Manufacturing Africa

Electric vehicles: Mobility business models and operational enablers

October 2021

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Contents of this document

Topics

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Complementing traditional OEM integration with other plays increases the frequency of touchpoints with customers

Relevant for customers of sales, lease-to-own and lease model

Low High

Value chain plays		Frequency of touchpoints
1. OEM integration (assembly and distribution)		Recurring touchpoint depending on traditional e-mobility plays; • Sales – no recurring touchpoint • Lease/lease-to-own – recurring touchpoints that can be leveraged for cross-selling
2. Vehicle finance		Depending on the set-up with the financial partner and whether this is a lease-to-own set-up; recurring touchpoints between customer and financing partner
3. Battery swaps/ Charging		Dependent on owner of charging infrastructure and type of charging, likely recurring touchpoints with a battery swap or public charging solution; some players have set up apps that track charging points and allow customers to set up e-wallets, e.g., Ather
4. Driver services	**Services package**	Service packages for drivers through a monthly/yearly subscription plan, allowing the creation of a vehicle ecosystem
	Ride-hailing app	Ride-hailing app enabling daily touchpoints for drivers and customers and collecting data that can be leveraged for other use cases (e.g., geospatial data)
5. Enterprise customer services		Enterprise customer services, e.g., planning of deliveries, fleet management, marketplace for deliveries providing daily touchpoints for the company and drivers through app log-ins and with potential of monitoring earnings through the app
6. Technology services		N/A — Not directly related to EV customers i.e., scope includes customers of technology or data services as explored in broader plays leveraging drivers' relationships

Source: Stakeholder interviews, press search

Models that **increase frequency of customer touchpoints** typically lead to **increased customer lifetime value** and **recurrent revenue streams**

Current EV players leverage those multi-play business models to create recurring touchpoints

NOT EXHAUSTIVE, SELECTED EXAMPLES

✓ Where companies typically play ✓ Variation by some players

Business models encountered for EV players		1. OEM integration	2. Vehicle finance	3. Battery swaps/ Charging	4. Driver services	5. Enterprise customer services	6. Technology services	Case studies (in following pages)	Additional examples
A. Sale		✓ REM and Ather sell E2Ws without batteries, and then rent out batteries only	✓	✓	✓	✓		OLA, BAJAJ, ATHER	OPIBUS, REM, MOBIUS MOTORS, YAMAHA, Fika CLEAN MOBILITY, gogoro
B. Lease-to-own		✓	✓	✓	✓			TUGENDE	STIMA BODA
C. Lease		✓	✓	✓	✓	✓	✓	zeway	TURO, Mottu, LeasePlan, SA Taxi, Flexclub, kovi, Localiza
Others	D. Pureplay lease model (not EV-specific)		✓		✓			moove[1]	watu
	E. Pureplay Charging infrastructure			✓					TotalEnergies
	F. Powertrain integrator designer	✓ Only selling powertrain design to other OEMs							Hero, SUZUKI, gogoro
	G. Ride-hailing platforms, including package delivery				✓	✓	✓		Uber, SWVL, Sendy, Bolt, SafeBoda

1. Moove and Uber partnership in Africa provides vehicle financing solutions for Uber drivers without owning the vehicles (e.g., unsecured financing)

Source: Stakeholder interviews, press search

A. Sale: Bajaj moved away from scooters for 10 years but is now re-entering with an E2W using the trusted household brand “Chetak”

Part of current EV business model

Bajaj’s current business model

OEM integration	Vehicle finance	Battery swaps/ Charging	Driver services	Enterprise customer services	Technology services
	Multiple third-party financiers given the wide recognition of brand				

Description

In 2009, the Indian company Bajaj decided to exit the scooter space to focus on motorcycles. However, it **re-entered scooter space, starting sales of its E2W Chetak** in January 2020 (currently present in 6 Indian cities).

The Chetak is:

- Powered by Li-ion batteries and has an in-city **range of 100km**
- Charged using a standard **5-15 amp** electrical outlet
- Designed as a blend of retro and modern style, with a metal body which provides a sense of reliability and sturdiness

Bajaj stated that it will not enter battery manufacturing or charging infrastructure.

Key differentiator

- Bajaj is building on a trusted household brand ‘Chetak’
- Bajaj leverages its strong pro-biking dealership network which has 500 touchpoints across the country

Source: Press search

Key learnings

Success factors

- Launching a new bike using a **trusted household name** can speed up adoption
- Leveraging on **existing dealership network** and relationships can speed up adoption

Challenges faced

- The bike will be sold at a loss initially at $2,100 per piece

Key takeaways

Traditional OEMs can leverage brand awareness to ramp up quickly and compete with start-up OEMs when launching new E2Ws

OEM focusing on market share could be willing to make losses initially to gain revenue

A. Sale: Ola has changed its business model several times and now covers most of the value chain

Part of current EV business model

Ola's current business model

OEM integration	Vehicle finance	Battery swaps/ Charging	Driver services	Enterprise customer services	Technology services
	Partnered with a total of 11 banks to offer financing[1]	Network of charging stations	Ride-hailing app OLA cabs	Corporate travel management services	

Description

Ola launched Ola E-Mobility in 2018 to enable Ola's **E-mobility pilot programme in Nagpur, India:**

- Tested E2W, E3W and E4W from Tata Motors, Kinetic, BYD, and TVS and **concluded E4W was not ready**
- ACME provided **EcoCharge Battery Swapping and Charging Stations**
- **Hyundai Motors and Kia Motors** announced an investment of $300 mn in Ola's EV initiative
- Ola **partnered with India Oil Corporation** to launch an electric charging station within Nagpur's airport complex
- Ola bought over FoodPanda in 2018 but shut it down in 2019 to re-focus on EVs because Swiggy, Uber Eats and Zomato were offering deep discounts

The company is now focused on **deploying 10,000 E2Ws and E3Ws:**

- Ola plans to launch in October 2021 its first electric scooter Ola S1 priced at ~$1,350 with a range of ~120km on a full charge (it had sold $150mn of scooters in 2 days of online pre-order launch)
- Ola plans to have a network of 100k+ charging points over 400 cities with charging time of 18 minutes for 75km of range

Key differentiator

Besides ride-sharing, Ola recognized that it was crucial to have a good E2W/E3W design and has set up an EV arm to proactively explore options

1. No public information on if OLA gets a fee for this service

Source: Press search

Key learnings

Success factors

- Tested all forms of EVs in India before **ruling out E4W**
- **Spun off E2W/E3W OEM** which raised start-up funding from SoftBank
- Leveraged Ola's brand recognition and services (e.g., **drivers to access loans)**

Challenges faced

- India's power grid is already over-burdened, so Ola needed to be **creative about when to charge**
- **Long waiting times at charging stations** and **high operation costs** pushed drivers to **return their EVs back to Ola and switch to ICE vehicles,** following this **Ola made available additional charging stations** to solve the problem

