NAVIGANT
RESEARCH

WHITE PAPER

Charging Ahead with EV Analytics

Adopting a Flexible Approach to IoT Infrastructure for EV Integration

Commissioned by SAS and Intel

Stuart Ravens

Principal Research Analyst

Table of Contents

Executive Summary

The electricity industry is waking up to the prospect of large-scale deployments of electric vehicles (EVs). And well it might, as all signs point to a future where EVs are increasingly common. Annual demand from EVs for electricity could exceed 400 TWh by 2035, creating the largest opportunity for new load growth in a generation. However, the vehicles will also pose significant problems to network utilities, particularly in areas where grids are already constrained. This report analyzes the future EV market and details the many opportunities and sizeable threats the vehicles create. It focuses on the data and analytics requirements of EV infrastructure and provides recommendations to utilities that are developing EV strategies.

Context

EV integration is a complex and unique issue. When EVs charge, they are loads; when idle, they are storage; and when dispatching back into a network, they are sources of supply. They also move around, so utilities will never have full visibility of their location. EV fleets and buses present different opportunities than individually owned cars. There is a complex and competitive ecosystem of stakeholders, some of which will be in direct competition with incumbent energy suppliers—there is little room for monopoly market thinking, even for vertically integrated utilities. The customer base is also diverse, with different needs and requirements. But complexity is only one issue. The future pace of change is arguably a tougher nut to crack. Utilities must prepare themselves for a dynamic and open future where change and uncertainty are the only constants.

This report details numerous future EV-related business models, the adoption of which will vary depending on market and regulatory requirements, but each will need careful planning. It is vital the industry acknowledges that the electrification of transport is a digitization project because EV business models rely heavily on Internet of Things (IoT) devices and an associated analytics platform that must be similarly planned. A handful of utilities are doing this right now; many more recognize the EV opportunity but have not yet built solid strategies. 2025 is often cited as the year when EVs step into the mainstream. While this may seem a long way off, it is far better to plan for now when EVs are not an operational problem—than when they are.

Recommendations

Navigant Research recommends the following:

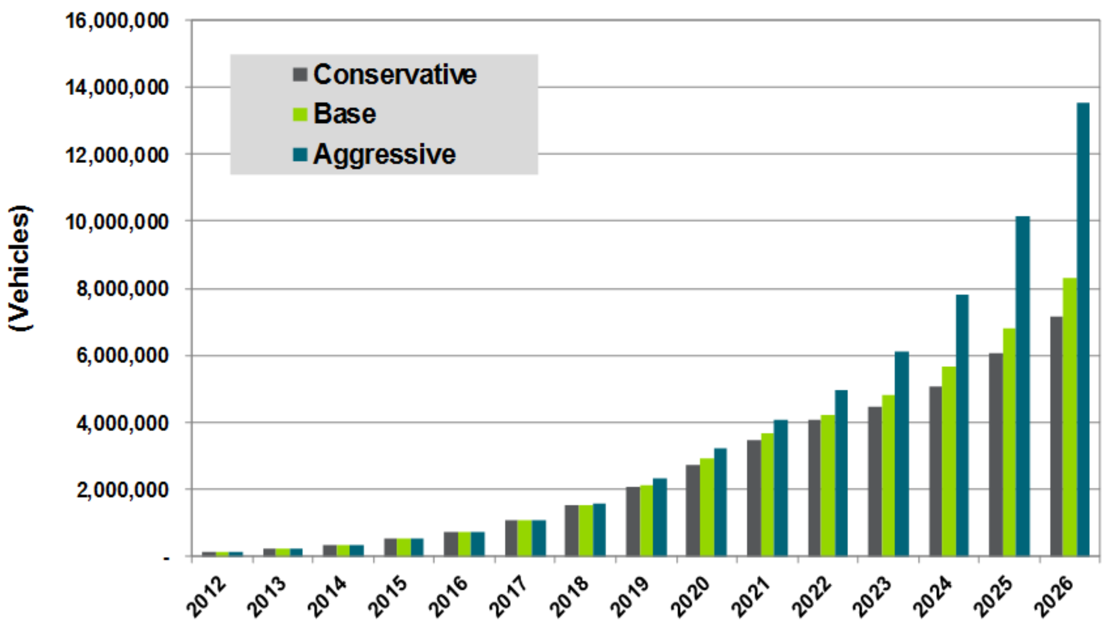
- Embed analytics throughout the EV ecosystem.
- Involve IT in EV planning at an early stage.
- Adopt a flexible approach to EV technology infrastructure.
- Match business model inflection points with technology developments.
- Incorporate forecasting, scenario analysis, and predictive analytics into the project lifecycle process.

EV Growth Creates Opportunities and Threats

EVs Present the Biggest Load Growth in a Generation

Navigant Research estimates annual sales of plug-in electric vehicles (PEVs) passed 1 million in 2017, the sixth consecutive year with annual growth of 40% or more since PEVs were introduced in 2011. Rollouts of long-range, electric-only vehicles at price points under $40,000 will further boost adoption, sustaining an annual growth rate of around 38% through 2020. The PEV market could be over 2.7 times larger in 2020 compared to the market size in 2017. While PEVs accounted for just 1%-2% of annual vehicle sales in 2017, they will likely become the leading global road transportation technology by 2050.

Chart 1 Plug-In EV Sales by Scenario, World Markets: 2012-2026



(Source: Navigant Research)

This report is focused solely on PEVs—either hybrid or exclusively battery-powered. For the rest of the report, they will be referred to as EVs.

