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MANAGING THE TRANSITION TO ELECTRIC VEHICLE TECHNOLOGY

Anthony Black[1]

Introduction

Until quite recently, the automotive industry was characterised by relatively mature, established technologies. With the introduction of electric vehicles (EVs) and more recently the prospect of self-driving cars, the sector is now at the cutting edge of global technological developments. The advent of electric vehicles is set to have a dramatic effect, not just on automotive manufacturing, but on industry more widely and on a range of other sectors such as energy and transport. This policy brief assesses the position with regard to the diffusion of EV technology, its impact and the questions that it raises for policy makers.

Technology-induced disruptions and strategic challenges

The internal combustion engine (ICE) remains the dominant vehicle technology globally but EVs are making rapid headway. The forecasts keep changing and have become much more upbeat over the last few years as battery costs fall and regulation tightens. A report by Bloomberg New Energy Finance in February 2016 predicted 5% of global vehicle sales comprising EVs by 2022 rising to 35% by 2040.[2] More recent predictions, however, are even more bullish. In 2017, Exane BNP Paribas predicted that penetration will exceed 25% by as early as 2030 as carmakers rapidly bring in new electric models. Bloomberg's latest projections (2018) are for 55% electric vehicle sales[3] by 2040 and 28% by 2030.[4]

This poses huge issues for established car companies. Not only do they have to invest large sums in mastering the new battery technologies but they will need to deal with managing the phasing down of their massive ICE investments. These technological developments are also attracting a flood of new entrants, some of whom have developed relevant expertise in other sectors. The most well-known of these is Tesla, but a range of firms are entering the sector. For example, the British appliance maker, Dyson, has recently announced it will build a plant to

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[1] Professor, PRISM, School of Economics, University of Cape Town.
[2] Bloomberg New Energy Finance (2016) *Advanced transport: Research note*. Bloomberg Finance. 25 February.
[3] This is for battery electric vehicles (BEVs) and plug in hybrids (PHEVs) but BEVs are projected to account for nearly 90% of the overall electric vehicle (EV) market in 2040.
[4] Bloomberg New Energy Finance (2018) *Long-Term Electric Vehicle Outlook 2018*. May 21.

make electric cars in Singapore.[5] In China there are over 300 hundred registered electric car start-up companies. In India there are 200-250 firms involved in manufacturing and assembling electric three-wheelers.[6] Most of these are small scale operations.

With sales in 2017 of 533,000 passenger EVs, China now accounts for 50% of the world market. But the shift to electric power has been most rapid in two-wheelers and approximately 25% of the global market for two wheelers is already electric. This is mainly due to their major presence in China, where there were some 200-230 million electric two-wheelers in use in 2015.[7] Penetration is much lower in other major motorcycle markets such as India, Indonesia and Vietnam but is growing rapidly from a low base, especially in India.

Policies to promote electric vehicles

China is a proactively pursuing electric technology through a series of far reaching policies.[8] This started with small scale research projects in the 1990s, which were ramped up in Phase 2 from 1999—2008. In Phase 3 (2009-2012) major changes in policy took place including full or partial bans on petrol motorcycles in 29 major cities, coupled with subsidies in certain cities and public procurement policies. These subsidies were later extended in Phase IV but Phase V, which started in 2016 plans to phase out subsidies and replace them with electric vehicle quotas for vehicle manufacturers. These quotas could very soon require that 8% of vehicles are BEVs or hybrids.[9] A general ban on fossil fuel vehicles, to be implemented at some future date, has also been mooted. China is also enforcing industry standards to consolidate and upgrade vehicle and battery production.

With a rapidly growing light vehicle market and the world's second largest motorcycle market, India has lagged with electric technology and until recently, in the absence of supportive government policy, it has been the firms which have been making the running.[10] The policy environment has now changed with the announcement of ambitious plans to transition rapidly to EVs.[11] The policies being pursued in India remain less forceful and less costly than those adopted by China. While the Indian government has set a goal of completely transitioning production to electric technology by 2030, this is considered unrealistic by local experts.[12]

In 2012, India introduced the National Electric Mobility Mission Plan 2020. Implementation rests on five pillars – demand generation, domestic manufacture, infrastructure development, R&D and fuel efficiency standards. The Faster Adoption and Manufacturing of Hybrid & Electric Vehicles (FAME) scheme was introduced in 2015 but budgetary outlays have, to date, been well below targets, which were in any event quite modest. For instance, in the union budget of

