PUBLICATION

A DOZEN MARKETS AND COUNTING: THE OPPORTUNITY FOR TWO WHEEL E-MOBILITY IN SUB SAHARAN AFRICA

PERSISTENT

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MOTORCYCLES ARE LEADING THE SHIFT TOWARDS GREEN MOBILITY ON THE CONTINENT

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Is Africa ready for e-mobility ?

On October 25th, 2021, Tesla's market cap passed the **$1 trillion** mark for the first time. As **1 of 7** companies to have ever passed the $1 trillion market cap, it is on par with the likes of Google, Meta, Microsoft, and Apple and has far surpassed legacy auto manufacturers. The achievement shows a strong vote of investor confidence in Tesla. It also shows a strong vote of confidence in electric mobility (e-mobility). In a little over a decade, Tesla has demonstrated that e-mobility is a commercially viable business.

As a climate venture builder, we at Persistent believe that the move to a greener transportation sector will be vital to Africa's sustainable development, particularly for its polluted urban centers where transportation often accounts for almost 50% of CO2 emissions. In Kenya, for example, transportation accounted for **52% of CO2 emissions** in the whole country as of 2014, per World Bank data.

For urban areas like Nairobi, it is likely even higher given the higher number of transport vehicles in urban areas. Given Persistent's decade long experience investing in early-stage climate businesses on the continent, we often get asked:

When will Africa be ripe for e-mobility? That is, do existing solutions already make commercial sense for cash strapped African entrepreneurs?

Our analysis suggests the answer is yes!
Electric motorcycles are the most representative means of transport in terms of volume and environmental impact. Electric motorcycles are commercially attractive in at least 15 African urban markets. The result is based on a simple framework that assesses whether the incremental final value generated from switching from an Internal Combustion Engine two wheel vehicle (ICE-2W) to an electric two wheel vehicle (e-2Ws) exceeds its incremental financial costs.

This article will provide some context on two wheelers (2Ws) in Africa and provide a simple framework to assess the value of their electrification that we will then use to identify some markets in Sub Saharan Africa (SSA)with strong potential for e-mobility.

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WHY ARE WE FOCUSING ON MOTORCYCLES?

THEY ARE SIMPLY THE MAIN MEANS OF TRANSPORT, CLOSEST TO PRICE PARITY, AND A KEY SOURCE OF YOUTH EMPLOYMENT.

There are various types of vehicles to electrify in Africa - bodabodas (two-wheeled motorcycles) tuk tuk´s (three-wheeled motor vehicles), cars, buses, boats, planes, agricultural machines, etc. Persistent is already actively working on the use of electric versions of some of these vehicles through its portfolio of investments. However, in this analysis, we focus on electric motorbikes for two reasons:

Their economic and environmental relevance and relative affordability.

FROM THE ECONOMIC AND ENVIRONMENTAL ANGLE, THREE TIMES MORE MOTORCYCLES ARE IMPORTED ANNUALLY INTO SSA THAN CARS.

The trend is likely to accelerate as incomes rise. This makes motorcycles a key commercial transport asset in the continent with strong past and expected future growth rates. Additionally, motorcycles are much more polluting than cars: motorcycles produce about 10x more hydrocarbon emissions per km than cars. As such, motorcycle electrification must be a key focus in advancing green transportation in SSA. Finally, for-hire motorbikes are, in most cases, run as small businesses in themselves, and, thus, are a key source of employment for many young Africans (as many as 60% of drivers are below 35 years old).

FROM AN AFFORDABILITY ANGLE, TODAY THE UPFRONT COST OF ELECTRIC CARS INCLUDING THEIR BATTERIES ARE OFTEN TWO TIMES OR HIGHER THAN REGULAR FUEL-BASED VEHICLES.

Whereas motorbikes themselves are typically the same or only marginally more expensive, but when we include the batteries they are typically up to 1x higher.