Since the creation of the electricity industry in the late 19th century until the credit crunch in 2007, energy consumption and—as a direct consequence—utility revenues have closely tracked economic output. However, the simple rule that the more an economy grows, the more energy it consumes is no longer the case. Since the economic downturn in 2007, both commercial and residential

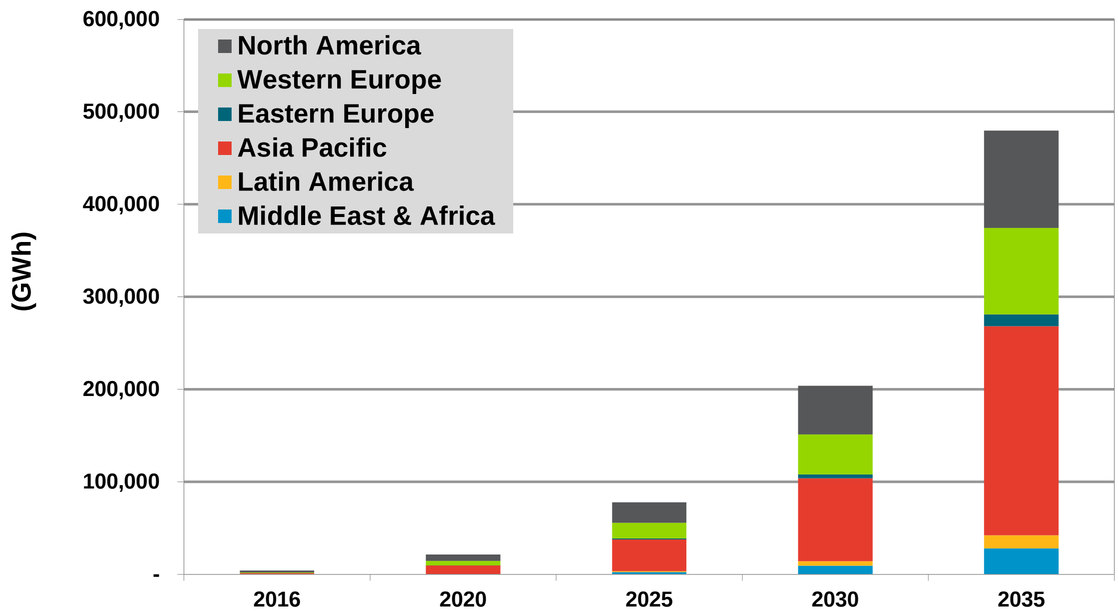
"We are **excited about EVs**. What we are trying to do is **speed adoption**."

– Manager, Customer Analytics, US Utility

customers have become, and continue to be, more energy efficient. As a result, the power industry was disappointed when the good times failed to roll again after the world economy picked up.

Since then, the industry has been searching for new load growth, which has thus far proved elusive. Chart 2 shows Navigant Research's forecast for electricity consumption by the transportation sector through 2035. The electrification of transport offers utilities the single biggest opportunity for load growth for decades. But the EV opportunity does not stop at simply increasing the volume of electricity sold; many other significant opportunities exist. From a network utility's perspective, EVs will significantly constrain capacity in certain parts of the network, an issue that can only be resolved through asset upgrades where the network owner can generate a return.

Chart 2 Road Transportation Electricity Consumption by Region, World Markets: 2016-2035



(Source: Navigant Research)

New Loads Can Cause Problems for Network Management

However, most of the charging infrastructure will be connected to low voltage distribution networks, which were not designed to accommodate these kinds of loads. Existing high power charge points can draw up to 17 kW continuously for 2 or 3 hours, which is more than a small house would draw in an evening peak period. While increasingly higher-powered charge points will reduce charge times and make EV charging more convenient, they will also increase the strain on electricity networks and ultimately overload parts of the network. The industry must come up with solutions for EV charging without shutting down loads. Customers have long become accustomed to always-on electricity, so more elegant solutions for capacity constraints caused by EVs must be sought out.

Society is on the brink of an EV revolution. Many business cases are already proposed—some will be successful, others will not—and many more will be developed as the market matures. Utilities cannot afford to be passive observers in this revolution because many of these opportunities will be open to competition.

The Unique and Rapidly Evolving Demands of E-Mobility

To date, the electricity industry has never had to deal with anything like EVs. They consume electricity but can also store and supply power back to the grid; they move around; they are not always connected to the grid; and utilities will never have full visibility of where they are at any one time. Utilities will have to work with a complex and competitive ecosystem of stakeholders, a diverse customer base with different requirements, and a wide range of technologies that affect the grid in different ways.

And complexity will only increase. As the EV market matures, it will change as quickly as it grows. Utilities must prepare themselves for a dynamic and fluid future where change and uncertainty are the only constants.

The E-Mobility Ecosystem Is Complex

E-mobility relies on many stakeholders whose influence will change as the market matures. The list includes utilities, their regulators, vehicle manufacturers, city governors, state and national legislators, technology vendors, oil & gas companies, mobility service providers, telecoms, fleet owners, insurers, and so on. In the early stages of the EV market, the focus is on building out a public charging infrastructure and incorporating EV penetration forecasts into long-term network asset planning and infrastructure investment programs. But as the EV market matures, customers will become more important to market evolution—and public sector involvement will shift to city planners in the form of smart transportation systems.

The E-Mobility Customer Base Is Diverse

Any company planning to target the new EV market will have to navigate a great deal of heterogeneity:

- **Multiple customer segments:** Different infrastructure is required for public recharging stations, residential charging units, and installations at commercial and industrial (C&I) premises, campuses, and transportation companies.
- **Multiple powertrain types:** Different powertrains have different levels of reliance on the grid. A hybrid requires no charging; a plug-in hybrid has a smaller battery and can run on gasoline/petrol or diesel when the battery is depleted; and a battery EV relies solely on the grid for fuel.
- **Multiple types of vehicles:** Each type of vehicle will have different charging requirements. For example, battery-powered bikes will have smaller batteries requiring low capacity charge points with longer charging cycles. Buses and trucks will have much larger batteries, the owner of which will want much faster charging. Charge points for larger vehicles may also be concentrated in one area.
- **Different levels of vehicle smartness:** Use cases will be limited by the level of connectivity and the data created by EVs and their owners. The earliest EVs are relatively data-light. As the market matures, manufacturers are pushing more technology and connectivity into vehicles, greatly expanding the number of potential EV-related use cases.

- **Multiple charge point types:** The type of EV charger limits the number of miles per hour of charge. The basic residential charger is Level 1 EV supply equipment, which will take all night to fully recharge an EV's battery. Conversely, a 50 kW DC fast charger can fully charge a battery in around 2 hours. Many vendors are lining up 350 kW chargers, which promise to fully charge a battery in minutes rather than hours. In March 2018, Dutch charge point provider Fastned became the first to deploy a 350 kW charge point—and others will soon follow.
- **Different levels of charger smartness:** In a similar vein to vehicles, chargers are also becoming smarter. The earliest chargers were essentially electricity sockets for a car and were not fitted with any sensors or connectivity. The market has matured with V1G chargers, which contain basic one-way communications so that utilities can operate smart charging programs. Vehicle-to-business (V2B) chargers allow behind-the-meter two-way power flow, enabling the building owner to use an EV battery to supply the building. Vehicle-to-grid (V2G) chargers are grid-connected and allow two-way communications and power flows between the grid and an EV.
- **New business models:** Electrification, while important, is not the only trend threatening to significantly disrupt the transportation sector. If shared ownership schemes proliferate—in February 2018, General Motor's Maven Gig launched an all-electric carsharing program in Austin, Texas—they could significantly reduce the number of vehicles on the road, but increase the intensity of each vehicle's use (and consequently their refueling intensity). While still in the early stages of development, driverless vehicles will completely disrupt the transportation sector. If the majority are EVs, a different charging infrastructure will be required than for current residential car ownership.