Key takeaways

On-the-ground testing will enable practical decision making

EV-focused business spin-off may enable additional investment

Use case specific EV adoption is essential

Creative charging method required to overcome overburdened grid

A. Sale: Ather positions itself on the high-end market segment by providing a high-quality bike and seamless customer experience

Part of current EV business model

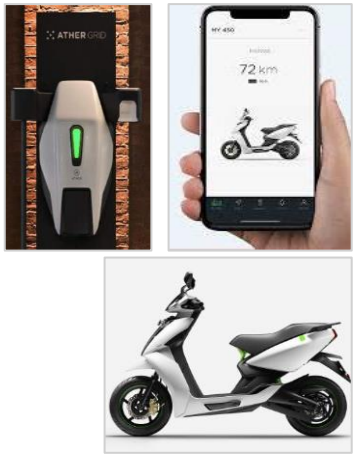
Ather's current business model

OEM integration	Vehicle finance	Battery swaps/ Charging	Driver services	Enterprise customer services	Technology services
	Possibility to lease or rent through their partner Bounce	Network of charging stations	SmartScooter with app for scooter updates	Partnered with Bounce for lease offering	

Description

Ather is an **Indian** mobility company active in charging space and provides value-added drivers services through a technology-enabled solution:

- **Charging:** Allocated $18mn to set up 6,500 charging stations
- **E2W:** Its product Ather 450 targets the younger population and commuters with short distances: it comes with a touchscreen, can store digital copies of driving license and other documents and GPS and other software systems



Key differentiator

- Following the Tesla model of innovation, design & customer engagement
- Offering seamless E2W experience, from E2W charging to mobile app and seeking to attract high-end buyers
- Actively experimenting with E2W charging

1. No public information on if Ather gets a fee for this service

Source: Press search

Key learnings

Success factors

- Actively **setting up grid infrastructure**, ~200 charging points over 24 cities as of September 2021
- Ability to **play end-to-end in the E2W space** and providing consumers a very attractive product

Challenges faced

- **Pricing is high** compared to what people are used to for E2W

Key takeaways

A high-end product with strong branding for quality can capture the premium market

High price in a price-sensitive market may deter buyers

B. Lease-to-own: Tugende is positioned as an asset financing company, with its main focus on motorbikes

Part of business model Tugende is currently playing in

Zeway's current business model

OEM integration	Vehicle finance	Battery swaps/ Charging	Driver services	Enterprise customer services	Technology services
	Finances non-EV specific motorbikes and other assets		Training and insurance		

Description

Tugende is a for-profit social enterprise formally established in 2012 **in Uganda.** The company mainly offers asset financing for non-EV specific motorbikes and other assets such as special hire taxies, retail fridges and boat engines

The company operates in Uganda and Kenya, and served over 40,000 clients over the years

Services:

Lease-to-own financing for income-generating assets

- Tugende works to create opportunities through ownership by kick-starting financial independence for Ugandan motorcycle taxi drivers
- Tugende is growing into new asset finance products such as retail fridges and boat engines

The company also offers value added services such as training and insurance

The company is working further on future opportunities by creating a digital profile for successful clients

Key differentiator

Tugende's financing service is not limited to vehicles only, it extends to different types of assets such as retail fridges, and boat engines

Source: Company's website; Press search

TUGENDE

Key learnings

Success factors

- Having more services other than vehicle financing can allow reaching a wider range of customers
- Operating in more than one location

Key takeaways

Extending its service line and financing other types of assets could be a way to capture different customer segments and generate more revenue

C. Lease: Zeway covers most of the value chain through its subscription platform

Part of current EV business model

Zeway's current business model

OEM integration	Vehicle finance	Battery swaps/ Charging	Driver services	Enterprise customer services	Technology services
		40 battery swap station across Paris	Insurance and assistance, maintenance and connected mobile app		

Description

Zeway is an electric scooter company in Paris. The company provides solutions for general public and companies looking for an electric, personal, sustainable, and economical mode of transport

- The company operates on a vehicle subscription model. A 3-year subscription where individuals lease electric scooters (SwapperOne) for a fee of €130 per month. The subscription package includes unlimited mileage, unlimited access to battery exchange stations, electricity included, insurance and assistance, maintenance, and a connected Mobile App. At the end of the 3 years, the owner can either continue the subscription at a reduced price (for 2 more years) or acquire a new model
- Zeway has 40 battery swap stations across the city, with stations positioned <2km from each other around Paris and the inner suburbs
- Zeway offers one type of scooter named SwapperOne which is a 50cc equivalent electric scooter with a 40km autonomy and connected mobile application. The scooter can be charged using swap stations or home charging cables


Key differentiator

Reliable battery swap system with 40 swap stations and a process that only takes up to 50 seconds

- The battery swap stations are integrated with the Zeway app – which allows users to locate the nearest station

Source: Company's website; Press search

Key learnings

Success factors

✓ Ease of use – Zeway has 40 swap stations throughout Paris with mobile app integration – that helps to locate the nearest station

Challenges faced

✓ The main challenge Zeway faced in developing E-scooters was the recharging time - Zeway got around the problem by implementing battery swap model and establishing swap stations across the city

Key takeaways

Having a reliable and an easy-to-use charging mechanism could help capture a large market share

D. Pureplay lease model: Moove only plays in the vehicle financing space, with its main focus on drivers in the mobility space

Part of current EV business model

Moove's current business model

OEM integration	Vehicle finance	Battery swaps/ Charging	Driver services	Enterprise customer services	Technology services

Description

Moove is a mobility fintech established in 2019 based in Sub-Saharan Africa. The company has now raised a total funding amount of $68mn, used to finance **vehicle purchase for ride-hailing drivers**. The company aims to have at least 60% of the financing go to EVs or hybrid cars.

Moove's business model involves providing loans to customers (**drivers in the mobility space: car-hailing, ride-hailing and bus-hailing**) on the sale of new vehicles, offering finance of up to 95% of the total purchase price within 5 days of their registration

- Moove offers loans for 5 car brands: Hyundai, Kia, Volkswagen, Toyota, and Suzuki
- Borrowers can repay over 24, 36, or 48 months based on a percentage of their weekly earning
- To ensure repayment, the borrower is required to sign up to the Moove app where the company deducts weekly repayments directly from the driver's Uber income

To date, cars financed by Moove have made more than 850,000 Uber trips covering >13mn km in Africa.

