PRISM

Policy Research on International Services and Manufacturing

Electric two-wheelers in Africa? Markets, production and policy

Anthony Black

PRISM, School of Economics, University of Cape Town

Justin Barnes

Toyota Wessels Institute for Manufacturing Studies

Brian Makundi

PRISM, School of Economics, University of Cape Town

Tobias Ritter

PRISM, School of Economics, University of Cape Town

Working Paper Series
Number 2019-1

Recommended citation:

Black, A., Barnes, J., Makundi, B. and Ritter, T. 2019. "Electric two-wheelers in Africa? Markets, production and policy". *PRISM Working Paper 2019-1.* Cape Town: Policy Research on International Services and Manufacturing, University of Cape Town.

Note:

An earlier version of this paper was presented at the Conference on Green Transformation and Competitive Advantage: Evidence from developing countries, Bonn, 18-19 June 2018.

Working Papers can be downloaded in Adobe Acrobat format from
www.prism.uct.ac.za.

Electric two-wheelers in Africa? Markets, production and policy

Anthony Black, Justin Barnes, Brian Makundi and Tobias Ritter

---

PRISM Working Paper Number 2019-1
University of Cape Town

Abstract

The current dominant vehicle technology globally is the internal combustion engine. But electric cars and two wheelers are rapidly making headway and in China there are already over 250 million electric two wheelers in use. Africa constitutes the last frontier for the automotive industry. Current levels of motorization are still exceptionally low, but vehicle transport is growing rapidly. With rapid economic and population growth, this is set to continue. Two questions then arise in the African context. Firstly, how rapid will the take up of electric vehicles be, in particular two wheelers? Secondly, where will these vehicles be produced? This paper explores these two questions and then goes on to argue for policies which will maximize the possibilities for the continent to leapfrog to electric technology for motorcycles by adopting proactive polices which yield not only environmental benefits but also potentially industrialization possibilities.

POLICY RESEARCH ON INTERNATIONAL SERVICES AND MARKETING

Policy Research in International Services and Manufacturing (PRISM) is a research and policy unit located within the School of Economics. PRISM provides a lens to focus research and policy work broadly on issues of globalization, trade and industrialization. It is home to a number of related research activities, projects and programmes concerned with issues of globalization, global value chains, industrialization paths, international trade, foreign investment, the defence industry, policy governance, infrastructure development, the role of knowledge intensive services, innovation, and international competitiveness. Another feature of PRISM's work has been its applied focus, responding to economic policy questions issues in South Africa, the rest of Africa and beyond

School of Economics Building, Middle Campus, University of Cape Town Private Bag, Rondebosch 7701, Cape Town, South Africa
Tel: +27 (0)21 650 4470
Web: www.prism.uct.ac.za

1. Introduction[1]

The internal combustion engine (ICE) remains the dominant vehicle technology globally but electric vehicles (EVs) and especially two-wheelers are making rapid headway. By as early as 2010, it was possible to state that "electric two-wheelers ….represent the first mass-produced and mass adopted alternative-fuel vehicles in the history of motorization technology" (Cherry, 2010:17). In China there were some 200-230 million electric two-wheelers[2] in use in 2015 (Altenburg et al, 2017: 193). 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, where it is being strongly supported by government policy (Bloomberg, 2017). The reasons that this technology is being promoted vary in different national contexts but reduced urban air pollution and the effort to gain ascendency in emerging technologies are key.

Africa constitutes the last frontier for the automotive industry (Black and McLennan, 2017). Current levels of motorization are still exceptionally low and electric vehicles are almost non-existent. But vehicle transport is growing rapidly and this is particularly evident in two-wheeler transport (Techserve, 2017). With rapid economic and population growth, this market expansion is set to continue. But the vast bulk of these vehicles are imported although there is some assembly of motorcycles albeit with limited use of domestic components. In Sub-Saharan Africa (SSA), outside of South Africa, there is minimal automotive production and the region runs a sectoral trade deficit of $16 billion. In comparison, India, with total economic size, population, per capita income and vehicle sales of a roughly similar magnitude, runs a trade surplus of $8 billion and is the world's second largest exporter of motorcycles. Indeed in SSA, the share of manufacturing in GDP is very low and has tended to decline even during the more rapid growth phase since 2000 (McMillan et al, 2014).