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THE FRAMEWORK: A SIMPLE 2X2 MATRIX THAT ASSESSES A MARKET'S ATTRACTIVENESS ECONOMICALLY AND ENVIRONMENTALLY

We built a simple, two-dimensional framework to perform a top down assessment of the attractiveness on the e-2W market. The framework draws on the current realities of ICE-2W in the market. The first dimension is the economic attractiveness of switching from an ICE-2W to an e-2W from a driver perspective. The second - since currently charging solutions are almost entirely grid based - is how green the current grid in a certain country is (e.g. how much electricity is generated from renewables vs. other polluting sources).

MATRIX DIMENSION 1:
ECONOMIC ATTRACTIVENESS OF SWITCHING FOR A DRIVER.

Let's make the following key assumptions, extracted from Persistent's past and current market and investment learning: adoption will be driven by energy cost savings and lease-to-own acquisition model.

Financial incentives are primary motivators for drivers. That is, they'll only switch if their daily spending on an e-2W is no more than for the ICE-2W they currently operate.

- Specifically, we assume that the **daily energy cost-saving** the driver generates from making the switch from gasoline (ICE) 2W to e-2W (See Figure 1A) must at least equal the daily incremental cost of switching to an e-2W (See Figure 1B) which they will pay in terms of higher daily lease payments.

- There are **significant user benefits of riding an e-2W motorcycle vs. an ICE-2W motorcycle.** These include faster acceleration, less noxious fumes, and smoke, fewer vibrations, and less noise. While our experience shows that most drivers value these, for our analysis we assume that they won't value them enough to switch to an electric motorcycle if it means a higher daily cost.

- In practice, electric **motorcycles generate maintenance and repair savings** for drivers when compared to ICE 2Ws. These savings are incremental to energy savings. Given their infrequent nature, we have excluded them from the analysis.

- On the flip side, we know that **behavior change is hard to achieve** (e.g. getting a driver to swap a battery instead of going to a fuel station), but we assume that no additional financial incentives are required to motivate drivers to switch beyond the above mentioned. Suffice to recognize that the driver is already used to a stop off to refuel. If a battery charging/swap process can be made no more inconvenient than filling up the tank, this should not be a factor.

Riders acquire the motorcycle and batteries on a lease-to-own model and charge their batteries at home

- **Lease-to-own is the predominant model** we see today for traditional motorcycles. Riders typically lease a motorcycle for a fixed daily amount over a period of typically 18 to 24 months. After the end of the period and completing their payments, they take full ownership of the vehicle. We believe this or similar financing models will be predominant for electric motorcycles today and in the near future

- **On energy access for the batteries,** there are two principal models with a number of variations for each:
  - **The first is home charging**: In this model, the battery cost is typically included in the lease-to-own contract and the driver owns the battery along with the motorcycle at the end of their lease-to-own period. Moreover, the driver charges his/her battery him/herself at a convenient location, most often at home. The key limitation of this model is that not every driver has a reliable and safe electricity connection available to charge batteries, particularly drivers living in informal settlements.

  - The second is the swapping model: In this model, the battery is owned by a provider, who sets up stations at which drivers can swap depleted batteries for charged ones. In this model, a driver is charged a combination of rental fee (to recover the battery cost over a period of up to the lifespan of the battery) and energy fee (to cover electricity cost included in the battery and upfront and operational costs of the swapping station) for each swap they make. The combined fee is typically priced at less than 80% of the driver's daily gasoline spend. Compared to the home-charging model, the company manages the inconvenience of recharge on behalf of drivers. This reduces the range anxiety associated with e-2Ws: will I find a place to refuel when I run out of power? Not surprisingly, in this model, the long-run overall cost for drivers is higher as the company needs to recover the upfront and operational costs of the charging station. However, swapping is a practical short to medium term solution, given that, often, in many Sub Saharan African markets, the quality and reliability of access to electricity is often better for businesses (as would be for a swap operator) than for households (as is the case for home charging). Hence, the current market prevalence of the swapping model among EV startups.

- For our analysis, we focus on the lease-to-own (battery + e-2W motorcycle)/ home-charging model. All else equal, e.g. equal access to electricity by both homes and business; equal lease periods for both vehicle and batteries, it is the most cost efficient and, hence, affordable long-run model for drivers. Based on the above assumptions, the key result of the economic dimension of the framework is:

For economic attractiveness, the daily energy savings by a driver switching to e-2W (Figure 1A) should be at least the incremental non-energy daily cost of making the switch (Figure 2A). Hence, the relationship on the following page.