Competition in E-Mobility Will Be Fierce

Part of the EV opportunity will naturally fall to power industry incumbents, but far from all of it. All infrastructure upgrades caused by EVs will be carried out by network utilities. And any private charging that relies on grid-sourced power will be billed by a licensed energy supplier. In vertically integrated markets, this will be a customer's current utility; in competitive markets, new suppliers could enter the market with EV-specific energy services.

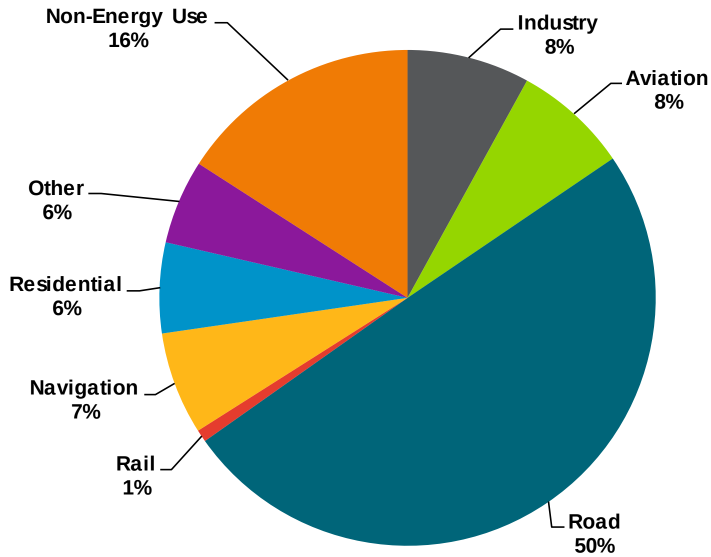
There is no guarantee that utilities can or will own EV charging infrastructure. Some regulators have banned or restricted utility deployment of EV charge points. However, some utilities have made investments in charge point infrastructure companies. Italy-based Enel's acquisition of California-based eMotorWerks demonstrates its intent to be at the forefront of EV charging. Additionally, the Energy Impact Partners investment fund (which counts Southern Company, National Grid, and Xcel Energy among its investors) has invested in EV charging platform vendor Greenlots.

As the EV market matures, it will likely converge with other energy services, most notably flexibility. Ubiquitous, connected EVs will present an attractive opportunity for distributed energy resources (DER) aggregators keen to offer batteries as flexible assets to the system operator. This kind of service is already being offered. For example, in the UK, Ovo Energy has a service that will charge a Nissan Leaf for free if the EV's battery is made available for grid services. Its rival, Good Energy, has partnered with Honda to investigate how vehicle-to-home (V2H) technology can power homes more efficiently.

Utility ownership of technology vendors and the aggregation of EVs to offer grid services could well be the catalyst for utilities to own charging infrastructure outside of their own service territories. Utilities could also compete directly with incumbents and third parties for a slice of the charge point market.

But competition will not stop at existing energy market players. The electrification of transport threatens the core business of some of the world's most powerful companies: the oil majors. According to the International Energy Agency, in 2015, road transport consumed nearly 50% of the world's oil output. Electrification, particularly if the electricity is generated from renewable or nuclear sources, is a huge risk. Already, Shell, BP, and Total have made significant moves into downstream energy—if the EV market grows alongside market expectations, this competition will only intensify.

Chart 3 Share of Oil Consumption, World Markets: 2015



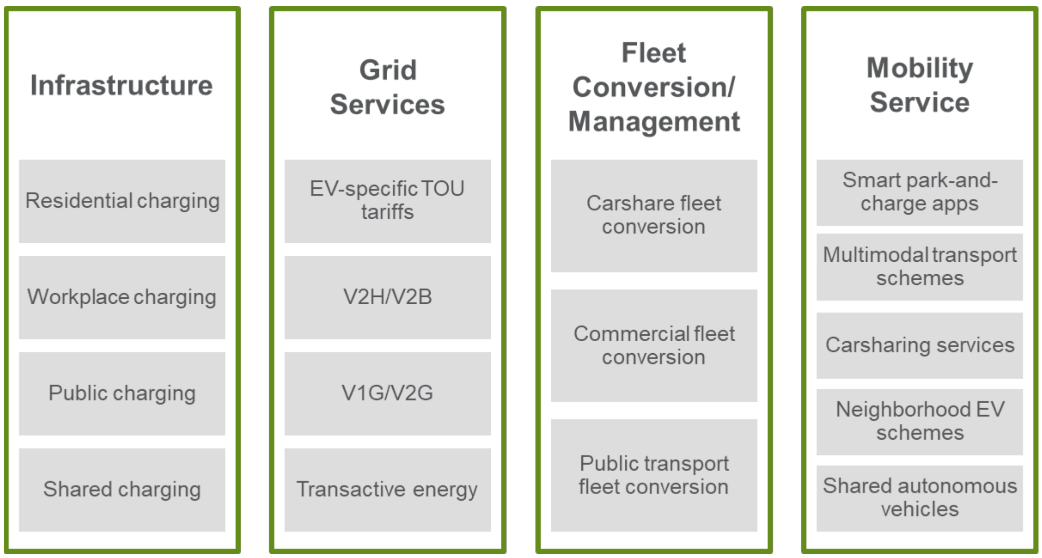
(Source: International Energy Agency, Key World Energy Statistics 2017)

The competitive threat is not something that might happen sometime in the distant future. Companies across the EV market are racing to test business models that tap value streams from EVs. Innovative partnerships are being formed today to gain first-mover advantage from new business models. Historically, moving first rarely gave an advantage to monopolistic utilities. However, moving to the EV market early looks increasingly like a strategic imperative. If utilities, network operators, and energy suppliers want to capitalize on the EV revolution, they must be at the forefront of innovation. Monopoly market thinking is dangerous in the fast-moving 21st century grid. While there are plenty of opportunities up for grabs, much will be open to competition.