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 a green economy (Altenburg and Rodrik, 2017). 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. There are also substantial co-benefits such as reduced air pollution which in turn can lead to declining health costs. Finally, there are innovation possibilities which could promote productivity and job creation (Altenburg and Rodrik, 2017).

Two sets of questions then arise in the African context. Firstly, why is the penetration of electric two-wheelers so low in Africa and how rapid will the take up of these vehicles be? Secondly, where will these vehicles be produced – will they be imported as is currently the case with

[1] Research assistance by Betty Ananeh-Frempong and Chris Grant is gratefully acknowledged.
[2] These included electric scooters, bikes and motorcycles.

conventional two-wheelers or are there prospects for domestic manufacture? This paper will explore these two questions and then go on to assess the case for policies which will maximize the possibilities for the continent to leapfrog to electric technology for motorcycles by adopting proactive polices, which potentially yield not only environmental benefits but also industrialization possibilities.

The starting point in section two is an overview of two-wheeler mobility and electro-mobility in developing countries. It also identifies the key policies which have driven these changes in China and more recently in India. Section three examines transport markets in Africa and the position with regard to motor cycle trade and production. The case for going electric together with required policies are considered in section four. Finally, and more speculatively in section five, we consider the potential for some kind of competitive advantage in this sector. Section six concludes.

2. Overview of two wheeler mobility and electro – mobility in developing countries

The global shift to electric vehicles is gathering pace. Forecasts keep changing and have become more upbeat 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 (Bloomberg, 2016). More recent predictions, however, are even more bullish. Bloomberg's latest projections (2018) are for 55% electric vehicle sales[3] by 2040 and 28% by 2030.

China is the world's largest market with sales in 2017 of 533,000 passenger EVs (Bloomberg, 2018: 7). The government is planning quotas that could require that 8% of vehicles are BEVs or hybrids by 2018.[4] The Indian government has announced ambitious plans to transition rapidly to BEVs. This includes an innovative strategy involving the leasing of batteries to public transport operators.[5]

[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] See 'Volts wagons' *The Economist*, 18 February, 2017.
[5] 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

Global motorcycle markets and production

The focus in this paper is on two (and three) wheelers which are widely used as a basic form of transport in Asia and parts of Africa. The global market for motorcycles (including scooters and mopeds) amounted to $75.8 billion in 2014 (Table 1), or 8.5% of the size of the global passenger vehicle market. The sector is forecast to grow at 2% per annum to 2019, with growth driven largely by Asia-Pacific markets.

Table 1: The global motorcycle market, 2010 - 2014

Year	Value ($ bn)	Volume (mn units)	Average unit cost ($)
2010	74.0	44.4	1,666
2011	81.1	50.6	1,602
2012	78.3	49.6	1,578
2013	77.5	49.3	1,572
2014	75.8	48.2	1,572
2019 forecast*	*83.5 (10%)*	*54.9 (14%)*	*1,520 (-3%)*

Source: MarketLine, 2015

*Figures in brackets represent percentage growth relative to 2014 values

Asia-Pacific is the most significant contributor to the global market with a 58.7% market share by value, while Europe accounts for only 13.8% and the USA 5.4%. In terms of market share by brand, Honda is the dominant multinational at 35.3%, followed by Hero (13.0%), Yamaha (12.0%) and Suzuki (4.1%).

Motorcycles are produced predominantly in China, India and Southeast Asia, in proximity to the large Asia-Pacific market. By 2020, it is forecast that 90% of all motorcycles produced will be manufactured in these locations. Given the high concentration of output from the four major brands (64.4% market share for Honda, Hero, Yamaha and Suzuki combined), it is unlikely that there will be any major change to this dominance over the short term (MarketLine, 2015). This is despite the emergence of a range of low cost Chinese motorcycle manufacturers, such as Grand River and Lifan, that have grown their market share globally.

