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# Electric Vehicles: Charging Infrastructure at a glance

**PLUGANDPLAY**



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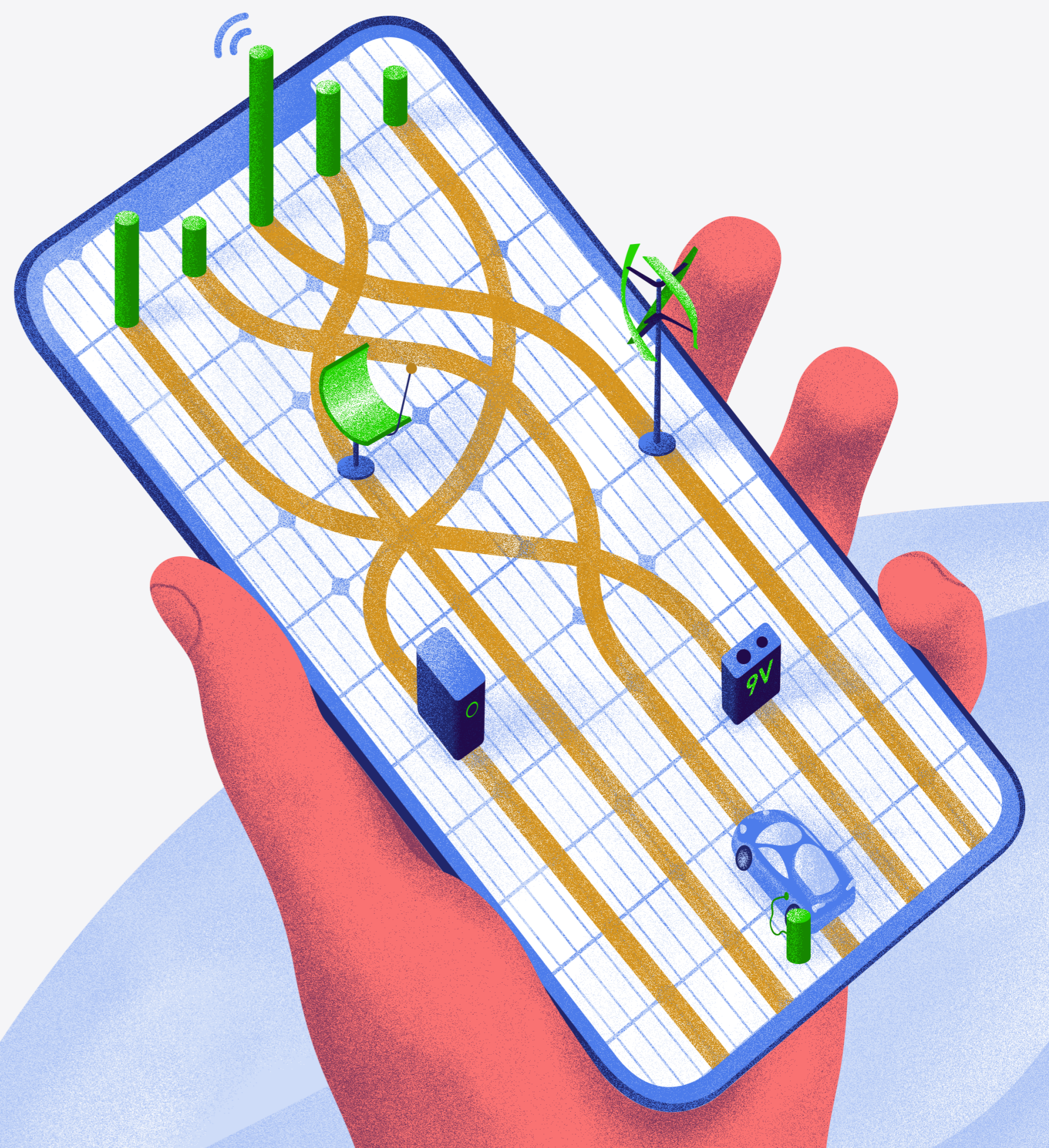
# Introduction

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Electric Vehicle penetration is increasing, driven by several factors including price point and charging network deployment. It is forecasted that electric vehicle sales will account for  $\frac{1}{3}$  of all cars sold by 2030.

This report will outline different types of EV charging fundamental features, their advantages and disadvantages, as well as the challenges faced to increase adoption rates.

The ebook will also feature some of the major players in the space and big moves that have occurred throughout the industry thus far. Additionally, this piece will include many startups and growth-stage companies working to implement the mass adoption of EVs through proprietary charging stations, data management tools, and other solutions across Africa, Europe, Latin America, North America, APAC, India, and China.