[5] A British investor pivots to Asia, *Financial Times*, 27/28 October, 2018
[6] Bloomberg New Energy Finance (2017) India EV Market Seeks the Tipping Point. Advanced transport – Research note. April 20.
[7] These included electric scooters, bikes and motorcycles. See Altenburg, T., Feng, K. and Shen, Q. (2017) Electric mobility and the quest for automotive industry upgrading in China. In Altenburg, T., Assmann, C. (Eds.) *Green Industrial Policy: Concept, Policies, Country Experiences.* UN Environment; German Development Institute/Deutsches Institut fur Entwicklungspolitik (DIE), Geneva; Bonn.
[8] Altenburg, T., Feng, K. and Shen, Q. (2017).
[9] See 'Volts wagons' *The Economist*, 18 February, 2017.
[10] Chaudary, A. (2014) Electromobility in India: Attempts at leadership by businesses in a scant policy space. *Discussion Paper 15/2014*. Bonn: Deutsches Institut für Entwicklungspolitik.
[11] See 'Modi government plans major policy push to promote e-vehicles'. *The Economic Times*, 27 May 2017. https://economictimes.indiatimes.com/news/economy/policy/modi-government-plans-major-policy-push-to-promote-e-vehicles/articleshow/58351446.cms
[12] Interview, Bloomberg New Energy Finance Delhi, June 2018.

2016/2017 there was an allocation of only $30 million, significantly less than the planned allocation of $119 million.[13]

EVs also benefit from certain tax incentives at the national and state level. At national level these include lower import duties on parts together with lower excise taxes. Various states levy value added tax (VAT) at lower rates The National Capital Territory of Delhi uses its Air Ambience fund, which is based on a levy on diesel, to provide small subsidies to EVs. A number of other developing countries such as Thailand, Vietnam and Indonesia have policies in place to promote electric vehicles.

South African technology responses

The South African automotive industry is almost completely foreign owned, at least at the vehicle assembler level. It is thus mainly reliant on the investment decisions of multinational firms and there is very little in the way of domestic technology. The level of R&D both local and foreign owned firms is low.[14]

There is, however, significant domestic expertise. One early development was Optimal Energy's 'Joule' electric project, which was developed by engineers who came out of the defence sector. The prototype cars were technically highly regarded but the company failed to obtain the finance necessary to industrialise production and the project closed its doors in 2012.

Fuel cells are of strategic interest in South Africa because of their platinum requirement. The Department of Science and Technology (DST) has accordingly funded major research programmes in this area.[15] The aim of the Hydrogen South Africa (HySA) research and development programme is to make South Africa a major global source of catalysts. However, prospects for fuel cell powered vehicles appear limited according most forecasts (see following section).

Medium term perspectives on production, investment and employment in South Africa

Due to the minimal penetration of EVs in South Africa currently, the impacts of the new technology are not yet apparent but they are likely to be substantial. As is the case elsewhere, take up rates will depend significantly on government policy.

The advent of EVs is certainly causing concern in developed country markets. A recent study concludes that in the EU, the increasing share of low emission vehicles will have a significant negative impact on automotive employment.[16] EVs require far fewer parts and much less servicing and maintenance. Battery production is capital intensive and the EU, in any event,

[13] Bloomberg New Energy Finance (2017).
[14] Black, A. (2014) Technology transfer and the development of the automobile industry in South Africa. In Studies in Technology Transfer: Selected Cases from Argentina, China, South Africa. UNCTAD Current Series on Science, Technology and Innovation No. 7. Geneva: UNCTAD.
[15] See Campbell, K. http://www.engineeringnews.co.za/article/south-africas-hydrogen-fuel-cell-programme-making-steady-progress-2017-04-13

[16] FTI Consulting (2018) Impact of electrically chargeable vehicles on jobs and growth in the EU. FTI Intelligence. 5 May.

lags behind China in this area.[17] But lower total costs of ownership will allow consumers to spend more on other goods, increasing GDP and total employment.

Similar results could be expected in South Africa although the negative employment impacts in automotive manufacturing are likely to be muted, given the already low level of local content especially in drive train componentry. In fact, the switch to electric technology could represent an opportunity to increase levels of localization.

South Africa is currently not a low cost vehicle producer compared to Asia's low cost producing countries such as Thailand.[18] A key drawback for South Africa has always been scale. Optimal scale is lower in electric than ICE vehicles. However, in battery production and certain other components, the economies of scale are significant. The lack of 'brown' assets in ICE technology can be an advantage for newcomer industries, which do not suffer the disadvantage of large depreciating assets.

Engine production

There is likely to be severe disruption to the large investments in ICE production in major global production centres. These established engine producers will suffer huge adjustment costs.[19]

South Africa has only one large engine plant and produces relatively few engine components. However, it a very large producer of catalytic converters and accounts for over 10% of global supply with exports in 2017 of R18.7 billion. Although they have declined a little in the last few years, catalytic converters are by far SA's largest component export accounting for no less than 37.2% of parts exports in 2017.