DAILY ENERGY SAVINGS (SEE FIGURE 1A) >= $2.78 (SEE FIGURE 1B)

FIGURE 1: DAILY ENERGY SAVINGS THAT GENERATE FROM THE SWITCH.

FIGURE 1A MUST EXCEED THE INCREMENTAL NON-ENERGY DAILY COST FOR A DRIVER SWITCHING FROM AN ICE-2W TO AN E-2W **(FIGURE 1B)**.

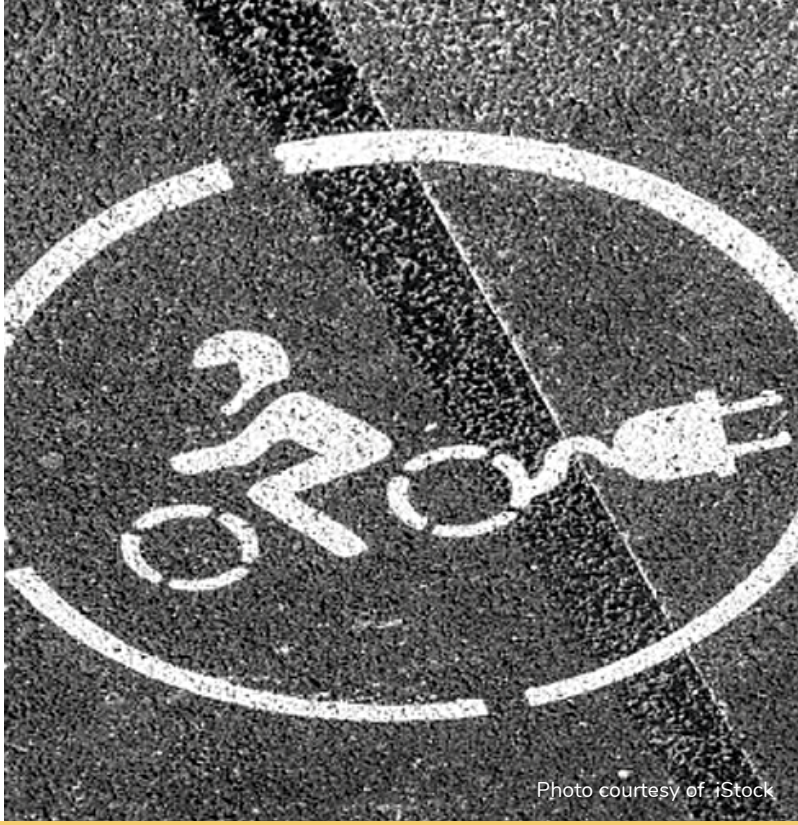


Photo courtesy of: iStock

The charts below show us that our target for the first matrix dimension is finding markets with clean energy where daily energy savings over ICE consumed petrol exceed $2.78.