Electric two-wheelers

According to P&S Market Research (2017), the global electric scooter and motorcycle market will reach $19 billion by 2025, growing by 6.9% per annum from 2017 to 2025. This relatively slow growth rate (compared to electric cars) is due to the large base market that already exists in China. China is the world's largest EV market and as mentioned above, totally dominates global production and sales of electric two-wheelers. In fact, approximately 25% of the global market for two wheelers is already electric (Altenburg, Feng and Shen, 2017). So growth rates in new markets such as India will be far higher. There, the sale of electric two-wheelers is expected to outpace electric car sales. Indian manufacturers such as Hero and TVS are launching new models

at a rapid pace. Hero Electric sold only around 30,000 scooters in 2017-18 but is hoping to sell 600,000 per annum by 2022-23 (Barooah, 2018). The company is now offering lithium-ion battery powered scooters with medium or high speed performance. A major factor driving the increasing competitiveness of EVs is the rapidly declining price of lithium-ion batteries, the price of which fell by more than 70% from 2010 to 2016. According to Bloomberg (2018) they will fall by another 73% between 2016 and 2030.

There is an extraordinary difference in the take up rate for two-wheelers across the developing world. Motorcycles are ubiquitous across most of Asia. They are also widely used in west Africa and to slightly lesser extent in east Africa. In southern Africa, there is much more limited usage. The contrasts are even greater in the take up of electric two-wheeler technology. In comparison to the huge numbers in China, the adoption rate in countries such as India, Vietnam and Indonesia has been far lower. In Africa, the use of electric two-wheelers is in its infancy.

However this is starting to change. There were over 20 manufacturers of electric two-wheelers in India in 2014 and electric three-wheelers are assembled by informal manufacturers, which make use of batteries and components imported from China (Dhar et al, 2017). Electric three-wheelers are gaining market share from cycle rickshaws and conventional ICE three-wheelers. With annual sales of motorcycles and scooters in excess of 15 million units, the potential in India is huge. According to the model, developed by Dhar et al (2017), fairly small policy changes could lead to a 30% market share for electric two-wheelers by as soon as 2020. Additional technological changes could lead to nearly all two-wheeler purchases being electric by 2030.

Policies to promote electric vehicles

China is a proactively pursuing electric technology through a series of far reaching policies (Altenburg, Feng and Sheng, 2017). 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. 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 both vehicles and two-wheeler and battery production. Electric two-wheelers have been further supported by the fact that those with pedals and a low maximum speed are classified as bicycles and require no driver's license or registration (Altenburg, Feng and Sheng, 2017). They are allowed to use cycle lanes.

As 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 (Chaudary, 2014). The policy environment has now changed with the announcement of ambitious plans to transition rapidly to EVs.[6]

The policies being pursued in India remain less forceful and less costly and are of greater relevance in most African countries. Ambitiously, the Indian government has set a goal of completely transitioning production to electric technology by 2030 although this is considered unrealistic by local experts.[7]

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 (Bloomberg 2017). 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 2016/2017 there was an allocation of only $30 million, significantly less than the planned allocation of $119 million (Bloomberg, 2017). Demand incentives under the Fame 1 apply to 33 two-wheeler models and 2000 rupees ($30) per qualifying two wheeler is paid to manufacturers, who in turn reduce prices to consumers.

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 (Bloomberg, 2017). Other countries in Asia such as Vietnam, Indonesia and Thailand are also introducing policies to promote electric two-wheelers.