# Basic Features of EV Charging Stations

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## Types of EV Charging

- **Level 1 Charging:** Plug in vehicle to standard outlet. The average charging rate is 4.5 miles/hour of charging. This would imply approximately 22 hours for full charge. Requires inverter either in-vehicle or externally.
- **Level 2 Charging:** Sits between Level 1 and DC Fast Charging. Supplies 240V (equivalent to electric dryer or oven) through an installed external inverter (typically) and cord thereby providing safety until plugged into EV. Allows for a range of charging speeds up to 19.2 kW or about 70 miles per hour of charging. Full charge achieved in 8 hours. Most recommended charging station for home installation.
- **DC Fast Charging:** Fastest type of charging currently available. 40 miles of range for every 10 minutes of charging, or about 240 miles of range per hour of charging. Home installations cost north of \$100,000. New public EV charging stations are being developed using DC fast charging.

*AC (Level 1 and 2) charging is dominated by personal vehicle consumers while **DC fast chargers** are used across commercial vehicles and personal car users.*

Increasing range and reliability on EVs will increase EV adoption and penetration across all markets. The strategic allocation of EV charging stations is of utter importance in order to push this mass adoption forward and create a steady and reliable infrastructure across countries.



## The market, classified by connector

Based on the connector, the market has been classified into:

- **Charge de Move (CHAdeMO)** - major market share in 2018 .
- **Combined Charging System (CCS)** - expected to register the highest CAGR over the forecast period owing to increased preference by major automobile manufacturers.
- **Others** (Tesla Supercharger and China GB/T).

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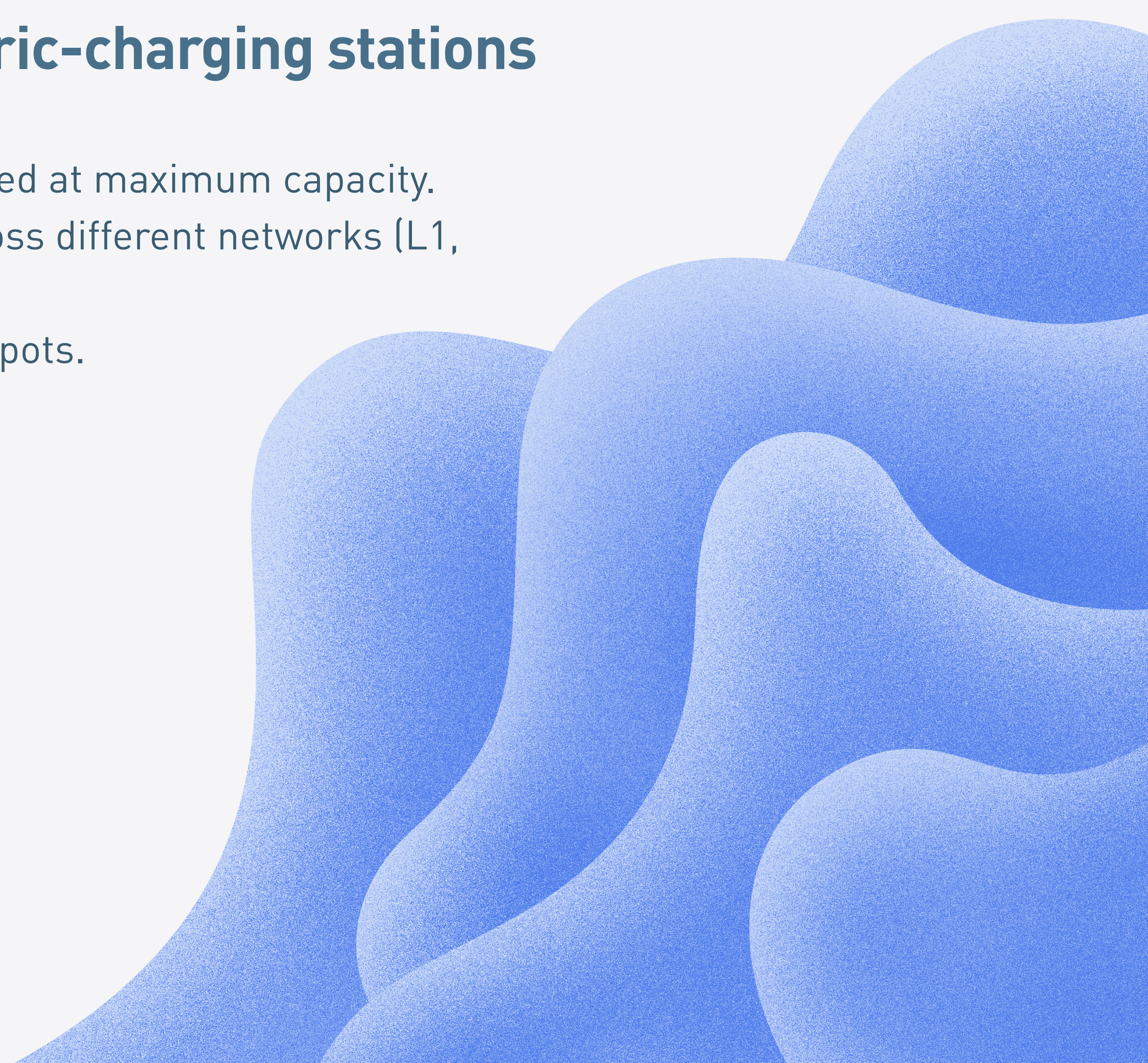
## Other advantages of EV charging stations

Among others, some advantages for electric utilities are the following:

- **Grid flexibility:** Flexible power consumption is heavily tied to both solar and wind power generation. EV Charging stations can act as a catalyst to use excess amounts of energy.
- **Peak-demand balancing:** Off-peak charging of EVs (for instance, charging at night) can help balance power supply and demand.
- **With V2X technology,** future vehicles and charging stations may be integrated as virtual power plants.