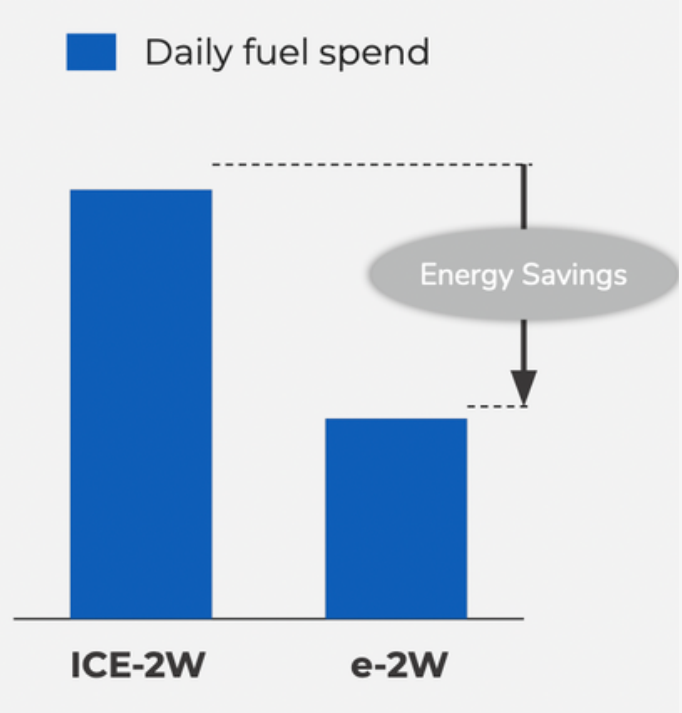


Figure 1A: daily energy savings

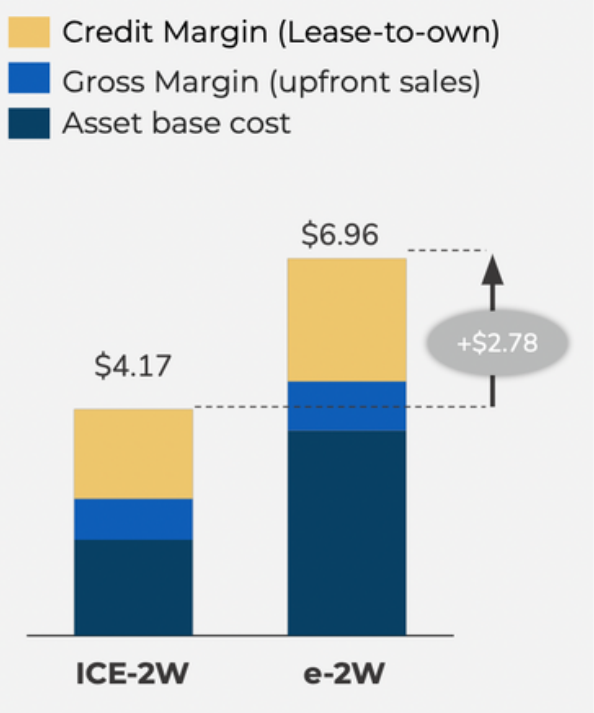


Figure 1B: incremental non-energy daily cost of switch

Key assumptions leveraging insights from Kenya, a fairly competitive 2W bike market: energy efficiency of ICE-bike (23 km/L; higher end) and e-bikes (20km/kWh; lower end); daily distance traveled (70km; lower end); daily lease payment (18 months; and lower end of payment of $4 per day)