Key differentiator

Moove is Uber's exclusive vehicle supply financing partner in Sub-Saharan Africa

The company finances all kinds of vehicles including EVs

Key learnings

Success factors

- ✓ Partnered with Uber – leveraged Uber's brand recognition
- ✓ Having different loan terms helps to capture different customer segments

Key takeaways

Creating partnerships could help capture more customers and generate revenue from additional services that come along the partnerships

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Independent commercial drivers value different levers than potential other EV buyers/users

Levers' types	Relevant factors… Independent commercial drivers	Other potential EV buyers/users
1 **Lower cost than an ICE** 	**Total monthly cost** lower than ICE • Availability of financing/leasing models that split the upfront cost of vehicle over time • Battery charging cost lower than fuelling • Lower maintenance costs • In lease-to-own models, resale value becoming important	**Total Cost of Ownership** (TCO) lower than ICE, including: • Vehicle upfront cost • Battery charging cost lower than fuelling • Lower maintenance costs • Resale value If on a lease model, **lower monthly costs** (including fuel/charging, maintenance)
2 **Better "ease of use"** 	**Battery charging options** (availability and charge duration, need to factor in lack of consistent electricity access) **Ease of payment** for vehicle and charging Availability of **maintenance/replacement vehicles** so they have more uptime than an ICE	Options for lease/lease-to-own fleet plans with additional services covered
3 **Preferential regulation**  **Regulation lowering TCO** compared to ICE **Regulation increasing accessibility** compared to ICE	**Financial government incentives** directly affecting EV cost	Financial government incentives with direct and indirect benefits, e.g., **reduced company tax** for enterprise customers and subsidies
	Non-financial government incentives that promote building charging infrastructure, set standards to promote **EV charging infrastructure interoperability**, and **prohibit/restrict use of ICE**, e.g., location based ICE bans	
4 **Driver and passenger comfort** 	Less **noise and less vibrations** than ICE equivalents leading to more comfortable rides, no risk of **exhaust burns, no exhaust gas pollution**	More comfortable rides leading to potentially **more satisfied employees**
5 **Environmental impact** 	**Low relevance** for independent commercial drivers in Nigeria given **low awareness**	Potentially relevant for companies where: • Environmental concern is a **key selling point**, e.g., companies in renewable energy • Customers have **environmental awareness** • **Investors are looking for green investments**

1: Levers that lower costs compared to ICE include reducing capex, maintenance and charging costs

Levers increasing likelihood of EV adoption	Incentive provider	Regions currently applying initiatives
1.1 **Reduction of upfront cost of capex –** Reduction of cost through better procurement of parts, lower cost batteries, efficiencies due to scale or other capex cost-reduction levers	Manufacturers/OEM integrators	N/A, done at company level
1.2 **Reduction of maintenance costs –** Increasing availability of generic spare parts and developing mechanics' EV experience could lower maintenance costs	Manufacturers/OEM integrators/mechanics	
1.3 **Reduction of charging costs –** Usually less expensive than fuel; potential to reduce profit margin on charging to further reduce costs	Manufacturers/OEM integrators/ charging distributors	
1.4 **Increase in resale value –** Increasing usable life of EVs and developing a second hand market place would increase resale value	Manufacturers/OEM integrators/ resellers/ cooperatives	
1.5 **Lease/lease-to-own models for enterprise and end customers** – Leverage global carbon finance funds to increase financing available for E2Ws and provide lease/lease-to-own models for EVs	Manufacturers/OEM integrators in partnership with financial institutions	US

Source: Press search, expert interviews

2: Increasing ease of use through access to charging infrastructure, payment platforms and EV mechanics can also incentivise EV adoption

Levers increasing likelihood of EV adoption	Incentive provider	Regions currently applying initiatives
2.1 **Access to electricity for charging (through public or private entities)** – Providing easy access through battery swap stations or alternative public charging options and communicating ease of charging would help change consumer views; Set up public charging points at workplaces, Government malls and along highways (potentially for free or at subsidised rates)	Government/charging distributors	 China, Singapore, US  Thailand (private sector)
2.2 **Payment platform** – Develop a common payment platform for charging stations and battery swap stations that would allow EV distributors to offer discounts as incentives for EV purchase	Manufacturers/OEM integrators/charging distributors	N/A[1]
2.3 **Mechanic capabilities for EVs** – Develop mechanic capabilities for EVs to support maintenance	Private sector	N/A
2.4 **Standards** – Set standards for batteries and charging infrastructure to allow for public battery swap stations and public charging points that can serve multiple brands of E2W and to meet safety requirements	Government	 India, China

1. Not applicable as information unavailable

Source: Press search, expert interviews

3: Regulatory incentives that lower TCO of EVs include reducing taxes for EV owners, providing subsidies and preferential power tariffs

	Levers increasing likelihood of EV adoption	Incentive provider	Regions currently applying initiatives
3.1	**Malus tax (increased tax for ICE owners vs. standard vehicle tax) increasing cost for ICE customers** – Increase taxes on ICE 2W (emitting CO_2) to incentivise switch to E2W	Government	Sweden, Norway
3.2	**Direct subsidies** – for purchases of E2W to bring down the purchase price or offer turnover schemes to encourage ICE owners to trade in their vehicles in exchange for a discount on EVs	Government	USA, Singapore, Germany
3.3	**Indirect subsidies leading to lower cost for end customer** – Offer indirect subsidies for purchases of E2W in the form of reduced taxes for import and registration of E2W to bring down the purchase price	Government	India
3.4	**Preferential power tariffs** – Grant preferential power tariffs to users of e-mobility through charging infrastructure	Government	N/A[1]
3.5	**Tax exemptions** –Tax exemptions (import duties, levies and VAT) for import of parts for EV manufacturing/assembly or reduction of sales taxes on all EVs	Government	Kenya
3.6	**Permit exemption –** Exempt EV owners from paying for operation permits, Registration certificates, License plate fees	Donors and Government	China, India, Norway
3.7	**Reduced company tax for enterprise customers** – Reduce company vehicle taxes where a certain proportion of fleet is electric	Government	Norway

1. Not applicable as no information available

Source: Press search, expert interviews

3: Government initiatives that improve access for EVs whilst discouraging use of ICE vehicles could also increase adoption

Levers increasing likelihood of EV adoption	Incentive provider	Regions currently applying initiatives
3.8 **Location-based ICE bans** – Set regulations that ban the use of ICEs within cities to encourage EV adoption	Government	N/A[1]
3.9 **Permit exemption –** Allowing holders of a passenger driver's permit to drive electric vans class or hold other permits for EVs	Donors and Government	 China, India, Norway
3.10 **Improved access** – Access to preferred transportation lanes and parking spots	Government	N/A
3.11 **Targets** – Set targets for E2W penetration and ICE 2W phase out to make consumers and manufacturers aware of E2W and government's commitment	Government	 Rwanda, Kenya, Thailand
3.12 **Curriculum** – Adapt the curriculum of university courses that currently focus on internal combustion engines to also include electric powertrains and e-mobility	Donors and Government	N/A
3.13 **Government procurement policy –** include EVs and preferential procurement of locally-assembled E2Ws for urban-based police, military and other service staff where they meet the performance requirements	Government, cities	N/A

1. Not applicable as no information available

Source: Press search, International Council on Clean Transportation, Natural Resources Defence Council, Norway Electric Car Association, US DoE, iea.org

A mix of regulations and incentives proved instrumental to stimulate the E2W market in Norway, China and India