EV Business Models Will Evolve Rapidly

The simple act of owning an EV provides utilities with the ability to engage with residential and C&I customers in new ways. This engagement can be as simple as discussing how to maximize the efficiency and convenience of EV ownership, which can then lead to new products and services. Navigant Research categorizes EV-related business opportunities into four lanes, as shown in Figure 1.

Figure 1 EV Business Model Lanes



(Source: Navigant Research)

Infrastructure Business Models

Most utilities active in the EV market are focusing their early efforts on charging infrastructure. These utilities recognize the future value of EVs and want to accelerate their adoption. Allaying potential customers' range anxiety is a significant driver, so some companies are not waiting for mass purchases of EVs before creating a charging network. Rather, they are proactively building this network in anticipation of future growth.

There is significant additional value to be gained from the provision of charging infrastructure for different groups of customers that extends beyond the sale of hardware and installation fees. Knowledge of where EVs are located and customer charging behavior is critical for future infrastructure planning. Yet, customers can install charging equipment from any vendor, without a utility's knowledge. In some jurisdictions, regulations are being introduced that legislate a requirement to notify utilities of charge point installations and minimum specifications for charging infrastructure such as communication standards or smart charging functionality. However, in other jurisdictions, regulatory restrictions on utilities installing charging equipment mean utilities can be left blind to EV-related activity.

Some of the most attractive infrastructure-related business models include the following:

- **Residential charging infrastructure:** Private charge point installation services—where permitted by a regulator—are a way for utilities to improve their knowledge of EV charging, and the data created by smart charge points is used to feed other use cases. Texas-based Austin Energy is working alongside third-party charge point installers to accelerate the deployment of charging infrastructure across the city. Customers are offered rebates for the charging infrastructure and unlimited access to Austin Energy's public charging network for a $4.17 per month fee.
- **Workplace charging infrastructure:** Larger-scale deployments on the staff parking lots of commercial customers offer greater economies of scale than single-point residential charging. Staff vehicle charging requirements are relatively slow and flexible—charging can be completed at any point during the working day—but with large numbers of EVs, demand can be high. Large parking lots require dynamic charging to ensure grid stability.
- **Public charging infrastructure:** The design, build, and operation of public EV charging infrastructure offers significant value, whether the charge points are utility-owned or owned by a third party. In the future, it could be a regulatory requirement for service stations to offer charge points.
- **Shared charging:** Some are investigating innovative approaches to maximize the financial return on customers' investments. The Share&Charge model, which acts as the EV charging equivalent of Airbnb, creates a virtual infrastructure of privately owned charge points. EV drivers can, for a fee, use a private charge point registered with Share&Charge.

Grid Services Business Models

EVs can have a significant effect on network reliability, depending on the concentration of EVs behind specific feeders, population densities, existing excess capacity in distribution networks, and distribution network topology. It should come as no surprise that the most common business models to be currently tested by utilities are those that focus on maintaining grid reliability:

"EVs are **part of a much broader offering** ... combined in a **DER** portfolio."

– DER Solutions Manager, US Utility

- **EV-specific time-of-use (TOU) tariffs:**
Customers can be moved onto EV-specific TOU tariffs that encourage EV charging at night or when renewables output exceeds demand. On windy weekends, wind output can far exceed demand, which can often result in customers being paid to take electricity. EVs are attractive new loads for system operators looking to balance demand when supply is high.
- **V2H/V2B services:** Customers may also want to use their EV batteries to augment electricity consumption in their homes or commercial premises. Utilities can be at the forefront of the supply of V2H and V2B services. Additional opportunities exist to upsell customers, for example, into a solar PV installation.

- **V1G/V2G programs:** Vehicle-grid integration is a tool that network utilities use to modulate the rate of power at which the battery is charged, either when the grid is constrained or when renewables generation exceeds current demand. Power flows in V1G chargers are unidirectional, so that charge points can be switched on or off. In contrast, the power flow in V2G chargers is bidirectional, allowing EV batteries to dispatch power onto the network. In practical terms, the only difference between the two is that V2G enables PEVs to participate in grid services far more than in V1G systems. Given this advantage, V2G is also more expensive and more difficult to implement. There are already a handful of suppliers—for example, Ovo Energy in partnership with Nissan UK—offering free EV charging if customers make their EV batteries available for aggregated grid services.
- **Transactive energy:** While it only exists in small-scale trials, there is significant interest and the next 2 or 3 years could see transactive energy markets emerge globally. Although initial interest lies in residential PV, if transactive energy does mature, it will only be a matter of time before EVs participate, both as a buyer of locally generated solar power and as a supply source during peak periods. For example, an EV owner could buy a neighbor's excess solar power during the day or sell stored energy back to the neighbor at night.

Fleet Conversion and Management Business Models

Converting fleets to electric powertrain is one of the biggest opportunities for utilities. Fleet owners will require extensive charging infrastructure that will have exacting requirements—typically, larger batteries to be charged by high capacity charge points, often at specific times of the day—and, as a result, will create unique load curves. Consequently, fleet charging infrastructure will require a concentration of high capacity chargers under a single feeder creating heavy demand on networks, which will require careful management and potential asset upgrades.

Different types of fleets will require different approaches:

- **Commercial fleets:** Commercial fleets are often used during working hours, so electricity demand will increase in the evening when most vehicles return to the depot to charge. This will create significant problems for networks with a coincident evening peak. Fleets that operate 24 hours a day will likely demand the fastest possible charging infrastructure, further compounding demands on the network. These companies may be prime candidates for battery swapping.
- **Public transport:** Public transport vehicles—most commonly buses—will similarly require rapid charging. Charging of vehicles may be more evenly spread throughout the day. However, bus depots—particularly in larger cities that have developed over hundreds of years—may be inconveniently positioned from a network perspective, requiring significant asset upgrades.
- **Carshare:** Carshare fleets will have a different load curve, given that assets are smaller and charging will be spread more evenly throughout the day.