3. Two-wheeler transport, markets and production in Africa

Markets and trade

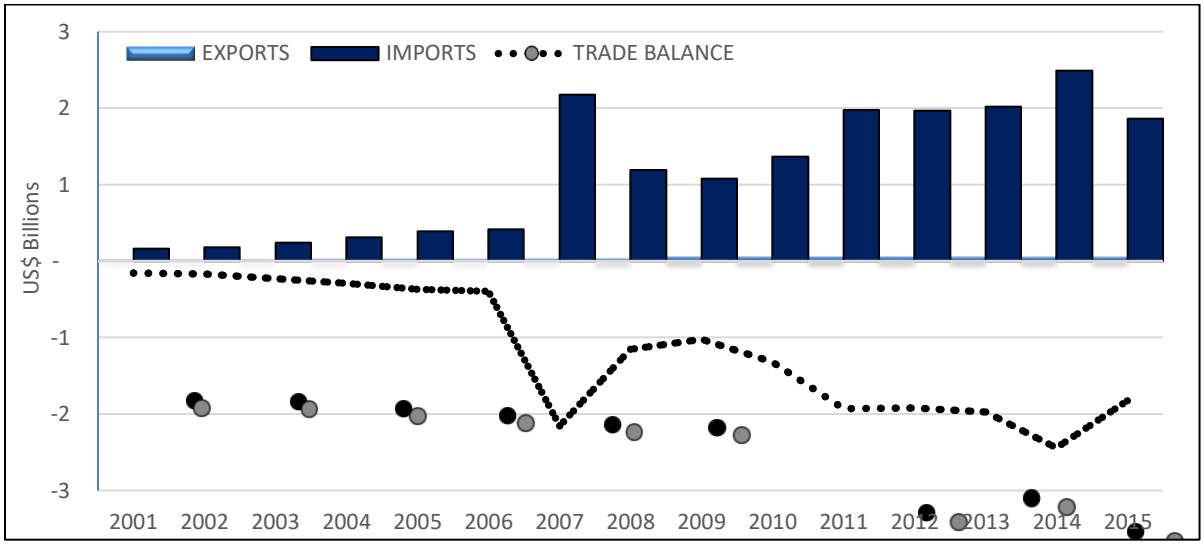
As mentioned above, there is very little automotive production in Africa and the continent is a large net importer of automotive products. This applies very much to motorcycles although there is some domestic assembly of mainly imported parts (Black et al, 2017). Africa is a large net importer as depicted in Figure 1. In 2015, imports reached $1.86 billion, representing 9.9% of

[6] 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

[7] Interview, Bloomberg New Energy Finance Delhi, June 2018.

global motorcycle imports. African motorcycle exports are minimal and reflect mainly re-exported products.

Figure 1: Africa's motorcycle trade balance with the world – US$ billion (2001-2015)



Source: ITC calculation based on UN Comtrade statistics, 2016 (Trade Map, www.trademap.org/Index.aspx)

Nigeria is Africa's largest importer of motorcycles, importing motorcycles worth $447 million, or 2.4% of total global imports, in 2015, with Egypt ($166 million), South Africa ($123 million), Kenya ($98 million), and Tanzania ($93 million) making up the balance of the top five importing economies. The fastest growing of the larger markets in Africa is, however, Ethiopia, which increased its imports at 21% per annum from 2011 to 2015 (Trade Map 2016). This is despite the country having the second highest average motorcycle import tariff (30%) of the 10 largest importing African economies. Angola has the most protected motorcycle market on the continent with a 32% tariff. These tariffs are, however, substantially lower than some of the leading motorcycle manufacturers globally. India, Vietnam and Thailand, for example, have tariffs of 100%, 90% and 60% respectively. Much of motorcycle demand in Africa is for small displacement, commuter-type products, with 88% of all motorcycle imports ($1.6 billion) in 2015 having an engine displacement between 50 and 250 cubic centimetres. This import segment grew at 5.5% per annum from 2011 to 2015 (Trade Map, 2016). The main exporters of motorcycles to the African continent include China, India, Thailand, Vietnam and Japan. Electric motorcycle imports into Africa are minimal and amounted to only $20.7 million in 2015, a mere 1.2% of total motorcycle imports.

Two-wheeler transport

Modes of transport (including the use of motorcycles) differ widely from country to country across Africa. The import of used vehicles is a major factor although much less significant in the case of motorcycles than cars. Accessing reliable data for vehicle ownership and sales in the majority of countries in SSA is a formidable challenge. The accuracy of data on the size of the vehicle parc is highly variable. Instead of attempting to estimate vehicle stocks, Black and McLennan (2016) focus on the annual flows of vehicles into SSA. A lack of domestic production in SSA (outside of South Africa) means that the trade flows into the region are a good proxy for the total size of the market.

What is clear is that there are very striking differences in the level of usage of motorcycles between countries in Africa (Table 2). For example, in South Africa, Zimbabwe and the BLNS[8] countries usage is very low, while just to the north, in Angola and Mozambique, motorcycle densities are high. Low densities in South Africa partly reflect the country's history of apartheid spatial planning, whereby black townships were located far from urban centres making motorcycle transport unsuitable. But there are also striking contrasts in West Africa, for example, between Nigeria with relatively high densities in urban areas and Ghana which has low densities. In some countries, densities are higher in urban areas while in others they are higher in rural areas. The reasons for these disparities require further research.