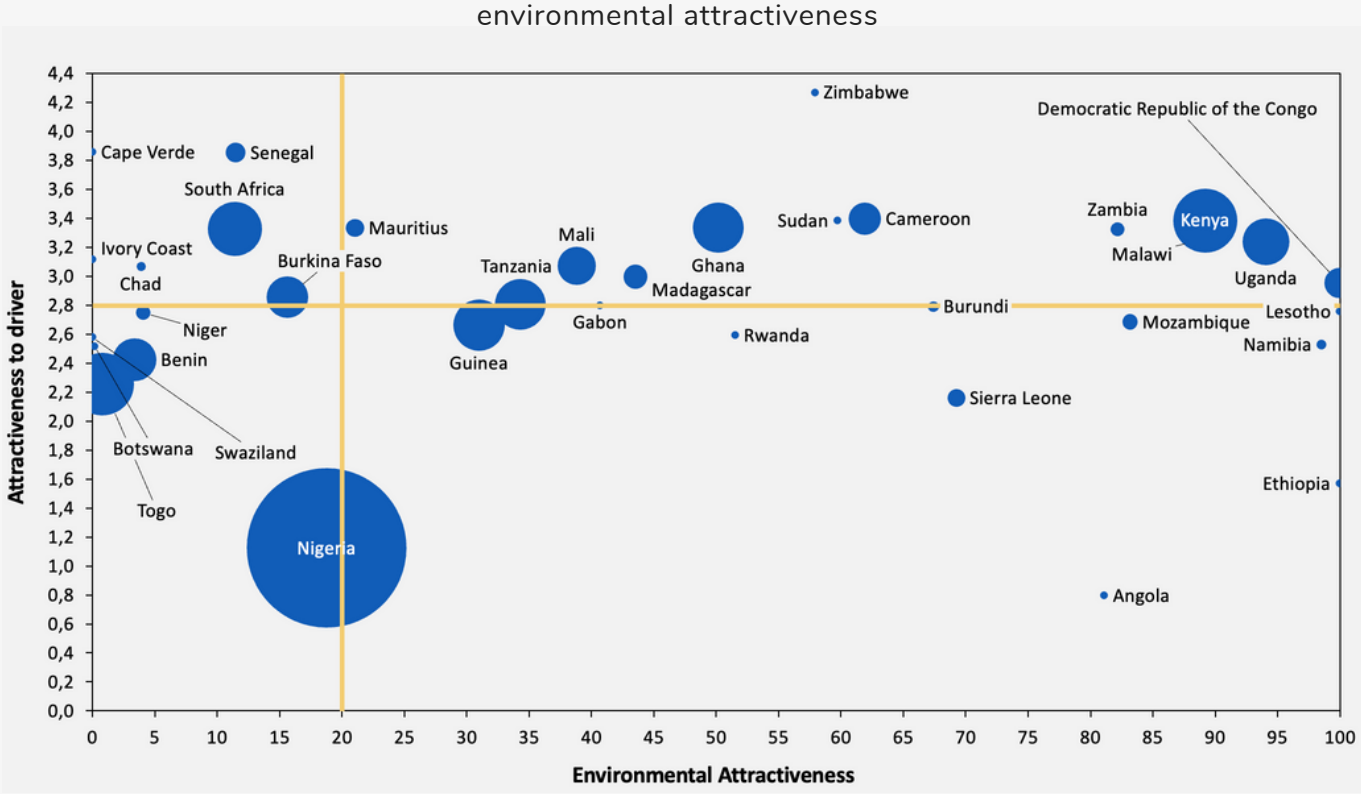
MATRIX DIMENSION 2: ENVIRONMENTAL ATTRACTIVENESS.

For this dimension, we use the market's share of electricity generated from low carbon sources as a proxy for environmental and climate attractiveness of the grid. According to BP Statistical Review of World Energy & Ember data, **the African average for low-carbon share of electricity production is about 20%.** We use this level as the minimum threshold for a market to be considered environmentally attractive. Some might prefer a higher threshold (e.g. 50%) but we thought it made sense to focus on the relative environmental attractiveness of a market for which the average marks a good relative point. An additional dimension we could have added was grid reliability. Anecdotes on grid reliability abound, but hard, cross-country data is limited. What this means practically is this: would-be investors should dig deeper into this topic for the specific country/countries they want to invest in to assess the impact on the market(s) attractiveness.

These two dimensions (economic and environmental attractiveness) form the basis for the simple 2x2 framework we developed to assess a market's attractiveness, based on a switching driver's basic unit economics (daily energy savings must exceed daily non-energy incremental cost from switching) AND a relatively clean electricity grid.

Results: Applying the framework above for markets for which data is available yields 15 markets that are attractive today. See Figure 2 for the applied 2x2 framework:

Figure 2: Map of countries by economic attractiveness to the driver vs. environmental attractiveness



Note that the bubble size represents the relative size of the 2W bike market in that country.

Photo courtesy of Ecobodaa

DISCUSSION:
15 MARKETS ARE READY FOR GREEN MOBILITY, AND ANOTHER 50% HAVE GREAT POTENTIAL. MOREOVER, ENERGY TRENDS SEEM FAVORABLE.

Countries with daily energy savings above $2.78 and grid cleanness above average

- Zimbabwe
- Cameroon
- Sudan
- Kenya
- Ghana
- Mauritius
- Zambia
- Uganda
- Malawi
- Mali
- Madagascar
- Democratic Republic of the Congo
- Tanzania
- Gabon
- Burundi

In order of economic attractiveness for the driver

As Figure 2 shows, most African markets for which we were able to find data are close to being attractive for green mobility from a value-to-driver perspective (daily energy savings from switching are close to exceeding the incremental daily cost of switching).
We split the markets as follows:

- **The top-right cell** represents Ready Markets. This is a set of 15 countries that emerge as attractive and represent about 40% of Sub-Saharan Africa's population. They include markets that have attracted investor attention like Kenya and Uganda and others that have yet to attract attention like Cameroon. In this set, there's a subset that has even stronger grid cleanness (50% or more share of electricity is from renewables). You can call them the "Super Ready Market." These are good places to start: high attractiveness to the driver and a very green grid, relatively speaking. These markets include the East African darlings like Kenya and Uganda. A market like Tanzania might be considered Super Ready if one counts natural gas as a renewable source of electricity generation: its share of electricity from renewables then leaps to about 80%. For our analyses, however, we take a conservative approach and exclude natural gas.