Mobility Services Business Models

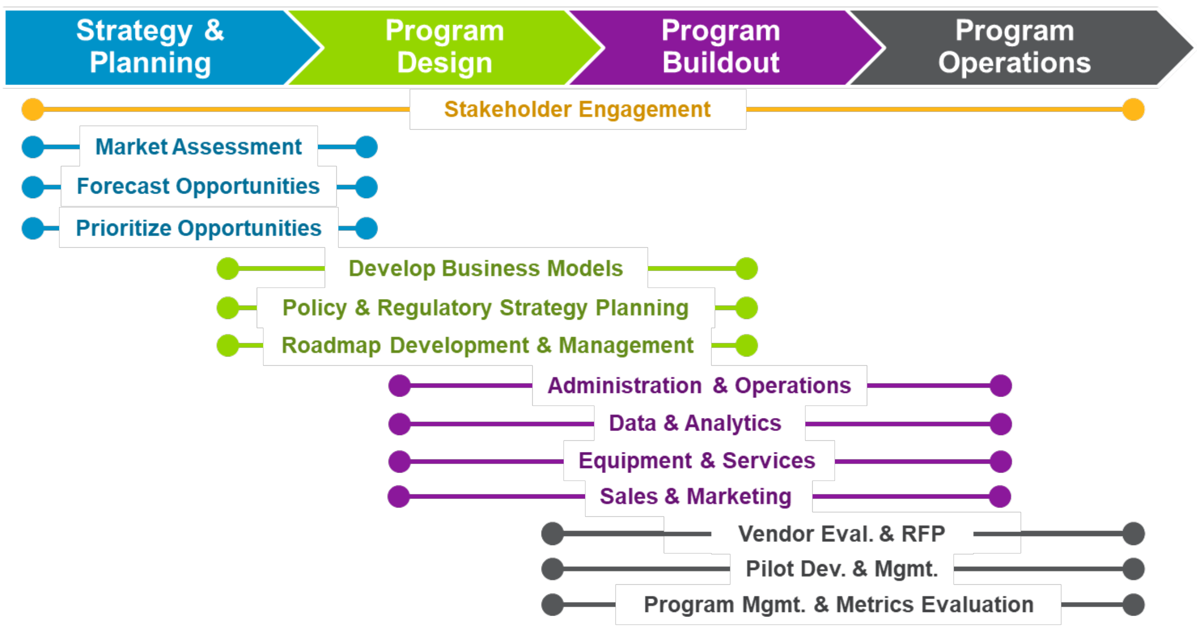
There is nothing to stop an ambitious utility from offering (most likely with a group of partners) mobility services. Navigant Research believes much of the innovation in mobility services will be application based and will consequently rely heavily on access to data from numerous sources. Mobility services include the following:

- **Smart parking and charge:** Many cities already offer apps that provide drivers with information on parking availability. These have recently been augmented with information on charge point location and availability. In the future, data on electricity grid congestion could be as important as traffic congestion, matching a charge point's physical availability with the network's availability to supply it with power.
- **Battery swap networks:** Several years ago, battery swapping was thought to be the solution to prolonged charge times. The Israeli company Better Place attracted significant interest in its proposed network of battery swap stations. However, the company failed to get off the ground and folded in 2013 after spending an eye-watering $850 million of investment capital. While Better Place has gone, the idea of battery swapping is still touted, particularly for fleet vehicles.
- **Neighborhood EV and other carsharing schemes:** As part of the trend toward shared ownership, neighborhood EV schemes, which are local shared ownership programs of low speed vehicles, are gaining increasing attention.
- **Shared autonomous vehicles (AVs):** Ubiquitous self-driving vehicles will likely be some years away. Given the expected trend for an increased proportion of new car sales to be electric, the further into the future AV adoption goes, the increasing likelihood they will be electric. AVs challenge current concepts of vehicle ownership, as they make shared ownership an attractive option—overall costs for urban customers can be reduced by up to half and parking is no longer an issue. The owners of fleets of self-driving vehicles will become attractive future customers for utilities.
- **Multimodal transport systems:** EVs are only one part of the transport system. City planners are keen to encourage mixed transportation for certain journey types to reduce congestion and maximize the efficiency of public transport networks. Multimodal transport systems will use apps to integrate park-and-charge services, shared ownership, AV schemes, ride-hailing services, and public transport.

EV Business Model Development Is a Four-Step Process

Navigant Research recommends a four-step plan-design-buildout-operate model for EV-related business model development. Utilities will be used to this approach for traditional grid investments because EV-related projects, despite some unique properties, are essentially the same thing. The transport-to-grid lifecycle planning approach ensures that the entire lifespan of the project is considered from the outset and is relevant for all the business models listed previously.

Figure 2 Transport-to-Grid Lifecycle Steps



(Source: Navigant Consulting, Inc.)

Plan EV Analytics Infrastructure Today

A Minority of Utilities Have Substantive EV Strategies

A minority of utilities are actively preparing for a future that includes EVs, with strategies that run deep throughout the organization. For the majority, talk is rampant, but actions are light. Californian utilities such as Pacific Gas and Electric Company and Southern California Edison are leading the charge in the US, closely followed by utilities in the northeastern US. Yet, there are many more in the industry doing a lot less. A March 2018 report by the Smart Electric Power Alliance found that only 15 of 486 US utilities represented in the survey were in a late stage of EV planning.

Some European utilities also have these late stage characteristics and are reacting to a regulatory environment that will encourage EV adoption. Norway and the Netherlands have some of the most advanced EV markets in the world when calculating charge points and EVs per capita. Italian utility Enel has made significant investments in the EV market. UK Power Networks is rapidly deploying business readiness programs, participating in numerous government consultation programs, partnering with energy suppliers on possible business models, and using advanced analytics to identify early any problems EVs may cause on its network.

Create a Strategy Before EV Growth Accelerates

Many in the industry look to the middle of the next decade as an inflection point for EVs. Depending on different scenarios, Navigant Research estimates a global EV population of between 39 million and 57 million in 2026. This level of penetration will not only create significant revenue for electricity suppliers, but will also cause a material effect on distribution networks. However, EV growth will not level off by the end of the 2020s; instead, adoption will accelerate. Many countries are committing to the ban on sales of internal combustion engine vehicles between 2030 and 2040, which will drive aggressive adoption, particularly in Europe and China through 2050. From 2030, utilities' problems with EVs could also grow exponentially.