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## The challenges for electric-charging stations

- Charging Stations are typically used at maximum capacity.
  - Reliability and standarization across different networks (L1, L2, etc.).
  - Long waiting times for available spots.
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# Acquisitions

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**ChargeMaster (London, UK)**  
Acquired by BP for 130 Million sterling in June 2018. ChargeMaster is the biggest provider of charging points in the UK.



**GreenLots (Los Angeles, CA)**  
Acquired by Shell at the beginning of 2018 for an undisclosed amount.



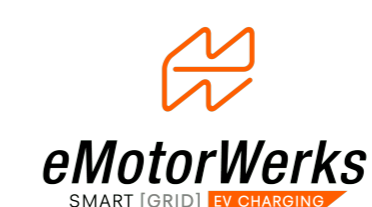
**NewMotion (Amsterdam, NL)**  
Acquired by Shell in 2017 for an undisclosed amount. Reached 100,000 charging points around March 2019.



**EVBox (Amsterdam, NL)** - Founded in 2010, EVBox is one of the pioneers in EV charging solutions, with more than 75,000 charging points across the globe. EVBox was acquired by ENGIE in 2017.



**G2Mobility (Paris, FR)**  
Acquired by Total in 2018 for an undisclosed amount.



**eMotorWerks (Los Angeles, CA)**  
Acquired by Italian utility Enel in 2017 for an undisclosed amount. They plan to deploy numerous charging points across Italy.



**Epyon (Amsterdam, NL)** - Named Cleantech Startup of the Decade in 2014. It was acquired by ABB for an undisclosed amount to expand their electric vehicle charging infrastructure offer.



# The global landscape

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## Africa

The continent is set to quickly expand in terms of microgrid infrastructure in the upcoming years. The establishment of these solar-based microgrids provides a big opportunity for decentralized charging infrastructure as well as opportunities to introduce electrified public transport. On the other hand, the lack of government support is still an issue that holds back further development.

An absence of a gas-powered culture could boost EV adoption if China can drive down EV costs and provide affordable EVs that appeal to the African market.

Other efforts in the land of the Sahara include those made in Nairobi, Kenya, where the company [Nopiaride](#) has piloted different usages for electric vehicles (using Nissan Leaf) around the city as part of a new EV initiative.

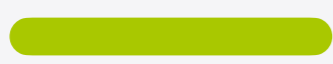
But according to several reports, the only country with specific set plans to expand EV infrastructure in Africa and increase adoption is South Africa. The country has committed to reaching 150,000 electric cars by 2025, which is a 150x increase from their current state of 1,000 electric vehicles. South African utility [Eskom](#) (who generates approximately 95% of the electricity used in South Africa and approximately 45% of the electricity used in Africa) disclosed in a public statement that there are still major challenges to overcome before mass adoption, one being the impact to the country's energy supply.





According to a spokesperson from the national utility, a massive growth in electric vehicles will not have a major impact on the overall energy supply. It was also further revealed that the power utility is making progress in its research on photovoltaic and battery storage options to power EVs in the future.

Another major hurdle facing large corporations leading the electric vehicle initiatives in South Africa is the 45% import tariff placed by the government on EVs.



## EV Infrastructure Companies based in Africa



**Founded:** 2009

**Location:** Joannesburg, South Africa.

This company has partnered up with Jaguar to build about 200+ AC charging points across the nation. Was acquired by Aviva Holdings in 2017.





## Europe

Norway leads the way in mass-market EV adoption (70%), followed by Iceland (45%) and Sweden (28%). Finland and Netherland trail behind with numbers above 10%. As per the main EU powerhouses, France, Germany and the UK follow behind with approximately about 8% market share on average.

Regulation including drivers such as CAFE emissions standards will most likely increase these numbers. In the UK, for example, policy has been set to

see that 50% of all new car sales will be hybrid or electric by 2040.

As part of its economic stimulus plan, Germany also announced that it would provide 500 million euros (\$563 million) to support the rollout of private charge points, of which there are 6.5 million worldwide.