- **The bottom right cell** is what we call, “Driver-Driven Markets.” In these markets, a key driver for economic viability is the average daily travel distance of the driver making the switch. In Rwanda for example, data suggests that drivers regularly cover upwards of 90 km daily. Using this as a new average travel distance pushes Rwanda, and a country like Guinea, into the Ready Market set. We know that Rwanda today already has several e-2W early-stage companies.
- **The top left** is Green-Constrained Markets. The seven countries in this quadrant represent markets where the economics of switching make sense for the driver but the switch to electric won’t generate significant environmental benefits and will likely struggle to attract investors who are looking to spur climate change. These are markets that can become Ready markets if their grid cleanness improves or if stand alone solar becomes a charging option.
- **The bottom left** is what we call Grey Markets. Many, like Niger and Togo, are on the cusp of meeting economic viability threshold but also have grids that come in below average in terms of renewable share of electricity generation. Nigeria also falls under this group. For these markets, government energy (renewable incentives) and tax (e.g. import exemptions) support will be important in driving both more green grids and lower EV costs to improve their economic viability. As with Green constrained markets, the rise of affordable, solar offgrid charging solutions could render these markets more attractive.

Photo courtesy of Ecobodaa

DISCUSSION:
WE BELIEVE GASOLINE AND ELECTRICITY PRICE TRENDS IN SSA MARKETS ARE LIKELY TO REMAIN FAVORABLE TO E-2W MOTORCYCLE ELECTRIFICATION:


Photo courtesy of Ecobodaa

The question of how gasoline and electricity prices are to evolve is uncertain. Yet we do believe there are some reasons to expect the price differential will continue. This price differential is essential to unlocking the daily energy savings that constitute one-half of the switching equation for drivers.

- Gasoline prices are likely to increase over the next five to ten years as the price of crude oil, a core constituent of gasoline prices, increases. Below are some reasons:
    - Crude oil prices account for **50%+** of gasoline prices. The EIA, a U.S. government agency that tracks and provides projections for crude oil prices, projects a 25% increase in crude oil prices between 2021 and 2030 **(from $71 to $89)**. This will be driven by growth in demand, and limited supply (limited amount of oil and pricing control by OPEC).
    - As price takers (80% of the 48 SSA countries are oil importers), most SSA markets will most likely pass on some or most of the increase to end consumers. **About eight SSA countries are oil exporters.**
- Electricity prices are likely to increase less than gasoline - or even drop - over the next five to ten years. Below are some reasons:
    - International initiatives like the USAID's Power Africa and **other programs by the World Bank** are aiming to enable intra-regional cross-border sales and transport of excess electricity. The net effect will be not only to increase access to electricity but also reduce its unit cost by growing supply.
    - Electricity price increase is a sensitive political topic in most SSA countries and therefore closely regulated. Because any increases are keenly felt by their populations, governments often aren't willing to raise prices. The reluctance to raise prices might explain why unit electricity prices are often below their unit cost in many SSA markets.

- Finally, and no less important, there's growing pressure on national utility providers - Kenya is an example - to provide electricity at lower prices to fend off competition from alternative electricity providers, especially solar C&I providers. Today, solar C&I electricity prices are often upwards of 20% less than national utility electricity prices, and **C&I users account for 75% of electricity demand in Sub-Saharan Africa.** So the pressure is great on national utilities to improve pricing. A likely net long term effect of the competition is that solar C&I price trends are indicative of where national utility prices are likely to head. In this regard, a BNEF report suggests that solar C&I electricity prices are likely to drop by about 50% over the next five to ten years. This means national electricity prices are likely headed in the same direction. It also means that, given its price trend, solar C&I will increasingly become a strong alternative (to grid electricity) for charging electric vehicles.