Electric motorcycles are hardly in evidence at all and there are no policies to promote them except of the most minor kind. For example, South Africa applies a small tax on purchases of ICE vehicles based on their level of emissions.

[8] Botswana, Namibia, Lesotho and Swaziland.

Table 2: Characteristics of motor cycle markets in selected African countries

	Motor cycle densities (share of road traffic)	Imports 2015 ($ million)	Policy and production	Comments
Angola	High especially in rural areas	50	High import duties on motorcycles	Road infrastructure being rapidly developed
Benin		60		High import figure reflects re-export to neighbouring countries, especially Nigeria
Cameroon	Medium with higher densities in rural areas	45		
Congo, Dem Rep of	High density especially in rural areas	60	No automotive policy or production	Very undeveloped infrastructure. Heavy congestion in capital, Kinshasa.
Congo, Rep of	Medium – higher in urban areas	21		
Egypt	Medium	166	Some domestic production Unsuccessful auto policy with industry threatened by imports in terms of free trade agreement with EU.	
Ethiopia	Medium	72	Developing auto policy. High protection of cars and motorcycles. Has introduced major green development strategy.	Imports of motorcycles growing rapidly in spite of high tariffs.
Ghana	Low, especially in rural areas	65		Extensive use of minibus taxis.
Guinea	Medium	76		High import figure reflects re-export to neighbouring countries.
Cote d'Ivoire	Low but with higher densities in rural areas.	35		
Kenya	Medium	98	Some small scale vehicle and motorcycle assembly. Developing automotive policy. Motorcycle assemblers have to use some local components.	
Morocco		64	Large, modern car industry	

Mozambique	High densities especially in urban areas	39	Some small scale automotive production	
Nigeria	Medium with higher densities in urban areas.	447	Developing automotive policy. No clear programme on motor cycles. Some motorcycle assembly	Massive congestion in large cities. 3 wheelers are widely used. Motorcycle taxis (okada) are the most common form of informal transport.
Senegal	Low	30		Widespread use of minibus taxis
South Africa	Low. Insignificant in rural areas	123	Clear policy and large, light vehicle industry. No motorcycle production	Well developed road infrastructure. Low income earners rely on minibus taxis as well as conventional public transport
Tanzania	High	93		
Zimbabwe	Low. Virtually non-existent in rural areas.	3	Historically some small scale assembly	Fairly well developed infrastructure

Note: Densities are based are approximate and based on field observations by authors in 19 countries. Low (0-10%); medium (11-20%); high (>20%).

Sources: International Trade Centre calculations based on UN Comtrade statistics (2016) – Trade Map www.trademap.org/index.aspx

4. The case for going electric

There can be little doubt that electric technology will be the main form of propulsion of two-wheelers within two decades. It, therefore, appears that there are significant opportunities to shift 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 two-wheelers across countries, is driven to a large degree by policy. China has hugely supportive policies while India, until recently, has been slow to promote electric two-wheelers. Newly introduced programmes offer some support but at nowhere near the Chinese level. There is little or no policy supporting electric mobility in Africa.

But should fiscally constrained African countries invest heavily in new automotive infrastructure and incentivize the adoption of new emerging technologies, or simply follow market dictates as latecomers in the sector?

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 motorcycle producers, the promotion of electric motorcycles 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.[9] A third factor which is of great importance in India, is the bid to reduce fuel imports and improve energy security.[10]

Electric two-wheelers potentially offer the opportunity of low cost mobility in Africa but it is clear that demand is currently very limited. The major constraint is, of course, the cost relative to alternatives. Table 3 sets out the factors that influence purchase decisions for EVs in India. Maintenance costs for two-wheelers tend to be very low. Battery costs are a major expense but are falling rapidly and this is the major factor accounting for the rapid improvement of cost competitiveness of EVs in general and electric two wheelers in particular. Of course there are other major obstacles including the availability and cost of electricity.[11]

While the major markets are likely to be in urban areas, dramatically falling costs of solar power open up new possibilities in rural areas including remote areas which lack access to the electricity

[9] This factor is dealt with in further detail in section 5.