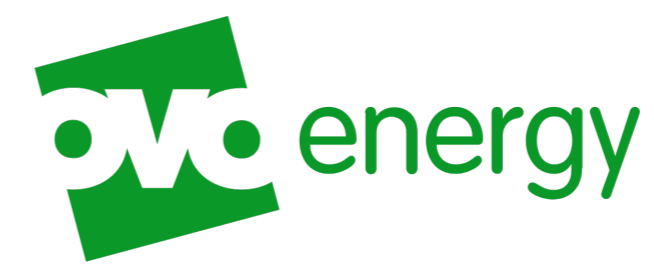
## EV Infrastructure Companies based in Europe



**Founded:** 2008

**Location:** London, UK

Ubitricity offers the first ever solution for complete scalable charging infrastructure anywhere with its proprietary metering and billing technology- the SmartCable. In February of 2019, the company was acquired by Honda Motors, after raising their third round of funding in a \$22.6Mn Series C led by EDF (Electricité de France), Next47, and Honda Motors.



**Founded:** 2009

**Location:** London, UK

OVO Energy is an independent energy technology company and supplier, as well as EV Charging structure providers. OVO Energy has raised a total of almost 250M sterling pounds across a total of two rounds. The company's last fund-raising was a 216 Million sterling pound round led by Mitsubishi Corporation.



**Founded:** 2013

**Location:** Helsinki, Finland

Virta is one of the companies leading EV infrastructure charging stations both in Europe and worldwide. Established in 2013 by a cohort of 18 Finish electric utilities, the company is now in more than 36 countries and has almost 100 employees. Virta is funded by JXTG Holdings, who invested via an undisclosed Corporate round around April of 2020.



**Founded:** 2016

**Location:** London, UK

InstaVolt delivers a premium electric vehicle (EV) charging infrastructure. The team raised a 12M sterling private equity round led by Zouk Partners in 2016 and the company has grown organically since. InstaVolt is now on track to be the largest owner-operator of rapid DC charging stations throughout the UK .





**Founded:** 2009

**Location:** London, UK

Pod Point is one of the UK's leading providers of electric vehicle charging. This company has manufactured and sold over 40,000 charging points and developed one of the UK's largest public electric charging networks. Pod Point raised a total of 12.3 Million sterling pounds in three venture rounds before it was acquired by Électricité de France (EDF) in February of 2020.



**Founded:** 2014

**Location:** Barcelona, Spain

Wallbox is a designer, developer, and manufacturer of intelligent charging and energy management systems. The smart EV charging company announced the closing of a €12 million second tranche of Series A investment in March 2020, bringing the total Series A round to €23 million. The round was led by VC fund Seaya Ventures, with additional investment from Endeavor Catalyst and existing investors such as Iberdrola.



**Founded:** 2020

**Location:** Stuttgart, Germany

Looking to reach the broader public in one of Europe's most electrified countries, Stuttgart-based HeyCharge was founded to accelerate the adoption of EVs. The company was founded by an experienced team including an ex-Googler, E.ON and Daimler and an ex-venture capitalist and aims to revolutionize the space by delivering an ultra-low-cost retrofit of electric vehicle charging infrastructure to multi-tenant residential (i.e. apartment) buildings.





## LATAM

Trends in electric vehicle charging infrastructure in Latin America rely heavily on government investments in public electric transport systems at both a regional and local level. Private EV adoption is still in a very early stage, leaving EV infrastructure far behind. Besides obvious price barriers to EV adoption, countries like Mexico, Colombia, Chile and Brazil are leading EV infrastructure adoption. In order for public EV Charging stations to become common practice in Latin America reliable and available electricity for electric scooters, bikes and electric motorbikes must be established first.

Some examples of this adoption are:

- **Mexico leads EV penetration** in Latin America with almost 2,000 vehicles being bought in 2018, accounting for about half of Latam's growth.
- **In Colombia, the adoption of EV vehicles is still very small** (with a total of 1,000 EVs registered in 2018). The government has eliminated import tariffs on electric vehicles and e-hybrid vehicles to boost adoption. This trend has been followed by other Latin American countries like Ecuador, Uruguay and Costa Rica.
- **Chile has focused its efforts on public electric transportation systems**, investing in about 200 buses throughout the nation. By leveraging their existing mineral resources in their capital to help manage the cost of large-scale EV adoption, they plan to eventually spread the benefit across the whole country.
- **Brazil plans to increase its EV vehicle adoption rate** by boosting R&D efforts in order to compete against ethanol-fueled vehicles. The country has also taken advantage of market forces to produce highly-competitive electric buses for their fleets.





The landscape so far looks promising, with companies providing mobility as a service and EV charging infrastructure trying to appeal and expand to the Latin American market. However, the limited average income across Latin countries still caps this progress, at least on what concerns pure EV adoption and infrastructure investment. EV Infrastructure implementation becomes more relevant in countries with big automobile markets and available land mass, such as Brazil, Chile, Argentina and Mexico, in which case increasing range becomes pivotal.