IN CONCLUSION:
30% OF SSA COUNTRIES ARE READY FOR THE SWITCH, AND ANOTHER 15% ARE ATTRACTIVE BUT PERFORM LOW ON GRID CLEANNESS.

While not explicitly assumed in our approach above, we believe governments play a dramatic role in driving the sector's emergence, using public policy tools like subsidies, rate regulation, and tax policy. DFIs and local banks can support with access to the right kind of capital. Alongside these players and what they can do, in the long-run, emerging EV market winners will likely have to focus on specific elements of the EV value chain.

Photo courtesy of Ecobodaa

- **As the simple framework showed, many of Africa's markets are either already attractive for green mobility or close to being attractive:** 15 SSA markets currently (25% of its markets) are attractive opportunities both commercially and environmentally. Another seven (15% more) are already commercially attractive but perform low on the environmental friendliness of the grid. So yes, Africa is ready! And more markets will be ready as battery prices continue to drop and e-2Ws continue their match toward price parity with ICE-2Ws.

- **While our analyses assumed no direct incentives from the government, there is an opportunity for governments to play a transformational role for the sector's emergence.** Given the socio-economic benefits (youth employment, better incomes, better health outcomes) and environmental benefits (less noise and CO2 pollution) of e-2W electrification, we believe governments should play a catalytic role. That role, e.g. temporary and permanent government tax reduction of duties and other taxes (e.g. VAT) for EV components, can help reduce the level of the $2.78 daily hurdle (incremental cost of switching) that daily energy savings must beat.

- **There is also a very important access to capital role for DFIs and local banking systems to play** in lowering the cost of both debt and equity capital that the sector will need to emerge strong. This is especially important in the long run when the capital needs of successful EV companies will switch from equity/grant to debt. DFIs could play a critical role in providing direct or intermediated patient capital; and, working with local banks directly or indirectly to provide local currency debt that is an important financial tool to mitigate the FX risk of buying working capital assets in hard currencies but generating revenues in non-hard currencies,

- **For a start, winners will have to become jack of all trades. In the long run, however, they'll have to find a niche.** Identifying potential markets as our framework enables is just the beginning. The harder work is setting up and running an e-2W/mobility company given that, like all startups, at an early stage it demands entrepreneurs to be jacks of all trades: running businesses that aim to cross the proverbial chasm by operating across much of the electric vehicles value chain. Leveraging our early-stage investor experience across Africa, we believe that, in the long run, value chain specialization by surviving market players (e.g. finance, manufacturing, distribution, charging, etc.) will be essential for the e-mobility sector's success. For each market player, some degree of specialization will likely be a key source of sustainable competitive advantage. Or as a French literary critic once put it: If you want to succeed, limit yourself.

GLOSSARY

C&I: Commercial and Industrial solar
ICE-2W: Internal Combustion Engine two wheel vehicle
e-2Ws: electric two wheel vehicle
EV: electric vehicle
FX: Foreign Exchange
Jack of all trades: a person who can do many different types of work
SSA: Sub-Saharan Africa

ABOUT PERSISTENT

Founded in 2012, Persistent is Africa's Climate Venture Builder. We believe in the power of carbon neutral economic development in Africa and as such are the leading experts and pioneer investors in the renewable sector on the continent. We build commercially successful businesses that can scale sustainably, driven by the belief that it is the best approach to outsized climate and socio economic impact in underserved African markets.

Operating out of Nairobi, New York, and Zurich, Persistent invests financial capital and human resources, through our venture building model, focusing on ideation to early growth stage. We often assign our team members (venture builders) to work in secondment operational roles, hand in hand with the management teams of our portfolio companies.

To date, Persistent has made 20 early-stage investments (2 exits) in PAYGO solar home systems, commercial and industrial solar, ecosystem enablers, and e-mobility players. Next to delivering solid financial returns, we have also contributed to improving over 4 million lives, powering half a million households, avoiding over 1 million tons of CO_2e, and creating 10,000 jobs to date.

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