NOT EXHAUSTIVE

		First-mover Norway	Industry leader China	Incoming player India
		2025	**2035**	**2030**
2	**Better "ease of use"**	2.1 Extensive charging infrastructure with 3.5k chargers/mn residents	Extensive charging infrastructure with 1.6k chargers/mn residents[2]	Government offers support for setting up charging stations – as a result, a number of start-ups have entered the space
		2.1 Public charging network funding	Public charging network funding	Target of 1 charging station every 3x3km grid in mega cities
3	**Preferential regulation** Regulation lowering TCO compared to ICE	3.1 **Malus tax** on ICE vehicles of an additional 25-50%	**Purchase bonus** for battery electric vehicles and plug-in hybrid electric vehicles proportional to driving range; **Price cap** on sale price of new energy vehicles	
		3.2		Central government offers **subsidies** on E2W[3], E3W, E4W[4] and buses in proportion to battery capacity
		3.5 Exempt from **import fees**, **VAT** (25% on purchase and leasing price) and **annual road/insurance tax**	Exempt from **purchase tax**, **consumption tax** and **vehicle and vessel tax**	Many state governments offer additional benefits like exemption from **road tax and registration fee** **GST set at 5%**, whereas this is 29-43% for ICE
	Regulation increasing accessibility compared to ICE	3.7 Target for ban on all new ICE passenger cars, light-commercial vehicles, and urban buses	Target for ban on pure ICE – hybrids will be permitted	2030 aspiration set at 30% of E4W, 80% E4W, 70-80% in commercial vehicles; however, no law in place
		3.9 Reduced prices for toll roads, parking fees, and ferry fares (maximum 50% of full price) and access to bus lanes	Battery EVs do not have license plate quotas, as opposed to ICE vehicles[2]	OEMs and battery solution providers are considering battery swapping technology in small format e-mobility (2W/3W) – e.g., Okinawa, Hero Electric
5	**Environmental impact**	5 **Long-term efficiency** or **CO_2 standards**	**Long-term efficiency** or **CO_2 standards**	**Long-term efficiency** or **CO_2 standards**

1. For EVs as of Jan 2019: includes tax incentives, avoided tolls and cash subsidies;
2. In Beijing province
3. Subsidy offered on E2W with advanced cell chemistry (e.g., lithium-ion)
4. Subsidy on E4W is only for commercial use case (e.g., taxi)

Source: Press search

East Africa has also begun to implement initiatives and set targets to drive EV uptake

STATUS AS OF FEBRUARY 2021

Incentive types	Key Parameters	Kenya	Rwanda	Uganda	Ethiopia
2. Better ease of use	2 Availability of models	Several players have begun to **design and locally assemble EV** which are suitable to the region, e.g., Opibus, Ampersand, Zembo			
	2 EV production ramp-up	**Local EV assemblers** are beginning to transition from their prototyping and testing stages to production (e.g., Ecobodaa, Kiri EV)			
		Large MNCs are beginning to consider entry into the markets, given the opportunity (e.g., Volkswagen has started assembling **EV in Rwanda**, **Siemens is piloting electric trucks, cargo-bikes and boats in Western Kenya**)		Uganda government committed ~$6.4 Mn to put the first fully home-made car on the road, part of a planned $39 Mn spend committed between 2018 and 2022	
	2.1 Charging station deployment (public and home/office charging)	In 2020, the **Ministry of Energy in Kenya** announced plans to require all new buildings to **incorporate charging stations, and KenGen** announced plans to roll out an **electric charging network** In early 2021, **Kenya Power** announced plans to build a **nationwide network of public EV charging points**	As of 2020, Siemens had announced plans to set up 15 EV charging stations in Kigali, Rwanda		
3. Preferential regulation	3 Policy changes		The Rwandan government is working on an EV policy to increase adoption of EV		
	3.5 Tax exemptions and incentives	**Kenya Finance Bill of 2019** proposed a reduction on excise duty for EV from 20% to 10%			
	3.10 Official EV penetration targets (e.g., X% of new vehicle sales by 2030)	**Kenya** has plans to **increase uptake of EV to 5% of all imported cars annually** by 2025 (National Energy Efficiency and Conservation Strategy)	Rwanda announced plans to convert all motorcycles to electric, though the timelines for this are yet to be announced		
5. Environmental impact	5 Fuel efficiency and CO_2 emission targets	All 4 countries have plans to cut carbon emissions below Business-as-Usual (BAU) by 2030 (64% for Ethiopia, **32% for Kenya**, 22% for Uganda 16% for Rwanda)			

Limited progress made to reduce the cost of batteries given that minimal lithium battery production takes place in the region, due to the lack of a developed mineral processing industry

Source: Emerging market EV experts' input, Web searches, Industry reports

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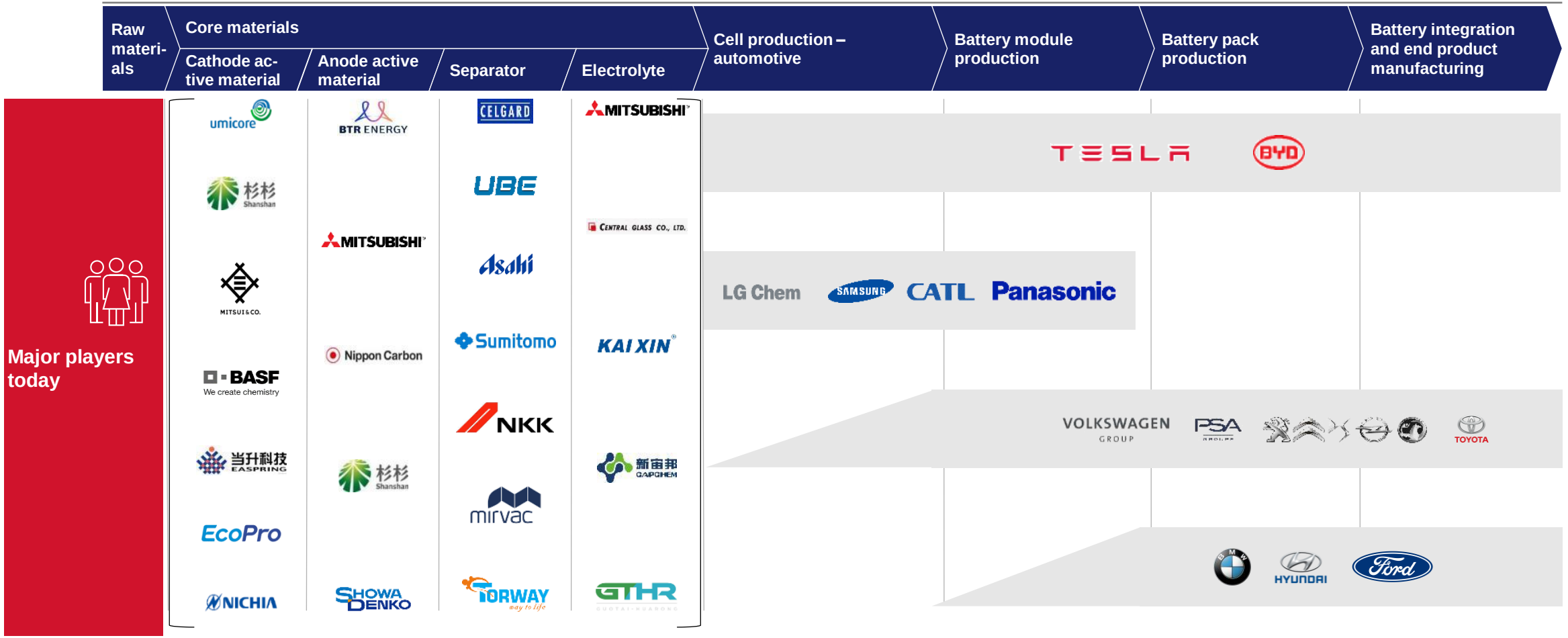
Major OEM players go upstream towards battery pack and cell production