[10] Interview, Bloomberg New Energy Finance, Delhi, June 2018.

[11] See Saxena (2014) for estimates of the impact of EVs on electricity consumption in India.

grid. Indeed, there are possibilities to use electric two-wheelers in conjunction with other appliances to greatly expand the ambit of renewable energy applications in such locations.[12]

Table 3: Factors that influence purchase decisions of electric vehicles in India

Parameter	2 Wheeler	3 Wheeler	4 Wheeler	Light commercial vehicle
Maintenance cost	1	1	1	2
Battery cost	2		2	4
Pick-up	3	5	3	1
Top speed	4	4	4	5
Charging time	5		5	
Running cost		3		3
Range		2		
Spares				

Note: 1 is most important 5 is least important
Source: Derived from Bloomberg (2017a: 16)

Urban air pollution

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 (Jochem et al., 2016). Currently, in China, electric vehicles have somewhat higher total CO_2 emissions than ICE vehicles due to the dominant role of coal based power, but this is gradually changing. A major reason that China has sought to promote electric two-wheelers is to address urban air pollution.[13]

Africa's growing cities are experiencing severe and increasing levels of air pollution. As Table 4 indicates, premature deaths in Africa resulting from air pollution (ambient particulate matter (PM)), while lower than in China, are rising rapidly while other risk factors such as unsafe water and sanitation and children underweight are declining. According to the World Health Organization (WHO), four of the worst cities in the world for air pollution are in Nigeria. An important contributor is transport. The costs are enormous. The OECD (2016) estimates the economic costs of ambient PM pollution to amount to $215 billion in Africa, including $69.9 billion Egypt and $41.8 billion in Nigeria.[14]

Table 4: Premature deaths in China and Africa from ambient particulate matter and other major risk factors, 1990-2013

	1990	1995	2000	2005	2010	2013
China						

[12] Interview, Nuru Energy, Cape Town. June, 2018.
[13] The other major factor was to achieve technological upgrading and leadership in electric vehicles (Altenburg et al, 2017).
[14] For studies of air pollution in Nigeria, see Njoku et al (2016) and Olowoporuku et al (2012).

Ambient PM pollution	577 451	631 080	685 658	778 330	857 991	916 102
Africa						
Ambient PM pollution	181 291	190 933	200 854	213 429	227 428	246 403
Household air pollution	396 094	422 895	436 463	429 199	450 969	466 079
Unsafe water	837 702	780 095	751 892	644 136	561 342	542 855
Unsafe sanitation	615 540	573 084	551 948	468 815	407 092	391 656
Childhood underweight	474 819	467 921	420 606	309 945	273 294	275 813

Source: Adapted from OECD (2016)

5. The potential for competitive advantage in electric two-wheeler production

China, India and other developing countries promoting electric two-wheelers are promoting EVs to bolster their position as global centres in the new technologies emerging in automotive manufacturing. The case for promoting EVs is much harder to make in developing countries if this equipment is to be imported. So it is useful to consider the potential for competitive advantage in this sector of the industry.

There is growing interest in a number of larger African countries in establishing some sort of automotive industry. Africa as a whole accounted for less than 1% of global vehicle production in 2016. Outside of South Africa and some countries in North Africa, vehicle production is almost non-existent. Annual sales of new vehicles are very low and in SSA outside of South Africa, the market is mainly supplied by imported used cars, which in many countries account for over 80% of domestic demand.

But the difficulties of establishing reasonably competitive production are enormous. The automotive industry is scale intensive and even the larger economies such as Nigeria and South Africa lack domestic markets, which are of sufficient size to achieve economies of scale. The two largest producers on the continent, South Africa and Morocco, have large established export markets. Regional integration would offset some of these difficulties but progress in this regard is slow.

A further problem is that most African countries suffer from weak manufacturing capabilities and poor infrastructure. In a detailed benchmarking exercise of manufacturing costs in Africa, Iarossi (2009) distinguishes between direct, indirect and invisible costs. Direct costs, which include capital, labour and electricity, are not the major cause of the region being uncompetitive. The main cost differences arise in indirect and invisible costs, which arise outside of the factory (Iarossi, 2009).