Oil and electricity demand

Global oil demand is set to decline significantly and oil importers such as South Africa could benefit from reduced oil imports. CSIR estimates are that electricity sales and required generation capacity will not dramatically increase due to the efficiency of EVs and the development of smart grids. In fact, electric vehicles can be turned into 'grid assets' because of the possibility of levelling charging requirements and returning power from EVs to the grid when required.[20]

The decline in oil consumption and imports is likely to have a significant impact on the trade balance. According to CSIR Energy Centre estimates, if South Africa were to introduce one million EVs, which on average drive 20,000 km per annum, this would reduce oil imports by at least 6% ($580 million per year).[21]

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[17] The UK Government has recently announced a £280 million Industrial Strategy Challenge Fund to support battery development and production https://www.gov.uk/government/collections/faraday-battery-challenge-industrial-strategy-challenge-fund

[18] See Barnes, J., Black. A and K. Techakanont A (2017) Industrial policy, multinational strategy, and domestic capability: A comparative analysis of the development of South Africa's and Thailand's automotive industry, European Journal of Development Research 29, 37–53.

[19] These are detailed, although in rather extreme terms, by Arbib and Seba (2017) Rethinking Transportation 2020-2030: The Disruption of Transportation and the Collapse of the Internal Combustion Vehicle and Oil Industries. RethinkX. May.

[20] Narayan, A. (2018) The electrification of transport could transform our future – if we are prepared for it. https://www.weforum.org/agenda/2018/08/we-must-get-it-right-with-electric-vehicles-for-the-sake-of-our-planet/ For estimates of the impact of EVs on electricity consumption in India see Saxena, A. (2014) Electrical consumption of two-, three- and four-wheel light-duty electric vehicles in India. *Applied Energy*, Vol. 115, No. 15.

[21] Personal communication, Mike Mulcahy (CEO, GreenCape), October, 2018.

Hydrogen fuel cell vehicles

By the end of 2017, there were fewer than 7,000 fuel cell passenger vehicles on the road globally, compared to over 2.8 million electric vehicles.[22] Fuel cell passenger vehicles are not expected to make up more than 3-4 % of the passenger vehicle fleet by 2040. There are however greater prospects in heavy vehicles and specialised transport equipment including, for instance, large drones.[23]

Even the Japanese government, which has been a strong proponent of fuel cell vehicles, expects fuel cell vehicles to account for only 3% of passenger vehicle sales in Japan in 2030. At that point EVs are expected to account for close to 30% of sales.[24]

Potential policy, regulatory and programmatic responses to technology disruptions

There are a number of reasons why governments, even in terms of their national, rather than international, objectives might want to promote the transition to electric vehicles or other green economy products.[25] These include the costs of pollution, the necessity to avoid a wedge developing between emerging globally dominant practices and avoiding lock-in to unsustainable and obsolete technologies and infrastructure. Finally, there are innovation possibilities which could promote productivity and job creation.

National circumstances vary widely and the leaders in adoption in the developing world are likely to include countries with large markets and established industries. Apart from India and China, these include Thailand, Mexico and Brazil. Supportive policies could include low cost measures to promote domestic demand (lower taxes, small subsidies); support for domestic production (tariffs on imports of automotive products with some exemptions for components) and infrastructure support (charging facilities). The phased establishment of 'smart grids' which for example allow for lower electricity pricing to households at off peak times is also of key importance.[26] Some of the above measures could be implemented on a trial basis in selected cities.

South Africa accordingly faces a major set of policy choices with regard to the promotion of electric vehicle technology.

There may exist an opportunity to leapfrog into emerging electro-mobility technologies in a product where the market is expanding rapidly and where the basic assembly technology is already well established. Successful production may then offer opportunities for related industrial expansion in related technologies. Yet, sales of BEVs in South Africa last year were minimal and the charging infrastructure remains very limited. By August 2018 there were only 13 fast chargers in place, mainly at BMW and Nissan dealers, although the planned rollout by GridCars will expand this to all the major urban centres and along the N1 and N2 during 2019.[27]

[22] Bloomberg New Energy Finance (2018).

[23] A South African start-up, FlyH2 Aerospace, designs and operates hydrogen-electric unmanned aircraft.

[24] Bloomberg New Energy Finance (2018).

[25] Altenburg, T. and Rodrik, D. (2017) Green industrial policy: Accelerating structural change towards wealthy green economies. In Altenburg, T., Assmann, C. (Eds.) Green Industrial Policy: Concept, Policies, Country Experiences. UN Environment; German Development Institute/Deutsches Institut fur Entwicklungspolitik (DIE), Geneva; Bonn.

[26] Interview, DTI. October, 2018.

[27] Personal communication, NAAMSA, October, 2018.