NON-EXHAUSTIVE LIST OF PLAYERS, ILLUSTRATIVE ONLY

EV battery value chain



Source: Yano Research, Fuji Keizai, Press search

There is a lack of standardisation for E2W, E3W, E4W batteries

Battery standards for various regional E2W players

SELECTED EXAMPLES, NOT EXHAUSTIVE, FOR ILLUSTRATIVE PURPOSES

Battery specifications	E2W company and main location			
	NIU	gogoro	SUN MOBILITY	PIAGGIO
	Chinese Mainland	Taiwan	India	Italy
Power	2.1 kWh	1.3 kWh	1.5 kWh	2.3 kWh
Charging protocol	Home charging ~7 hours to charge	Home charging Battery swap	Battery swaps (stations charge 14 batteries in ~1 hour)	Home charging ~6 hours to charge
Communication protocol	N/A	App to monitor battery health, charging progress and battery location	Cloud-connected app that monitors battery performance	N/A
Weight and dimensions	~10 kg	~9 kg	~12 kg	~15 kg
Other specifications/ comments	Battery Pack harnesses 170 cells of lithium-ion technology	Batteries are encased in a durable, waterproof, aluminium case	N/A	N/A

Source: Press search, company websites

- **Players** globally have a **varying set** of battery **specifications** that suit the product and markets where they are present
- This **lack of standardization could make it difficult** for **E2W** players **to change battery suppliers** and **lead to higher costs**
- **For E2W, Piaggio, KTM, Honda and Yamaha** are part of a **worldwide consortium** to agree on a **standard for swappable E2W** batteries – the consortium has not released any defined standards yet
- For **E4W**, OEMs globally are **building batteries into chassis**, meaning owners **cannot swap or remove the batteries**, for quality control and **safety reasons**

Worldwide battery cell production capacity represents 600+ GWh in 2020 and is expected to grow to 3,000+ GWh by 2030

Scope: worldwide, all announced capacity including capacity under discussion

ALL CAPACITY ANNOUNCED, SOME MIGHT NOT MATERIALISE DUE TO YIELD < 100% AND RISK OF ABORTED PLANS

Incumbent[1] | OEM JV or OEM subsidiary | Integrator[2] | Startup | Others

Battery cell production capacity 2020-30, all announced including capacity under discussion,

Region	By 2020	By 2025	By 2030	Increase between 2020 and 2030
Asia	429 + 85 + 532 (81%)	1,118 + 302 + 1,562 (66%)	1,226 + 339 + 1,732 (56%)	x3.3
Europe	55 + 2 + 57 (9%)	191 + 107 + 143 + 39 + 480 (20%)	250 + 212 + 967 (32%)	x17
North America	45 + 6 + 56 (9%)	187 + 119 + 336 (14%)	229 + 119 + 378 (12%)	X6.8
Rest of the world	5 (1%)	5 (0%)	5 (0%)	x1.0
Grand Total	489 + 130 + 15 + 650	1,495 + 460 + 174 + 2,383	1,731 + 708 + 379 + 259 + 3,081	x4.7

Assuming a yield of 80% and assuming 70% of integrators and start-ups abort their plans, 2030 capacity would be 2,208 (vs. 505 in 2020)

1. Incumbent – traditional player in the cell manufacturing industry
2. Integrator – new to the cell industry, previously worked in another industry (e.g., Oil & Gas) or in a different segment of the battery value chain (e.g., core materials)

Source: Company announcement, expert insight

- Battery cell production is **expected to increase 4.7x capacity** by 2030 compared to 2020 if all announced capacity is operational
- The **region with the highest capacity is Asia**, representing **81% now and 56% by 2030 with 1,700+ GWh**
- The **highest growth** is expected to come **from Europe with capacity expanding 17x to reach ~1,000 GWh**
- 2 main risks might decrease actual installed capacity for 2030:
  - **Yield <100% (typically 70% - 90%)**
  - **Aborted plans, most likely for new players** (integrators and start-ups representing 20%+ in 2030)

Top 10 suppliers in 2020 are from Asia and have ~67% of total capacity, the number of suppliers is expected to double by 2030

Scope: worldwide, all planned capacity including capacity under discussion

ALL CAPACITY ANNOUNCED, SOME MIGHT NOT MATERIALISE DUE TO YIELD < 100% AND RISK OF ABORTED PLANS

xx Capacity share from the total

Archetype: OEM JV or OEM subsidiary | Incumbent

Battery cell production capacity 2020-30, sorted by decreasing 2020 capacity, including for 2025 and 2030 the capacity in discussion not yet validated, in GWh

Cell manufacturer	Chemistry	Headquarter	By 2020		By 2025		By 2030		Increase between 2020 and 2030
LG Energy Solution	NMC, LMO, LCO, NCA, LFP	South Korea	79	12%	258	11%	258	8.5%	x3.3
BYD	NMC, LMO, LCO, NCA, LFP	China	65	10%	130	6%	130	4%	x2
CATL	NMC, LMO, NCA, LFP	China	52	8%	297	12%	363	12%	x7
CATL/SAIC	-	China	36	5.5%	72	3%	72	2%	x2
CALB	LFP	China	36	5.5%	164	7%	239	8%	X6.7
Panasonic/Tesla	NMC, LCO,	Japan	35	5.5%	49	3%	49	1.5%	X1.4
Farasis Energy	NCA	China	35	5.5%	69	2%	81	3%	X2.3
Eve Energy	NMC, LMO, NCA, LFP	China	35	5.5%	35	1.5%	35	1%	x1
Samsung SDI	NMC, LMO, LCO, NCA, LFP	South Korea	35	5%	60	2.5%	60	2%	X1.7
Guoxuan	NMC, NCA, LFP	China	29	4.5%	56	2%	56	2%	X1.9
Others – ~30 others in 2020, 80 others in 2030			214	33%	1,193	50%	1,738	56%	X8.1
Total (40 players in 2020, 90 in 2030)			650		2,383		3,081		

67%

CATL has multiple partnerships for a total capacity of 506 GWh planned for 2030

Panasonic has additional partnership and independent capacity with a total of 82 GWh planned for 2030

Disclaimer:

Capacities are based on company announcements – actual operational capacity might be lower

Source: Press search, expert's input

Contents

Charging infrastructure decisions for EVs firstly require consideration of charging mechanisms

Considerations on charging mechanisms

Type of customers

Independent commercial drivers:

Usually drive **more than 60km** per day – so would need to recharge once a day or every 2 days depending on model

- Can they charge at home or at a workplace **overnight**?
- How would they charge during the day?
- Can the battery be removed from the EV?