> "[We] need to **understand the right pace of growth** for EVs for a **robust infrastructure**."
>
> *– DER Solutions Manager, US Utility*

While 2025 or 2030 may seem a long way off, it is critical that the industry prepare for EVs now. Growth in absolute numbers of EVs on the road will be manageable over the next few years. After that, things will move quickly because EV adoption is forecast to follow an S curve. And as this report discusses, when the EV market matures, there will be demand for increasingly complex business models that require sophisticated data and analytics. The question utilities must ask is whether they would rather conceptualize their analytics infrastructure now, when the number of EVs on the road are manageable, or when EV growth and requirements change rapidly.

Analytics Are Essential to Business Model Development

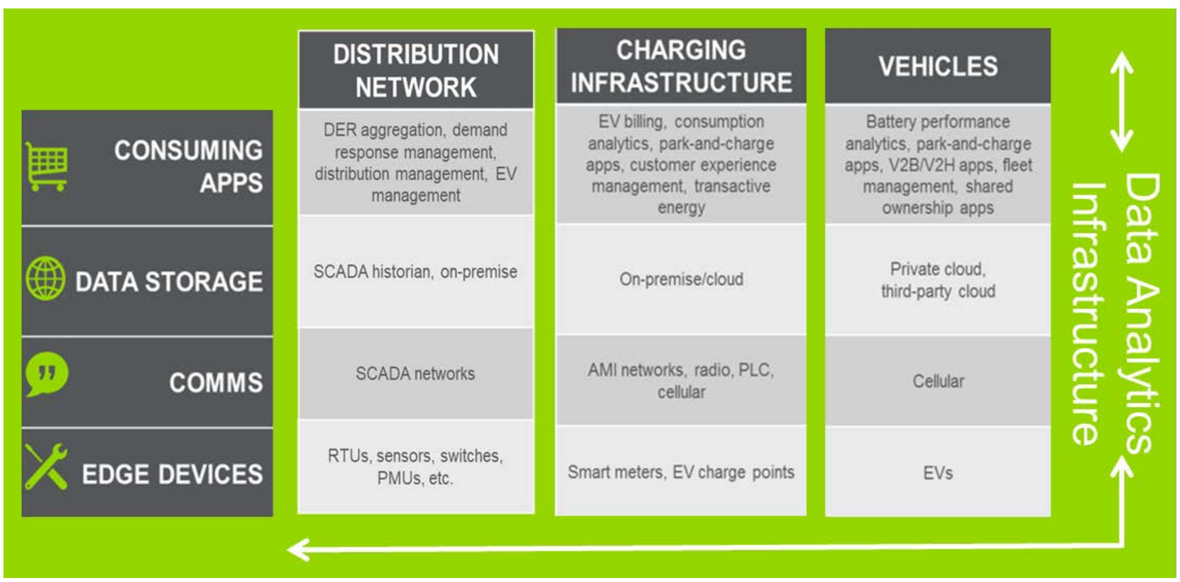
Redefining EVs as IoT Highlights the Value of Data Integration

To understand the importance of data in EV planning, it is worthwhile to take a step back and reconsider what EV technologies—vehicles, charging infrastructure, distribution network assets, and the applications that monitor and manage them—actually are. In Navigant Research's opinion, this technology infrastructure is (despite some unique characteristics) an IoT ecosystem.

Figure 3 shows how interrelated devices create data that is transported, stored, and analyzed by consuming applications and how this data can be analyzed at the edge (where it is created) while it is in motion, in database, in the cloud, or by consuming applications. This technology stack can be reused for any IoT deployment—from healthcare through to manufacturing. EVs really are just a form of IoT and, like other IoT programs, they will benefit from an approach that is supported by an IoT analytics platform.

And the primary guiding principle for maximizing value from any IoT project is the combination of data from multiple sources to create new actionable insights. Therefore, it is critical that an EV strategy must include a data strategy that optimizes data access, both for existing and future business models.

Figure 3 EV Technology Infrastructure Is an IoT Ecosystem with Pervasive Analytics



(Source: Navigant Research)

Embed Analytics throughout the EV Ecosystem

The primary goal of IoT is to facilitate delivery of business outcomes. The electrification of transport is also the digitization of transport. Data is created at the edge and across the technology ecosystem and has the potential to serve numerous business models. The rest of this report discusses how the utility industry can maximize this potential. However, it is worth bearing in mind that analytics can—and should—be deployed throughout the technology stack: in devices at the edge, on data stored in the cloud or on-premise, and embedded in specific applications.

Not all data is equal, so different strategies are needed for the analytics software that analyzes each data type. For example, data—particularly data of relatively low value, produced in large volumes—should be analyzed at the edge. A remote terminal unit installed to monitor power quality issues on a feeder with a high concentration of EVs must only notify the network control room if certain conditions, such as capacity constraints or drops in voltage, have been exceeded. Event stream processing can be pushed to the edge to perform this task, removing the requirement to pull all data back to a central repository before it is analyzed. Other data will be analyzed on-premise; for example, a utility may want to analyze numerous EV-related datasets to help with long-term asset planning. Alternatively, data may be analyzed in the cloud; for example, a customer segmentation exercise based on historical EV charging behavior.

Involve IT in EV Planning at an Early Stage

Many are keeping a close eye on forecast EV penetration rates and incorporating these into their long-term asset plans. Some utilities' analysis of the effect of EVs on networks is highly sophisticated. However, it is of concern that strategic planning has not yet crossed the boundary between business units and IT. Current planning for EVs sits within separate business units—which may work together closely—but few utilities have a long-term strategic plan for an IT infrastructure to support EVs. Many utilities have not yet committed significant resources to EV planning, with just a small team focused on EV business model development, and are not yet thinking seriously about analytics infrastructure.

There is a risk that while the utility side of the business sets about creating EV strategies, they will be created in silos. As new use cases are developed, new point solutions will be created to support each one. As the EV market matures, the pace of change could well become frenetic, making it harder to sustain this point-solution approach. For well over a decade, utilities have recognized the need to converge data, applications, and teams managed by operations with those managed by IT departments. IT-OT convergence is a prerequisite for many of the business models proposed in the paper.

While a silo-based approach to program development is not an immediate concern for utilities, within a couple of years it will be—all the business models discussed in this report will rely on data and associated analytics. Different departments will require access to the same data. They will have different requirements for analytics and varying degrees of analytical skills.

