with Shenzhen Goch Investment.

Battery Technology Development

Natural resources play a role in future transport strategies at the government level. In this respect China has a major natural advantage in terms of batteries, in the form of its reserves of lithium, which has been described as the 'feedstock' of electrification. The focus is also on jobs and China looks set to become a major player in the EV battery industry.

Batteries became the global focus of attention a few years ago with 'Green New Deal' style initiatives from governments around the world as part of the measures to protect their economies against the threat of recession after the financial crisis.

The car industry is important in the larger western economies. However, under pressure from the green lobby, the governments of these economies cannot always support this 'dirty' industry without imposing conditions about becoming 'cleaner' – so EVs were made a priority and became part of bail-out packages for US carmakers such as GM. There was a parallel dash to invest in battery technology in the US from around 2008 and companies vied for funding under the Obama stimulus plan. The US Government focused on batteries owing to fears that the country might lose out in terms of jobs to Asian manufacturers – which led to the creation of the National Alliance for Advanced Transportation Battery Cell Manufacture, a public private partnership, in Chicago at the end of 2008.

There was a sense of urgency inspiring companies – and countries – to gear up to ensure that there would be sufficient battery manufacturing capacity to meet the new demand. In 2009 there were over 40 advanced battery factories being built in China alone. In the US, the Obama stimulus package focused attention on the battery industry through the Batteries for Electric Energy Storage in Transportation (BEEST) programme, which provided funds for research and development into low cost battery technologies.

US regions geared up to attract battery manufacturers to invest, with states like the auto-focussed Michigan offering favourable tax incentives to companies to invest in battery manufacturing. 2008 to 2010 saw a flurry of investment in automotive battery manufacturers by both venture capital and industry investors in the West. Fisker Automotive led a round of investment in Advanced Lithium Power, while Boston Power Inc. was backed by Foundation Asset, Oak Investment Partners, Venrock and others, raising \$55 million in January 2009. Other successful fund raisings have included for Imara Corporation, Envia Systems, PowerGenix and Sakti3.

One high flyer in the US battery industry was A123 Systems, which developed advanced lithium-ion batteries and energy storage systems for EVs, as well as electric grid and commercial applications. The A123 batteries are based on the company's proprietary nanoscale material-based technology, initially developed at the Massachusetts Institute of Technology.

A123 listed on NASDAQ in September 2009, raising almost US\$400 million at a price of US\$13.5 per share. Later that year, its share price hit a high of close to US\$23, valuing the company at over US\$1.6 billion. The company also received a grant from the US Department of Energy for US\$249 million to build three plants in Michigan. However, in October 2012, the company filed for Chapter 11 bankruptcy when a last ditch attempt to save the company by Wanxiang Group of China fell apart. The company's assets are currently being auctioned with possible buyers including Johnson Controls Inc, the Wanxiang Group, Japan's NEC Corp. and Siemens of Germany.

Towards the Future: FCEVs

But perhaps the focus on batteries and the challenges of charging will all seem irrelevant in a few years. The longer term goal for many governments and OEMs around the world is a move to fuel cell EVs. Fuel cells have been around for a long time and have failed to take off commercially in the automotive industry. However, they are now widely used in stationary power applications and in some motive applications such as fork lift trucks.

The date of 2015 has been set by many car manufacturers as the target to introduce commercially viable fuel cell vehicles, or FCEVs. The FCEV drive lost a bit of momentum around 2009 when US Secretary of Energy, Steven Chu, publicly withdrew his support. However, failures of companies like A123 and evidence that the US efforts to build a battery industry have not yet come to fruition have reawakened interest in FCEVs. FCEV proponents include Daimler, Honda, Hyundai and Toyota .

In terms of FCEV cost, Pike Research cites Daimler's comments that "the cost of the fuel cell drivetrain can be reduced to around that of a diesel hybrid, through volume production and materials cost reduction". If so, Pike concludes, fuel cell cars are set to compete with battery EVs.

The 2015 timeframe is adhered to by most of the OEMs mentioned above, but Hyundai has already announced a move into series production of its FCEV. There has also been a drive by governments to roll out infrastructure for hydrogen, especially in Europe and Japan, to provide the fuel for the vehicles. In Europe, Germany's H2Mobility programme is targeting 50 hydrogen stations by 2015 and 1,000 by 2025. Other similar programs are being developed in the UK, France and Japan.

Companies such as Linde and Air Liquide, which historically have expertise in industrial gases, are gearing up their businesses to meet this latest challenge. New players with hydrogen solutions which utilise 'distributed' renewable energy resources are also emerging. London Stock Exchange AIM-listed UK company, ITM Power, is running trials around the UK and beyond of its electrolyser technology which generates hydrogen from renewable sources. ITM Power has worked closely with Hyundai on trials using the Hyundai FCEV. Meanwhile Italy's Acta, which is also listed on the AIM market and has an alternative electrolyser technology, is working with Asia Pacific Fuel Cell Technologies (APFCT) of Taiwan, which has developed a fuel cell scooter.

Fuel cell electric bikes are not as common as battery electric bikes yet, but this could be a major market in the future if the infrastructure challenge can be overcome. The UK's Intelligent Energy, a fuel cell developer, is also working on a fuel cell scooter, in partnership with Suzuki.

The pace of investment in EVs has eased, but it is clear that this industry – in whatever incarnation (batteries and/or fuel cell personal vehicles or PRT systems) – is here to stay. EVs look set to gain market share incrementally, if more slowly than had been originally projected, in most major western markets. The opportunity in China is even greater than in most markets. In a 2011 report Accenture concluded that China would have a competitive advantage over the US in EVs. The Accenture argument is that Chinese car ownership is set to almost triple over the next decade, to some 200 million, meaning that "in China there will be no losers".