The main infrastructure constraints are electricity and transport. Africa needs to spend 4.5% of GDP to significantly improve its infrastructure but according to one study, a group of countries comprising Cameroon, Kenya, Nigeria, Senegal and Zimbabwe were only spending 1.3% of GDP

between 2010-2015 (MGI, 2016:117). While wages in Africa are generally low, when one controls for factors such as per capita income, living costs, firm size and sector this is not the case and South Asia and East Asia respectively have a 60% and 25% labour cost advantage. Capital costs are also high in Africa, with firms having to pay higher interest rates than is the case in Asia, for instance (Iarossi, 2009). While there is substantial variation between countries, electricity costs are also relatively high in Africa.

Indirect costs include transport costs and the regulatory environment and these are again higher in most African countries. But the biggest cost penalties arise in the areas of invisible costs which take account of the quality of the business environment. They include, for example, the high collateral requirements of securing loans, and losses due to unreliable infrastructure services. Poor electricity supply is the key infrastructure constraint and apart from the disruption to production, it leads to firms having to invest in private generation equipment. In all, invisible costs in Africa accounted for 13% of sales compared to less than 8% in the next highest region (South Asia) and below 3% in East Asia (Iarossi, 2009).

Even South Africa, which has a large trade surplus in the automotive sector with the rest of Africa is not itself a low cost producer when compared to Asia's low cost producing countries such as Thailand (Barnes et al., 2015). It is clear, therefore, that there is currently a huge gulf in production costs between competitive international producers and the infant automotive industry in SSA outside of South Africa.

Given that most African countries battle to compete in manufacturing, the argument for leapfrogging in production is therefore somewhat speculative. But three points can be made. Firstly, the automotive industry is scale intensive with huge barriers to entry. Motorcycles have offered a production entry point for a number countries in Asia because the market has been large and the technology relatively simple. The same argument would apply in Africa. Nigeria, for example, is a major market for motorcycles and is surrounded by other markets, which collectively add up to a very large regional market.

A second and related point is that barriers to entry are lower in electric two-wheelers. The case of China demonstrates that lower scale and lower technology are viable options in electric vehicles. There were some 2600 assemblers of complete electric two-wheelers in China in 2010 although 50 firms accounted for about half of this production (Altenburg et al, 2017). Linked to this are innumerable small scale parts makers and suppliers putting together products which use quite low technology. In India there are 200-250 firms involved in manufacturing three-wheelers (Bloomberg, 2017). However, in battery production and certain other components, the economies of scale are significant.

A third potential advantage, particularly in relation to other forms of automotive production is that the motor cycle market in Africa, unlike the car market, is not dominated by used imports, which currently massively impede the possibilities for domestic car assembly. This makes it politically easier to implement protectionist measures to support domestic manufacture.

Fourthly, 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 (Altenburg, 2017). Established ICE producers will suffer huge adjustment costs.[15] The countries facing adjustment include China and India, which are heavily invested in ICE technology. A similar argument could feasibly be applied to newcomer countries.

6. Conclusions and policy recommendations

This paper has made an implicit case for the promotion of electric vehicle technology in Africa. The continent is set to become the 2nd largest market for motorcycles (in unit terms) after Asia and will grow rapidly over the next decade. A number of larger countries are looking for ways to enter basic automotive production and with simpler technology and a large market, motorcycle production is clearly an opportunity. However, it makes little sense to pursue ICE technology, given that the world's largest market (China) has already substantively converted to electric technology and the 2nd largest market (India) is pursuing an aggressive strategy to follow suit.

There are enormous complexities, however. The current market for electric two-wheelers in 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. It is difficult to make a case for low income African countries to subsidise imported electric vehicles. 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, low cost Asian producers.

A number of African countries are wanting to get into automotive production. Given the rapid worldwide shift to EV technology, it would be sensible to consider leapfrogging to electric technology. Optimal scale in electric technology is lower than in ICE technology. The experience of both China and India is that there are dozens of domestic firms involved in domestic assembly and some of these are quite small.

[15] These are detailed, although in rather extreme terms, by Arbib and Seba (2017).