Nevertheless, the opportunity for investment comes along with companies aiming to improve solutions, efficiency, and operations for micro-mobility (charging, maintenance and operation of electric scooters, bicycles, motorbikes, etc.) which will most likely be the starting point to drive electric mobility adoption in many Latin American countries.





## The US

Clean air acts are largely driving governments to accelerate adoption of electric vehicles by consumers. Economic incentives for the electric car manufacturing industry have motivated corporations across the US, Germany, and Japan to support transition or be left behind. R&D into the design, range, and maintenance of electric vehicles is underway by manufacturers.

### ***Government Initiatives driving growth of EV:***

- **Electrify America** - multibillion dollar effort imposed on VW as penalty for Dieselgate
- **Evolve NY** - EV expansion initiative in NY.
- **DoE** (Dept. Of Energy) offers funding opportunities to advance EV projects.
- **Ohio** offers rebates for EV Charging Stations.
- **U.S. Oil** dependence benefits.

### ***Examples of US e-mobility Hubs:***

- **Austin is the burgeoning micro-mobility hub of the US**, with 7 providers offering a total of 17,600 vehicles.
- **Pittsburg announced a Pittsburg Micromobility Collective (PMC)**, a self-organized collective for last-mile and alternate commute mobility providers. Led by Skinny Labs (aka Spin) and joined by Zipcar, Ford Mobility, Waze and Swiftmile. Mobility “toolbox” will include: 150 electric pedal-assist bicycles, expanded carshare, new carpool and shared-ride services, multimodal trip planning, 50 public curbside electric charging stations, and shared e-scooter vehicles.





## Climate change fueling the EV market

To address the net-zero carbon emission standards, governments are incentivizing the growth of the electric vehicle charging station market by providing funding, subsidies, and incentives.

City infrastructure and automakers are investing heavily in DC (Direct Current) charging stations and supporting the launch of long-range BEV's.

- **Tesla has focused their efforts on** designing and developing electric cars as well as DC fast charging stations -via the Tesla Supercharger.
- **ABB is pioneering innovation in the EV market** - besides charging stations, ABB also offers customers specialized after-sale services to ensure seamless uninterrupted vehicle charging compatible with all types of EVs, CCS and Type 2 AC charging. They have set up more than 6,000 DC fast charging points globally solidifying themselves as the leaders of the EV infrastructure market.





## EV Infrastructure Companies based in the US



**Founded:** 2003

**Location:** San Carlos, CA

Tesla is the largest seller of EVs and largest built network of EV charging stations with over 1,500k "Supercharger" stations and more than 13,000 underway. The company's first V3 next generation chargers released in June for all Tesla made models delivering 250 kW of power and 75 miles of range in only 5 mins.



**Founded:** 2007

**Location:** Campbell, CA

ChargePoint is creating the world's largest EV charging network. Funded by investors including NYSERDA, American Electric Power, BMW i Ventures, Daimler, Siemens, Chevron Technology Ventures, ChargePoint has raised close to 550 Million USD through 10 funding rounds.



Spin off of Volkswagen, with \$2 billion to build out EV charging infrastructure. Electrify America developed 484 charging stations across 17 cities in 42 states in 2019 to decrease the gap between charging stations to under 70 miles.

Working on a charger with 20 miles of range/minute compared to 9 mi/min offered by DC chargers today (largely due to the settlement made with the US govt over their diesel-emissions cheating scandal).



**Founded:** 2014

**Location:** Sunnyvale, CA

Supplies cities and private operators with docks equipped to park and charge scooters and e-bikes, enabling operators to provide better equipped (charged) products to their customers. It is an open platform for docking but only offers charging for Swiftmile customers. After raising \$5Mn from Sinai Ventures, Plug and Play and Verizon Ventures, SwiftMile raised an undisclosed Series A round around fall of 2019.



# blink

**Founded:** 2006

**Location:** Miami, FL

EV supply equipment (EVSE) and EV charging services. Blink is a cloud based software that operates, maintains, and tracks all EV charging stations connected to the network. Blink became a publicly traded company after accepting a \$18.5M public offering in 2018.

# ample

**Founded:** 2014

**Location:** San Francisco, CA

Ample has created a platform to deliver full charge to electric cars, utilizing autonomous robotics and smart-battery technology to deliver energy. Ample has raised a total of \$55M from 5 investors (Shell Ventures, Moore Strategic Ventures, Hemi Venture, Trirec, VAS Ventures, Repsol Energy Ventures). The company's last funding round was a 25 Million USD Venture round announced in February of 2020.

# FREEWIRE

**Founded:** 2014

**Location:** San Francisco, CA

FreeWire Technologies is an intelligent energy system platform that has developed a battery-based storage solution for EV charging and diesel generator replacements. The company combines robotics, energy storage, and grid integration to create an advanced network of mobile EV chargers. They have raised a total of \$55M, with investors including BP Ventures, ABB Technology Ventures, Silicon Valley Bank and VOLVO Car Group, amongst others. Their last funding was in April of 2020.