Adopt a Flexible Approach to EV Technology Infrastructure

One of the biggest mistakes a utility can make is to approach the technology infrastructure required for EV business models in the way they have approached other business processes. The perfect example of this is the development of the first generation of billing systems. These systems were developed to support a well-defined workflow that changed little over long periods of time. The result was an IT infrastructure that was similarly inflexible.

If the utility industry is to maximize the benefits and minimize the potential negative effects of EV growth, it requires a much different approach to IT and analytics infrastructure. The effect of EVs on the electricity market will be deep, wide, and unique—and their effect will likely be felt much sooner than some expect. The EV market will grow rapidly; as it does, market dynamics, and their technological requirements, will change rapidly. Business models will become increasingly sophisticated and converge with others. Consequently, the IT and analytics that underpin a utility's EV-related processes must be highly flexible.

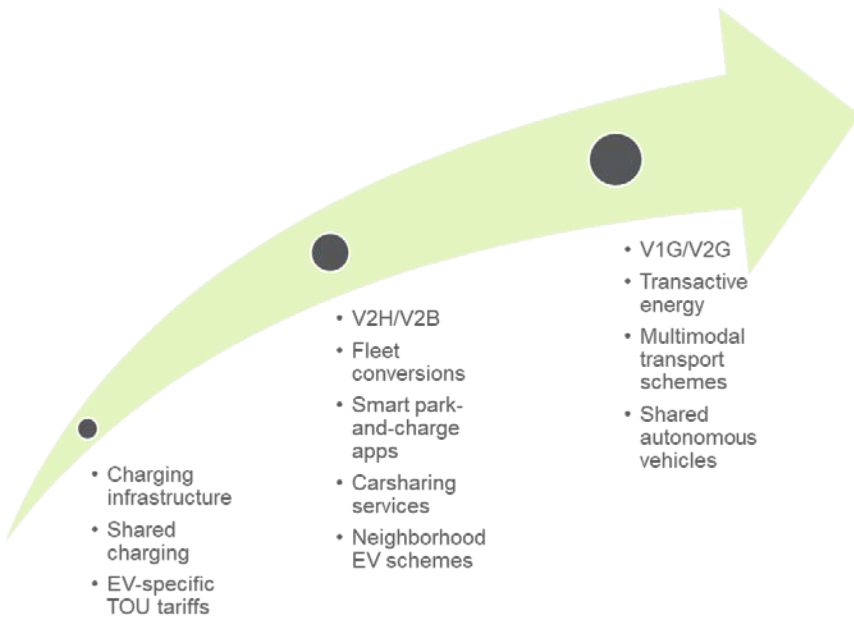
Match Business Model Inflection Points with Technology Developments

There will be different inflection points for each business model. For example, the effect of EVs on network management will only occur when a critical mass of EVs starts charging below a specific feeder, and this critical mass will vary depending on the excess capacity of each feeder. Network utilities' experience will differ based on the speed of EV adoption, population densities, the age of network infrastructure, current excess capacity, the level of smartness of charge points, the availability of charge point data, and the ability to curtail charging. So, the timing and types of response will change across different locations.

EVs are just one part of a much wider story. They are not the only opportunity for new load growth; heat pumps are another example, and utilities must manage how the two interact and affect the network. The business models proposed in Figure 4 become increasingly complex and incorporate many different technologies beyond EVs. For instance, a demand response (DR) program will be agnostic to the type of load or supply and will just focus on where and when loads can be turned up or down and supplies switched on or off. As a result, EV programs cannot be designed in a silo and must evolve alongside, and interoperate with, a wider portfolio of energy-related programs.

In addition, some of the business models may never prove to be of value and will not get past the trial phase. However, it is important that the industry, as part of its overall EV strategy, plans for the adoption of different scenarios. Figure 4 details a potential adoption curve of increasingly complex and sophisticated EV-related business models.

Figure 4 EV Business Model Maturity Curve



(Source: Navigant Research)

Over the course of the next 20 years, other DER will grow too, particularly distributed PV and storage. Network utilities will need to model different scenarios for the adoption of different technologies and assess the effect they will have on network management at a feeder level. In addition, as DER grows, models will have to be created to identify the potential value of different products and services. The increasing complexity of business models will require more data from more sources, IT-OT convergence (merging the assets, people, and processes of traditionally disparate information and operations technology), and a sophisticated data and analytics platform. As EV adoption grows, the requirements for the data analytics platform will broaden, but will be based in the fundamental insight related to what loads and supplies are currently available for the system. From that knowledge, utilities can support demand-side management by augmenting the system with data on network congestion, real-time pricing, customers connected to a charge point, and more.

And the platform will have to work alongside numerous legacy applications. These include distribution management systems, DR management, DER management systems, asset management, asset planning, load forecasting, energy trading systems, network connectivity models, location-based analytics, CRM and billing, and customer portals.

> "[We are] currently **encouraging the market**. We are **not** making **concrete investments**."
>
> *– Energy Policy Manager, US Utility*