Individual commuters:

Usually drive **less than 60km** per day – so would not need to charge during the day – overnight charging could be an option, if **access to a plug-in** available

- Can they charge at home or at a workplace overnight?

Charging speed

Fast charging:

- ⊕ **Could add to convenience** (currently fast charging for E2Ws takes 20-30mins, hyper fast takes ~10mins for full charge), likely **necessary to avoid drivers** to switch back to ICE
- ⊖ Reduces the **longevity of batteries** if done with fast-charging infrastructure
- ⊖ **Charging infrastructure more expensive than slow charging** as usually requires more complex infrastructure

Slow charging:

- ⊕ **Better for the battery** than fast charging
- ⊕ Less costly and requires standard infrastructure which is readily available
- ⊖ Requires ~4-8 hours of constant power for a full charge

3 charging mechanisms exist for EVs, with battery swaps likely to be a feasible E2W solution for Nigeria

Scope: E2W, E3W, E4W charging infrastructure

	Description	Example of EV companies	Potential owner of infrastructure	Expected revenue streams	Feasibility in Nigeria
1 **Battery swaps**	Stations where **one swaps out depleted batteries for charged ones** within minutes – **different levels of automation exist** (fully automated vending machine style or non-automated manual switching) Either **centralised model** with distribution of charged batteries or **decentralised** with several charging stations that charge their own batteries	Gogoro, Taiwan Ampersand, Rwanda	EV companies; charging infrastructure owners; energy providers	**Pay per swap** or **subscription model** with monthly payments for a number of swaps	**High feasibility for E2W** as **battery swaps do not require fast charging** and potential for **solar-powered energy for stations** Also allow for multiple customers to be serviced simultaneously Model has not been piloted at any scale for E4Ws
2 **Public charging stations**	**Slow charging** – **1-2 charging points in public areas, e.g., streets or malls**. EVs can plug in to these points while parked Potential for **street vendors** connected to the grid to provide simple plug-in charging solutions as seen in India	Pod Point, UK	EV companies; malls; retail outlets; street charger owners	Pay per charge, or contracts with government and grid energy providers for provision of free charging stations	Possible but would require set up of infrastructure with stable power on streets/malls, **complementary solution**
	Fast charging – dedicated charging operations similar to petrol stations but with specific interfaces for fast charging of EV batteries	BP, UK Tesla, US	Large energy providers; EV companies; charging infrastructure owners	**Pay per charge** model, potential for **loyalty scheme**	**Low feasibility** due to **the necessity for stable electricity** leading to the need for a **additional battery storage** as part of the charging infrastructure set-up (given low grid reliability in Nigeria) Risk of **long lead time in peak demand**
3 **Plug-in charging**	**Plug with interface** which connects to domestic/office power for charging of batteries: • Standard outlet (slow) • Installed wall charger (faster)	TGOOD, China	EV companies; multiple electric companies; white label providers	One-time payment for interface	**Low feasibility** for homes and smaller offices which largely rely on unstable grid power and diesel generators High feasibility for **larger offices and logistics depots** which might have off-grid power options (e.g., rooftop photovoltaic system), risk of non-green energy (e.g., diesel generators)

Source: Press searches, expert interviews

Main benefit of battery swap is the possibility to switch a battery immediately

Scope: E2W charging infrastructure

Details to follow

		Speed of charging	Benefits	Constraints	Customer segments the mechanism is applicable to: Independent commercial drivers	Corporates with dedicated fleet[1]	Individual
1 **Battery swaps**		**Slow charging usual practice** but could need fast charging if high frequency of users For customer – immediate	Provides **immediate fully charged battery** with lower cost of energy than fast charging For some set-ups: **agility and ability to re-deploy,**, e.g., if batteries charged centrally and distributed in the city, possibility to move battery storage points	Limited by number of charged batteries in stock	✓ Tailored to individuals that do not have access to other power sources	✓ Potential for logistic/ large organisation fleet contracts	✓ Potential if covering large distances
2 **Public charging**	**Slow charging stations**	**4-8 hours** for a full charge	**Lower cost of energy** than fast charging Does not require special infrastructure	Inconvenience due to time taken to charge Lower monetisation potential	✗ Unlikely to be viable for independent commercial drivers or large organisations where time is money	✗	✓
	Fast charging stations	**20-30 minutes** for fast **~10 minutes** for hyper fast with latest technology	Provides **fast charging** for customers Potential to **charge premium on fast charge** and **cross-sell** during idle time	Very costly Requires special infrastructure Worse for the life of the battery	✗ Likely higher cost to charge than battery swaps; battery swaps would provide immediate access to fully charged batteries at a lower cost	✗	✓ Based on affordability
3 **Plug-in charging**		Usually slow charging **4-8 hours**	Ease of use for home or workplace charging – during the day or overnight	Inconvenience due to time taken to charge Could be unfeasible if grid power issues and no backup power	✗ Unlikely to have access to reliable power	✓ Potential for organisation fleet depot	? May have access to home power although likely to be through a diesel generator

1. Corporates and public sector entities

Source: Expert interviews, press searches

Technical set-up, power sourcing solutions and ownership options are important to evaluate feasibility of the battery swap stations

Scope: E2W charging infrastructure

Considerations when evaluating battery swap stations

1. Technical set-up

Choice of technical set-up:

- Centralised models
- Decentralised models

High-level assessment of technical set-up against:

- EV driver accessibility
- Logistical ease
- Affordability
- Optimisation of battery inventory

Location of swap stations (e.g., within gas stations, or standalone)

2. Power sourcing solution

Three options considered:

- Connecting to the grid
- Connecting directly to alternate generation source
- Connecting to dedicated generation source

Choice of power access based on:

1. Grid reliability and possible alternatives
2. Use of existing infrastructure or dedicated infrastructure
3. Preference for a “green” source of energy i.e. avoiding diesel generators

3. Ownership

Choice of station:

- Standalone
- Shared space stations

Choice of ownership model:

- Own and operate the battery swap solution
- Franchise to a partner

1: The decentralised battery swap model for E2Ws could be a potential option based on logistical ease, driver accessibility and potential for scaling