What policies are appropriate? National circumstances vary widely and the leaders are likely to be countries with large markets and ambitions in the automotive industry. These include Nigeria, Egypt, Ethiopia and Kenya. All have limited resources and limited technological expertise but supportive policies could include low cost measures to promote domestic demand for electric two-wheelers (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 latter would in the first place require a regular and reliable electricity supply, which is not the case in major Nigerian cities, for instance. Some of the above measures could be implemented on a trial basis in selected cities.

The arguments set out above are speculative and require much more detailed investigation. But it is the contention of this paper that there exists an opportunity for Africa to leapfrog into emerging electro-mobility technologies in a product where the market is expanding rapidly and where the basic production technology is not unduly sophisticated. The successful production of electric two-wheelers may then offer opportunities for related industrial expansion in other types of EVs and related technologies.

References

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.

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.

Arbib, J. and Seba, T. (2017) *Rethinking Transportation 2020-2030: The Disruption of Transportation and the Collapse of the Internal Combustion Vehicle and Oil Industries*. RethinkX. May 2017.

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.

Barooah, S (2018) Hero Electric eyes 20x growth in 5 years. 15 May http://www.autocarpro.in/news-national/hero-electric-eyes-20x-growth-29484

Black, A., Makundi, B. and McLennan T. (2017), Africa's automotive industry: Potential and Challenges, *Working Paper Series N° 282,* African Development Bank, Abidjan, Côte d'Ivoire.

Black, A. and McLennan, T. (2016) The last frontier: Prospects and policies for the automotive industry in Africa, *International Journal of Automotive Technology and Management* Vol. 16, No. 2, pp 193-220.

Bloomberg New Energy Finance (2016) *Advanced transport: Research note*. Bloomberg Finance. 25 February.

Bloomberg New Energy Finance (2017) India EV Market Seeks the Tipping Point. *Advanced transport – Research note.* April 20.

Bloomberg New Energy Finance (2018) *Long-Term Electric Vehicle Outlook 2018*. May 21.

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.

Cherry, C (2010) Electric two-wheelers in China: Promise, progress and potential. *Access*, No. 37, Fall.

Dhar, S, Pathak, M, and Shukla P (2017) Electric vehicles and India's low carbon passenger transport: a long-term co-benefits assessment. *Journal of Cleaner Production*. Volume 146, 10, pp. 139-148

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

Market Line. (2015). *Global Motorcycle Manufacturing.* August 2015.

McKinsey Global Institute (2016) *Lions on the Move II: Realizing the Potential of Africa's Economies.* McKinsey and Company.

McMillan, M, Rodrik, D. and Verduzco-Gallo, I. (2014) Globalization, structural change and productivity growth, with an update on Africa, *World Development*, Vol. 63, pp. 11-32

Njoku, K. L., Rumide, J., Akinola, M. O., Adesuyi, A. A., & Jolaoso, A. O. (2016). Ambient Air Quality Monitoring in Metropolitan City of Lagos, Nigeria. *Applied Science Environmental Management*, *20*(1), 178–185. Retrieved from http://dx.doi.org/10.4314/jasem.v20i1.21 KEY

Olowoporoku, A. O., Longhurst, J. W. S., & Barnes, J. H. (2012). Framing air pollution as a major health risk in Lagos, Nigeria. *WIT Transactions on Ecology and the Environment*, *157*(Figure 1), 479–488. https://doi.org/10.2495/AIR120421

OECD & International Energy Agency (IEA). (2017). Global EV Outlook 2017: Two million and counting. Paris: OECD/IEA.

P&S Market Research (2017) https://www.psmarketresearch.com/market-analysis/electric-scooter-and-motorcycle-market

Saxena, A. (2014) Electrical consumption of two-, three- and four-wheel light-duty electric vehicles in India. *Applied Energy*, Vol. 115, No. 15.

Techserve (2017) Africa Two-Wheeler Market to Surpass $10 Billion by 2022**,** September https://www.techsciresearch.com/report/africa-two-wheeler-market/1249.html

Trade Map. (2016). www.trademap.org/Index.aspx

Wang, H., and Kimble, C. (2011) Leapfrogging to electric vehicles: Patterns and scenarios for China's automobile industry. *International Journal of Automotive Technology and Management*, 11(4) pp. 312–325.

webBikeWorld. (2015, November 4). *Motorcycle sales statistics, news and information*. www.webbikeworld.com