# SparkCharge

**Founded:** 2014

**Location:** Boston, MA

SparkCharge manufactures mobile DC fast charging units. SparkCharge is a scalable solution that ends EV range anxiety, and creates a charging infrastructure solution at a fraction of the cost. The company has raised a total of 4.3 Million USD from investors including PJC, Techstars and North43.



## APAC

The adoption of EVs in southeastern APAC - without considering China and India - is significantly slower compared to Europe and the Americas due to the high vehicle costs and lack of public charging facilities. There is huge potential in the motor controller and charging equipment market for Asian countries as EV sales continue to grow. Indonesia, for instance, currently stands as the world's 3rd largest scooter market and a lot of those scooters are electrifying now.

Electric vehicle growth in Asia can be seen through two different countries: India and China.





## India

In India, the government has rolled out a National Electric Mobility Mission Plan (NEMMP) to address the issues of National energy security, vehicular pollution and growth of manufacturing capabilities and set plans to shift to electric vehicles by 2030. The country is leading the way with electrification of scooters and 3-wheelers.

Manufacturers such as Reva Electric Car Company (RECC) and Ola are working to meet those goals.

In December 2018, the government released a document outlining the standard for EV charging infrastructure, requiring stations to be in every 25 km along all road and highway stations. The government is currently working to electrify public transportation as the subsidies available for two-wheelers, three-wheelers, and buses grow. A total of \$140 million was designated to develop charging infrastructure.

### Government Initiatives:

- **The Delhi Government** is leading the way for the EV industry in India, approving 1,000 electric buses for Delhi public transport systems.
- **The Uttarakhand Government** promotes the use of EVs by providing Rs.10- 50 crore (\$1.3 Mn - \$7Mn

loans) to build out EV charging infrastructure. In addition to this, the government will not charge an infrastructure tax for five years to the first 110,000 EV customers.

- **The Maharashtra Government** is focusing on developing the EV industry by exempting EVs from road taxes and providing 15% subsidies to the first 110,00 customers registered to the state. Along with \$15,500 government subsidies per charging station for the first 250 stations set up.
- **Energy Efficiency Services Limited (EESL)** is procuring 10,000 EVs from manufacturers for distribution to government departments, thereby reducing the costs of EV's substantially.

Charging Infrastructure in India faces many challenges ahead. The cost of EV's is especially high, particularly due to the heightened cost of imported Lithium-ion cells, last at \$275/KWh, including GST (Goods and Services Tax) at 28% coupled with a lack of Lithium.



## China

China dominates the EV battery market. Chinese battery manufacturers account for 80% of EV batteries sold in Asia Pacific across all car types and EV sales and adoption are highest in the country.

**The Chinese government promotes the development of EV charging networks as a matter of national policy.**

This policy is also followed by provincial and local governments who are also promoting EV charging through a growing investment in cords and plugs, dominating the EV charging technology.

In addition to this, state policy plans to reimburse 30% of the total value of all electric vehicles.