Technical set-up of E2W charging infrastructure

Details to follow | Low | High

Potential technical set-ups	Centralised from driver's point of view: Centralised charge and swap	Decentralised from driver's point of view: Centralised charge and on-demand delivery	Decentralised from driver's point of view: Centralised charge with decentralised swaps	Decentralised
Charging	Centralised	Centralised	Centralised	Decentralised
Battery swapping	Centralised	On-demand/delivery	Decentralised	Decentralised
EV driver accessibility	Possible where easy to get to central location but not convenient for EV drivers that are spread across large areas with lots of traffic (as is the case in most Nigerian cities)	Most convenient option given on-demand model	Multiple stations lowering travel times and increasing convenience	Multiple stations lowering travel times and increasing convenience
Logistical ease	Easier to manage logistics given no concerns of moving batteries	Would require a lot of coordination and logistics solution to deliver on demand	Would require coordination and logistics solution to pick and drop batteries to each station	Easier to manage logistics given no concerns of moving batteries
Affordability	Likely the most cost efficient given the charging at scale and no logistical costs of moving batteries	Lower charging costs than decentralized charging due to scale Evaluation of transport costs needed for delivery and pickup of batteries needed	Low charging costs than decentralized charging due to scale Evaluation of transport and decentralised storage costs for batteries needed	Likely to be the most costly option from an infrastructure perspective (as not achieving scale) Low transport cost
Optimisation of battery inventory[1]	Full optimisation of batteries as only 1 charging and distribution location, not many spares required	Full optimisation of batteries as only 1 charging and distribution location, few spares required	More inventory required as spares would be needed within each station	More inventory required as spares would be needed per station
Potential locations of swap stations	Centralised location which could be convenient for the majority of drivers	No physical swap station as delivered to client in an on-demand model	Same as decentralised	Convenient locations such as gas stations (similar to LPG[2] cylinder model), malls Standalone stations
Examples		TotalEnergies LPG[2] cylinder distribution model		gogoro

1. Battery inventory is required to be maintained (high cost factor) though may require less inventory in a centralised model as optimisation of batteries can more easily be achieved; battery inventory needs to be replaced ranging from 500-1,500 cycles; these are preliminary estimations for battery efficiency to drop down to 80%. Contingent on speed. Faster charging lowers battery life
2. Liquid petroleum gas; TotalEnergies Kenya gas cylinder model

Source: Expert interviews, press searches

1: Case study: Gogoro offers decentralised automated battery swap stations in Taiwan with ~1 GoStation per 4km2

Background

- Taiwanese company founded in 2015
- Core product is an electric scooter (E2W) with an **extensive battery swap network** to extend its range
- Partnered to develop new battery that can be swapped by a rider **within 6 seconds**

Innovative business model

Subscription business model:

- Customers pay a monthly subscription fee[1] for access to batteries stored in GoStations

Extensive infrastructure of charging stations:

- GoCharger is a **boom box–sized unit** that can recharge **2 Gogoro batteries** through a single 110-volt outlet. Retail customers can make their GoCharger available for the general public to use as revenue stream
- 350 GoStations across Taipei, or 1 GoStation per 4 km^2. Each station resembles a vending machine and costs less than $10,000

Smart E2W with integrated app:

- Gogoro E2Ws have 30 sensors that analyse riding patterns and optimise energy use

Right price and perks:

- Gogoro priced at $2,970 (ICE equivalent at $1,050). Price includes 1 year of theft insurance, 2 years of free electric battery swapping and 2 years of free maintenance
- Scooter sales revenues to offset initial investment in GoStations

GoStation[2]

Availability in Taipei

GoCharger

Gogoro App

Lessons learnt

1. E2W manufacturers and battery OEMs must agree on a standard so that **battery swap stations** can be **used across all vehicles** in the ecosystem
2. Establishing an **extensive charging network** helps to address consumer concerns about electricity access and battery life
3. **Battery swaps can be efficient** as evidenced by the 6-second battery swap process

1. Flex Plan: $9.60 per month and $0.07 per amp-hours used, or $1 to travel 20km
2. Battery swap stations can vary in size but usually hold 20-50 batteries and typically take 3-8 hours to charge

Source: Press search

2. Zembo in Uganda have plans for 3 fully solar-powered battery swap stations charging 20 batteries per day

BASED ON PUBLICLY AVAILABLE INFORMATION FROM PRESS SEARCH

Background

Ugandan company founded in 2019

Zembo is selling E2Ws on a **lease-to-own model** (2 years to reach full ownership) which it expects will generate additional demand for the charging stations

The E2W is low cost to operate and durable enough for Uganda's roads:

- The bike parts are sourced from China but assembled in Kampala
- Zembo Storm is powered by a lithium battery and can travel **60km** on a single charge
- Each motorcycle has a **GPS tracker** to enable Zembo to monitor its performance and switch off the bike in the case of non-payment or theft

Zembo has 18 battery swap charging stations in Kampala as of 2020

Battery swap model

- Zembo is planning to **set up 3 off-grid** and **1 grid connected solar hybrid** charging stations
- Zembo operates on a **pay-as-you-go battery swap model** and batteries can only be recharged at Zembo stations
- Each station has a **charging capacity of 20** clean solar-powered motorbike batteries per day per station
- Zembo is piloting a **lease-to-own** model

Potential set-up of solar panels

https://www.yunussb.com/blog/2020/1/27/mia-spotlight-the-solar-powered-motorcycle-for-africa

Source: Press searches, expert interviews

3: Gogoro owns and operates its own battery swapping ecosystem in Taiwan with capex of each station at ~$10,000

Background

Gogoro is the pioneer of battery swap stations and technology

Currently **owns and operates** 2,000+ battery swap stations

Each Gogoro E2W comes with 2 removable batteries with range of ~95km

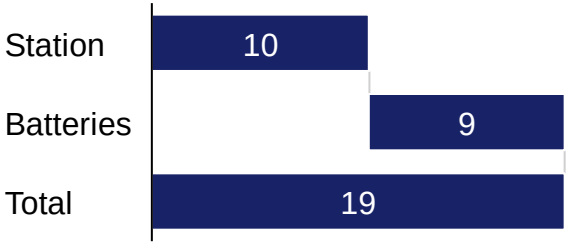
Charging station set-up

Set-up: 8-40 batteries per station, 40KW, 220V AC source, rider to provide 2 batteries to pick up new ones

Pilot: 30 battery swap stations

Current: 2,000+ battery swap stations

$19k Capex for 1 swap station with 30 batteries ($k)



Annual **opex**: ~$4k

With potential to charge an estimated 7,500 batteries[1] a year at an assumed 1$ per charge, **break-even** could be reached in **5-6 years**[2]

Business model 1: Private transportation

Location: Taiwan

Bike purchase at ~$4,000 with incentive of **free swaps for a prescribed duration**

Beyond free period, riders have an option to take either duration-based plan or distance-based plan

Duration-based plan (3 months to 3 years)

- Tariff: $900-1,200 per month
- Unlimited battery swaps

Distance-based plan (160-960 km)

- Tariff: $299-799 per month
- Unlimited battery swaps

Business model 2: Ride-sharing

Location: Germany

Gogoro has **collaborated with Coup** (subsidiary of Bosch) for the ride-sharing service

Customers have the option to pay $3.40 for 30 minutes or $24 for a full day

Customers can locate, book and pay to rent a Smart scooter through the Coup app

There are **no battery swapping stations**. Instead, Coup employees are present in stations where scooters are parked and **switch out the batteries**

1. Assumption 30 batteries a day, 250 days a year
2. Calculation showing a break-even at 5.4 years with assumptions of annual revenue of 7,500$ vs annual cost of $4,000 + CAPEX cost split over the years

Source: Press search, expert interviews, Gogoro website

Contents

Charging technologies differ by speed and price

Charging technology is not yet standardised and constantly evolving, with regular technological improvements