The question of the rate of adoption is complicated. Is it feasible to project substantial conversion to EVs where there is limited fiscal space to subsidise alternative, greener engine technologies, nor much base market demand?[28] Or should we simply follow market dictates as latecomers in the sector, perhaps attempting to take advantage of market opportunities that manifest in demand for ICE-based vehicles operating in an established petrol/diesel based infrastructure?

The case for going electric

There can be little doubt that electric technology will be the main form of propulsion for new vehicles within two to three decades. It, therefore, appears that there are significant imperatives to shift South Africa's market towards electric technology. While operating conditions in various countries play an important role, the extraordinary differences in the take up of electric vehicles across countries, is driven to a large degree by policy. In the developing world, China has hugely supportive policies while India, until recently, has been slower. There is currently little policy support for electric mobility in South Africa although there are a number of initiatives and policy documents on the issue, both by NAAMSA, various government departments and other stakeholders.

In developing markets, it would make sense to go for the new emerging technology rather than ICE technology, which is set to become obsolete in the medium term. In China and India and other major developing countries, which are actively promoting electric technology, the promotion of electric technology is being driven by three main factors, which vary in importance in different national contexts. The first of these factors are concerns about urban air pollution in major cities. This is a vital issue in both China and India. Secondly, countries such as China and India but also Vietnam and Thailand, see the promotion of electric vehicles as part of a deliberate strategy to develop competitive advantage in new technologies. A third factor, which is of great importance in India, is the bid to reduce fuel imports and improve energy security.[29]

The major constraint is, of course, the cost relative to alternatives. But purchase costs are set to fall in line with rapidly declining battery prices. Maintenance and running costs are already low.

Electric vehicles offer the benefits of reduced urban air pollution and reduced CO_2 emissions, although the latter depends on how electricity is being generated,[30] Currently, in South Africa, electric vehicles do not have significantly lower CO_2 emissions than ICE vehicles due to the dominant role of coal based power. But this is gradually changing and the advent of smart grids will in any event offset the need for increased power generation. South Africa's cities are experiencing severe and increasing levels of air pollution and the costs are high.[31]

There could be an argument that with the take up of electric vehicles in Africa likely to lag global developments, South Africa should continue to supply this market. After all used engine plants are likely to be cheaply available as developed countries move to electric technology. Also, it is

[28] Black, A. Barnes, J. and Monaco, L. (2018). Structural Transformation in the Auto Sector: Industrial Policy, State-Business Bargaining and Supply Chain Development. Final Project Report. IDTT.
[29] Interview, Bloomberg New Energy Finance, Delhi, June 2018.
[30] Jochem, P., Doll, C., Fichtner, W., 2016. External costs of electric vehicles. *Transportation Research Part D Transport and Environment*. Vol. 42, pp. 60-76. http://dx.doi.org/10.1016/j.trd.2015.09.022
[31] Roy, R. and N. Braathen (2017), The Rising Cost of Ambient Air Pollution thus far in the 21st Century: Results from the BRIICS and the OECD Countries, OECD Environment Working Papers, No. 124, OECD Publishing, Paris. http://dx.doi.org/10.1787/d1b2b844-en

difficult to make a case for a middle income country to subsidise imported electric vehicles for high income consumers.

However, this argument can be countered. South Africa's main automotive markets are in developed countries. Most importantly, electric technology is not restricted to wealthy consumers. As mentioned above, the highest rates of penetration in developing countries, are in low cost two wheelers. Electric two-wheelers also have huge potential in Africa which is set to become the 2nd largest market for motorcycles (in unit terms) after Asia.[32] While this is not necessarily a market opportunity for South African firms, it is indicate of the fact that electric automotive technology is by no means only a luxury product.

There are enormous complexities, however. The current market for electric vehicles in South Africa is tiny. China and to a lesser extent, India, have placed significant subsidies in place. But they have major domestic production with the bulk of the market being supplied by domestic products. A major driver is governmental ambition, supported by manufacturers, to establish ascendency in EV technology. There needs to be a tie up to a domestic assembly strategy but this represents even more challenges, not least in terms of competing against established producers. But as indicated above, optimal scale in electric technology is lower than in ICE technology. Also, due to its underdeveloped power train sector, South Africa will have far less to lose in terms of stranded assets than will the more advanced manufacturing centres.

The development of the electric vehicle sector is *par excellence* an industry which requires 'joined up' policy across a number of government departments. Appropriate policy to develop the market and a domestic production strategy needs to be seriously investigated.

[32] See Black, A, Barnes, J., Makundi, B. and T. Ritter (2018) Electric two-wheelers in Africa? Markets, production and policy http://www.greengrowthknowledge.org/sites/default/files/Electric%20two-wheelers%20in%20Africa.pdf
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