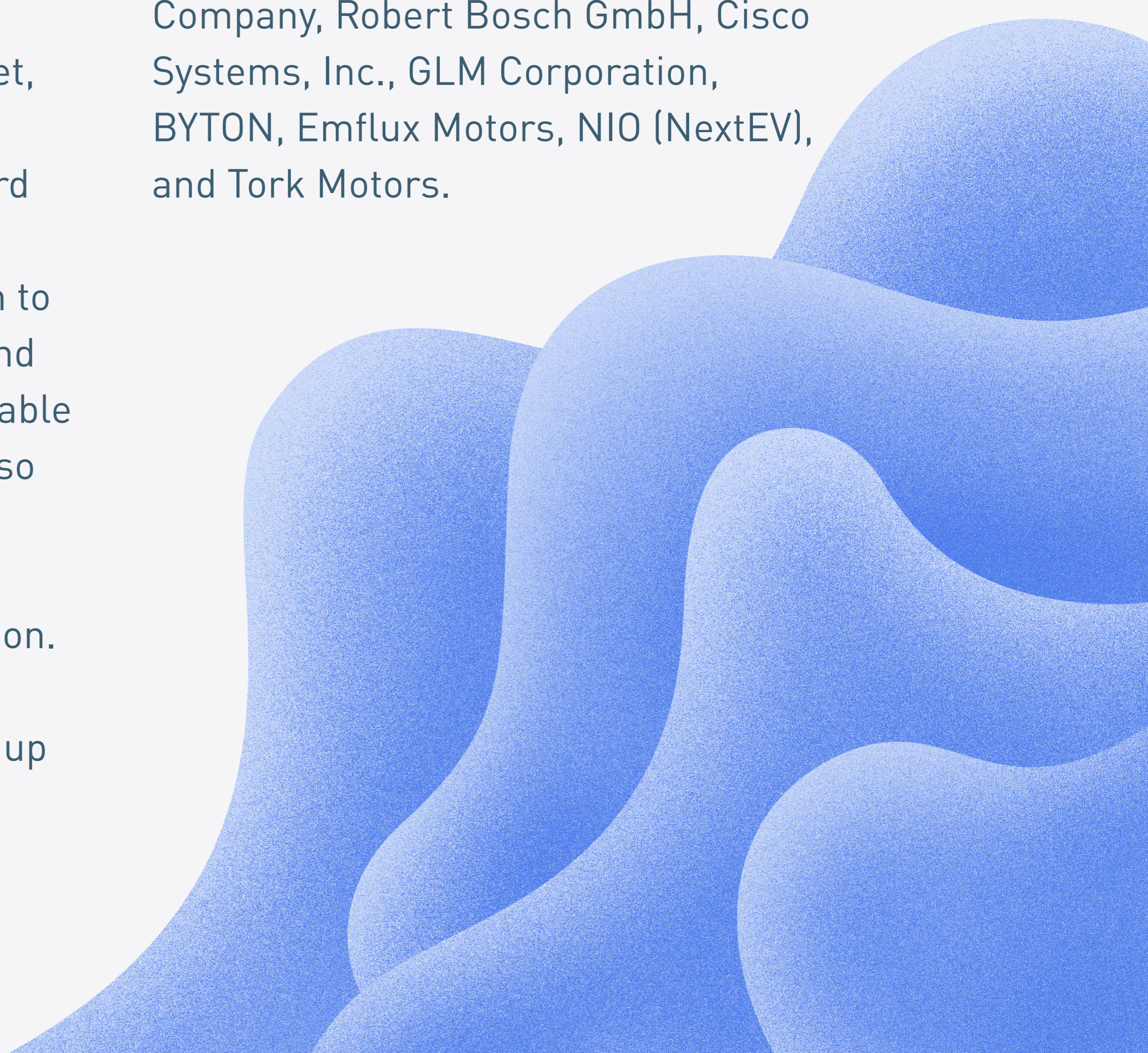
In its annual Global EV Outlook, the IEA (International Energy Agency) said the number of public slow and fast charging spots reached 862,118 globally, with China, the world's largest car market, taking a 60% share. China GB/T is a nationwide EV fast-charging standard established by the government. The government has spent nearly \$60Bn to establish the electric car industry and reduce the number of licenses available for fuel combustion cars. They've also established a multiyear EV charging infrastructure plan and are largely invested in EV charging data collection.

There are 5 vehicle types that make up the Chinese market: two-wheelers,

three-wheelers, four-wheelers, commercial vehicles and buses. The two- and three-wheeler e-vehicle markets are the largest in China followed by Japan and South Korea. The four-wheeler market is said to grow over 48% of the total value of EV's sold in APAC. China also makes up 99% of the world's electric buses.

China has more than 100 electric-car makers and holds a strong grip on the global supply of components necessary to manufacture batteries- anodes, cathodes, separators, and electrolytes. The country owns 50-70% of each of these components.

Next-gen EV's are expected to change the shape of the Asia Pacific automobile industry in 2025 with the introduction of new products offered by Toyota Motor Corporation, Siemens AG, Ford Motor Company, Robert Bosch GmbH, Cisco Systems, Inc., GLM Corporation, BYTON, Emflux Motors, NIO (NextEV), and Tork Motors.





## EV Infrastructure Companies based in Asia



**Founded:** 2019

**Location:** Shanghai, China

ChargeDot is a Chinese e-mobility solution provider. They supply AC and DC charging stations with the necessary software platform. Chargedot was acquired in October 2019 by ABB.



**Founded:** 2013

**Location:** Bengaluru, India

Backed by the founders of Flipkart, Tiger Global, Hero Motocorp and others, Ather Energy has designed India's first truly intelligent electric scooter Ather 450, powered by a comprehensive public charging network, Ather Grid, built and designed in India.



**Founded:** 2011

**Location:** Taipei, Taiwan

Gogoro provides EV scooters and a battery swap charging network for electric scooters powered through its Gogoro Network. The company has raised 480 Million USD through subsequent rounds with investors including Temasek Holdings, Sumitomo Corporation and french utility Engie. In what concerns joint venture partnerships, a good use-case is BP's partnership with Didi in China to establish [new charging points across the country.](#)



# The Role of Public-Private Partnerships

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Government-funded investment can play a great role in defining the Energy transition and driving the mass adoption of electric vehicles through different initiatives.

Some examples of these initiatives are:

- **The UN is partnering with different governments in Latin America** to promote investment in EV infrastructure across governments, local municipalities and the private sector in Latin America through its [MOVE](#) program.
- **According to a report from the [Coalition for Urban transitions](#)**, applying three types of new mobility services – electric, on-demand minibuses, subsidised shared rides, and trip-planning and ticketing apps – can make public transport more affordable, accessible and sustainable, if integrated properly.
- **An example of a company exploring partnerships in this space is Toyota.** Through its [Toyota Mobility Foundation](#), Toyota is prioritizing access to mobility through strong transportation systems with the higher purpose of achieving social equity. TMF' s goal is to help people become more mobile.