NON-EXHAUSTIVE

Applicable vehicle segment E2W E4W

Overview of 2020 charging technologies

	AC		DC			
	1 Slow AC (L1)	2 Fast AC (L2)	3 DC Fast Charging DC50 (≤ 50 kW)	High Voltage (HV): Tesla supercharger	High Voltage (HV): Direct Current Super Fast Charging (DC150+)	
Charger type and power						
	1.5kW	7.7-22kW	50kW	120kW	150kW	350kW
Voltage	230V	230V+	230V+	480V+		
Description	Standard home socket outlets, residential segment only	**3 types:** **Basic home**: non-network "dumb" chargers that rely entirely on electromechanical controls Fully commoditised **Advanced home**: networked charger connects through home Wi-Fi or wireless card Digital user interface and open protocols and standards **Public:** similar to advanced home chargers with additional customer authentication capabilities & more durable housing	Control device with open protocols and standards, 5x10 kW power modules, and liquid-cooled power cables	Similar to 50kW design with additional power modules		
Plug type	Schuko/wall outlet 	Type 2 	CCS; CHAdeMO 	Tesla 	CCS; CHAdeMO 	CCS; CHAdeMO 
Charger price	**n/a**	**$350-5,000**	**$20,000-50,000**	**~$100,000**	**$100,000-150,000**	**$150,000+**

Source: Press and web search, expert insight

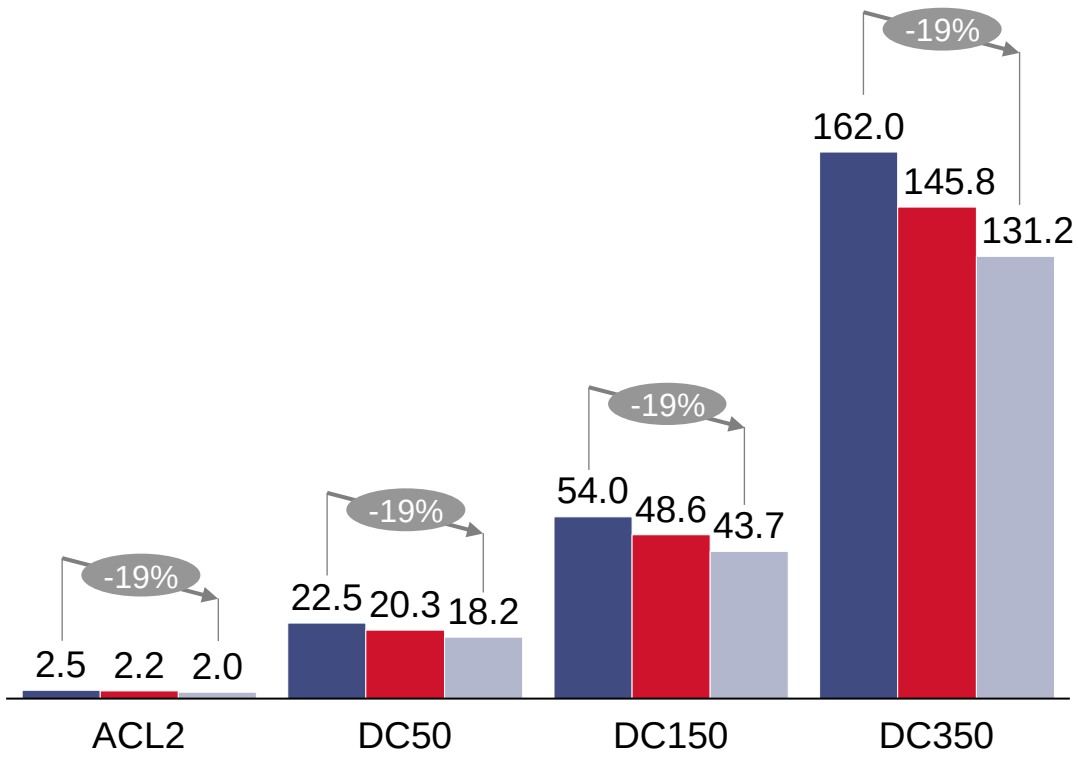
EV charger prices are expected to go down; an analysis on Europe shows a decrease of ~20% by 2030

European perspective on EV charger prices

EXCLUDING RESIDENTIAL

Evolution of EV charger prices, 2020-30

€ thousands per installed unit



Source: Expert interviews, press search

AC (L2)

- Prices of AC L2 chargers are **likely to decrease** in the near future as well as in the long term due to
  - **Economies of scale** for AC L2 chargers
  - **Lack of differentiation** as hardware becomes a commodity

DC

In the short term:

- Due to **rapid technological advancements and increase** in the **power output** of DC fast chargers, the average price is expected to decrease

In the long term:

- The **price per kW** will **likely decrease** over time as it becomes a “commodity”

Both global and regional players compete in the charger manufacturing industry

NOT EXHAUSTIVE, 2017 OUTLOOK OF CHARGING INFRASTRUCTURE PLAYERS, BIG PLAYERS ONLY

LIST OF PLAYERS IS INDICATIVE ONLY AND DOES NOT CONSTITUTE A RECOMMENDATION

		AC charging	DC charging <50 kW	DC charging High Voltage (HV)
Global players		ABB, SIEMENS, Schneider Electric	ABB	ABB, SIEMENS
Regional players	North America	SemaConnect, chargepoint, EVBOX, LEVITON, ClipperCreek, GE, efacec	BTCPower, TRITIUM, SIGNET, chargepoint, efacec	chargepoint, efacec
	Europe	Ingeteam, ebg, ICU, GARO, MAGNUM CAP, MENNEKES, CIRCONTROL, pod point, EVBOX, CIRCUTOR, DBT, chargepoint, Gothaer	CIRCONTROL, ies, TRITIUM, CIRCUTOR, Ingeteam, DELTA, MAGNUM CAP, gh, EVTEC, LAFON, DBT, ebg, efacec	ElektraNova, ebg, efacec
	Asia-Pacific	BYD, LCOLA, HITACHI Inspire the Next, Potevio 中国普天, POWERCUBE, 奥特迅, UTEK, DELTA, SOROTEC, Hong Kong EV Power Limited 香港電動能源有限公司	DELTA, HITACHI Inspire the Next, SIGNET, NEC, 国家电网 STATE GRID, 奥特迅, Potevio 中国普天, BETEC, BYD, Fuji Electric, HASETEC, TAKAOKA TOKO CO.,LTD., nichicon, UTEK	TRITIUM, HITACHI Inspire the Next, DELTA, 国家电网 STATE GRID, NEC, 奥特迅

Other types of charging

Suppliers of electric bus chargers are **similar to DC** charger suppliers

Wireless charging exists but is still a nascent technology

- The market is already organised with **big players present** given the growing EV opportunity
- As the market grows, some products will likely **become more commoditised**, e.g., AC charging and DC ≤ 50 kW, with white label players likely to enter the market

Source: Interviews with experts, Companies' websites