Mobility has proven to have direct social and economic implications. It provides access to jobs, education and other opportunities that are inextricably linked to an individual's economic empowerment.

**There are many utilities, OEMS and industrial conglomerates investing in EV infrastructure and V2G startups and initiatives.**

Besides Tesla or ABB, other major charge point providers include Anglo-Dutch group Shell ([RDSa.L](#)), France's Engie ([ENGIE.PA](#)), Germany's E.ON ([EONGn.DE](#)), Volkswagen ([VOWG\\_p.DE](#)) and ChargePoint, whose shareholders include Daimler ([DAIGn.DE](#)), BMW ([BMWG.DE](#)) and Siemens ([SIEGn.DE](#)).





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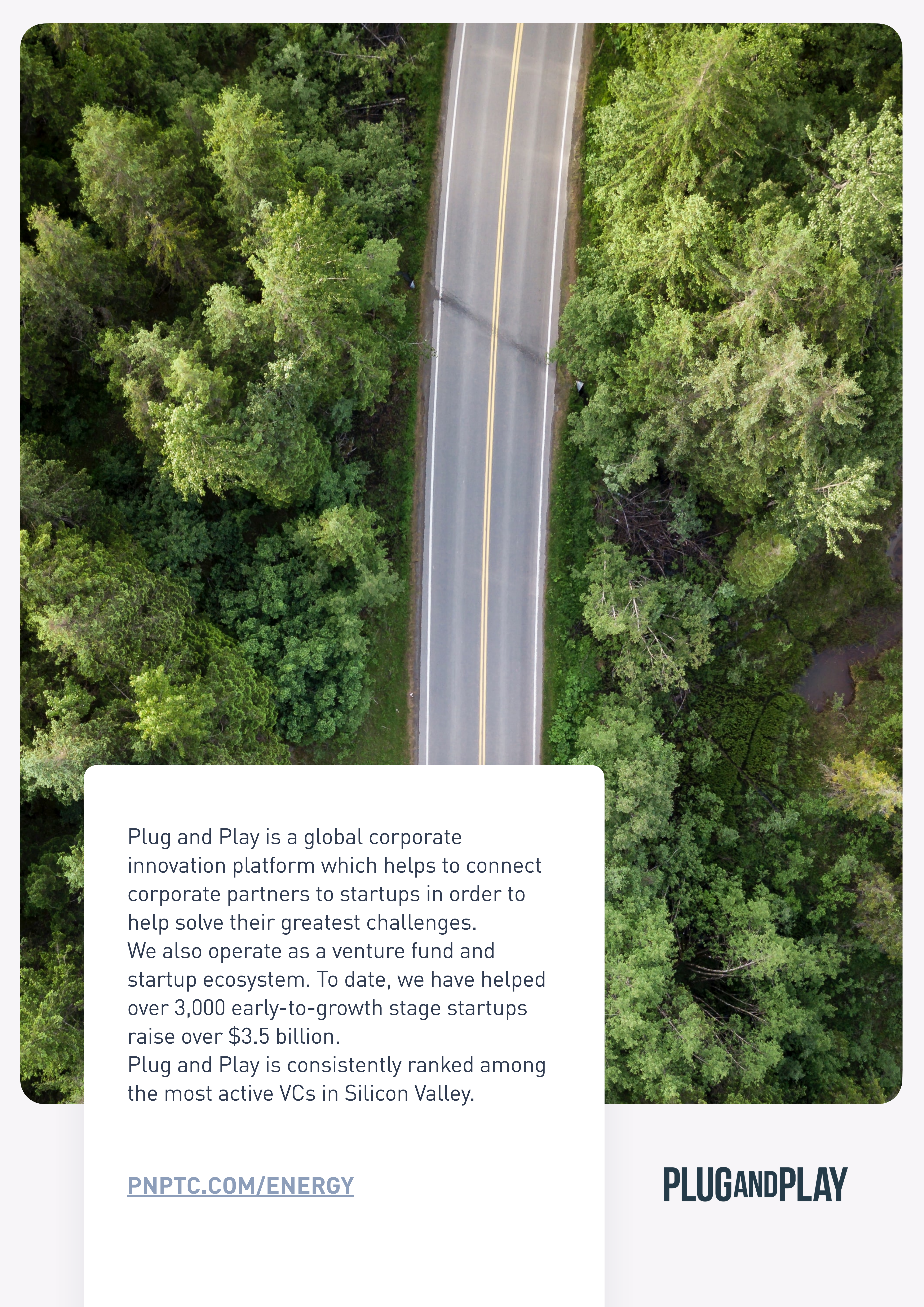


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An aerial photograph of a two-lane asphalt road with a double yellow center line, flanked by dense green trees. The road runs vertically through the center of the image.

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