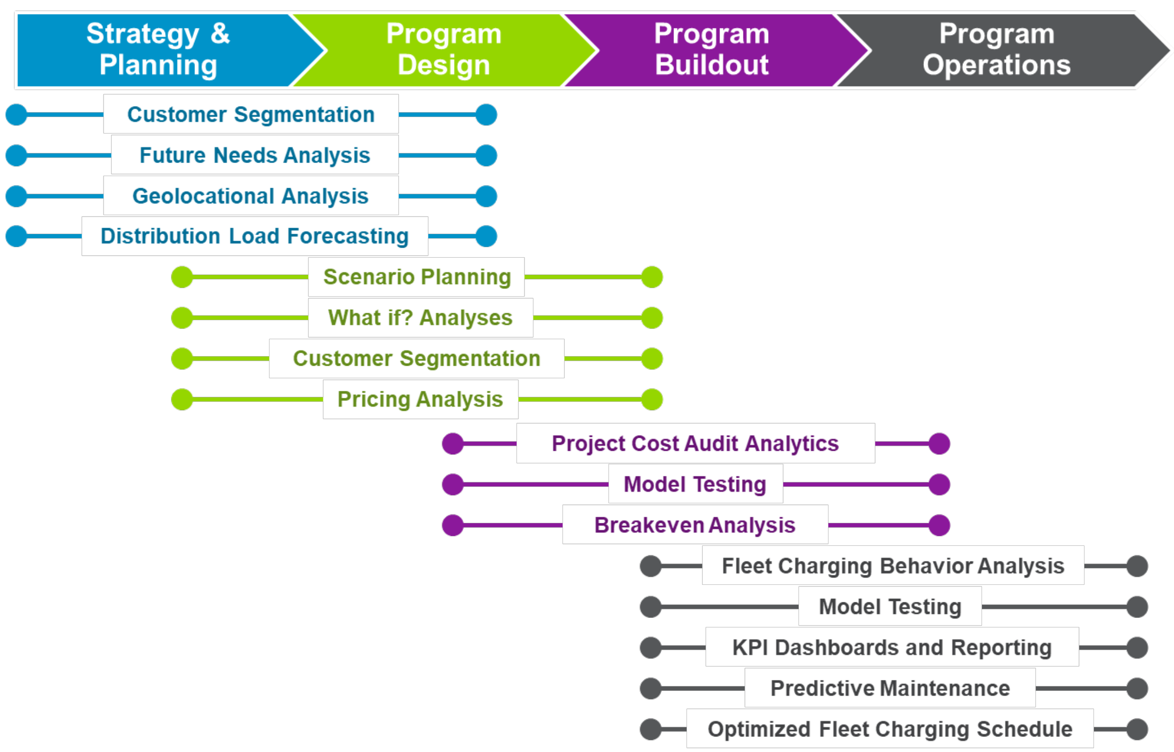
Consequently, it is imperative utilities focus on long-term requirements when designing a data and analytics infrastructure for EVs. Each trigger point for new EV business models should be matched with a trigger point for data and analytics. Additionally, if EVs record expected exponential growth, the industry will find it has far less time to plan, design, and build the infrastructure for far more complex business models. It is therefore more sensible to plan for an infrastructure that supports both current future requirements.

Incorporate Analytics into the Project Lifecycle Process

Data will flow throughout the EV ecosystem, providing the visibility that enables control and gives insights to better understand e-mobility customers. Data will help utilities understand where, when, and how batteries are recharged and how it will affect their future network investments. But to do this, analytics must be baked into the long-term EV strategy.

For example, the most mature EV-related analytics use case forecasts where and when EVs will have an effect on utility networks. Figure 5 shows how analytics can help network utilities throughout the project lifecycle.

Figure 5 Analytics Requirements for Network Planning



(Source: Navigant Research)

Network utilities will need to be warned years, rather than months, in advance of material problems in the network so they can secure regulatory approval for network investments and upgrade infrastructure before the problem manifests. Few will be offered a blank checkbook to fund these upgrades—many regulators have banned infrastructure investments based on long-term future requirements, as the system is open to gaming. Analytics can help throughout the network planning project lifecycle.

Strategy and Planning

Analytics can help network utilities forecast distribution loads by identifying the areas most likely to be affected by EVs and project when problems will likely occur. This can be done by analyzing existing charge point locations, customer type and choice of EVs, charging behavior, location, the feeder to which they are connected, the excess capacity of that feeder, and so on. Analytics can help forecast where EV adoption is likely to take place, the likely charging behavior, and effects on local networks.

> "[Our] **EV modeling** revisits all EV forecasts [and] how this will influence charging. This will **support our main EV strategy**."
>
> *– Project Lead, UK Network Utility*

Program Design

Forecasting is a critical capability in the program design phase. Scenario planning can be used to test different investment options. This may be to forecast the investment requirements of different options and their likely adoption by specific customer segments in specific geographies. For example, a network utility may want to understand the investment implications of increasing the rating of a transformer or the cost and likely efficacy of flexibility to manage capacity constraints such as TOU pricing and DR.

Program Buildout

Analytics can help a network utility better track and audit project costs, providing real-time updates on project progress. Network planning is an ongoing project that will never end; however, when planning for the EV ramp-up, there are some specific tasks that will only be performed once. Analytics can help the industry to monitor asset planning performance and optimize future planning iterations.

Program Operations

For operations, the level of required analytics varies from simple key performance indicators dashboarding to monitor current performance to machine learning. The exponential growth of EVs creates an exponential growth in new data points. Increasing numbers of EVs will provide utilities with the opportunity to test and refine their existing models with new data, improve asset planning processes, and better demonstrate to regulators the rationale behind decisions to either upgrade infrastructure assets or invest in network flexibility.

EV Data and Analytics Requirements Highlight the Need for a CDO Role

While utilities are rightly excited by the potential of EVs, few to date have matched their enthusiasm for business model development with technology infrastructure planning. This report highlights the need to align new business strategies with a data and analytics strategy. Yet, the industry has demonstrated a patchy (at best) response to this need.

The corollary is that utilities' business and technology strategies are out of sync. This would not happen if a fully functioning chief digital officer (CDO) were in place. A true CDO straddles the boundary between business units and technology. They will be knowledgeable about both data management and analytics, but will also understand business requirements. The role of the CDO was developed to help companies through digital transformations and to develop new digital products and services. There is a clear need for a CDO to help manage utilities' growth into the world of EVs and wider DER-related services.

Collaborate to Maximize Access to EV Data

The most successful utilities will be those that adopt a platform-based approach, where there is a fundamental recognition in the value of making data available to all interested parties. Across the value chain, stakeholders are wide and varied. These stakeholders are as likely to be outside the organization as in it. An open data approach, which needs to incorporate data protection principles, will best accelerate innovation in the development of EV business models. One utility with which Navigant Research spoke as part of this project already recognizes the value in collaboration by always including a discussion about sharing data in the first meeting with potential partners.

> "[We] **want to push [our] thinking elsewhere**. The industry typically waits for people to make the first move."
>
> *– Project Lead, UK Network Utility*

Manage Visibility Gaps

Finally, the industry must—at least in the early stages of EV deployments—manage gaps in their data. For example, private charge points may be installed without a utility's knowledge. So, a utility will not know where at least some EVs are, the demand this places on local network infrastructure, the EV owners' charging behaviors, or any segmentation insights into these customers to assist the sale of EV-related programs (such as the propensity to adopt an EV tariff or buy solar panels). Working with charge point installers, rather than competing directly, will create an atmosphere where data sharing is improved. However, each individual utility will have to decide whether there is more value in accessing shared data or a share of the charge point market.

Where charge point data is not available, some utilities have tried to identify EVs through load signatures at a feeder; however, success has so far been mixed. Utilities have been offering rebate programs on charge point installation to encourage their adoption and ease the adoption of EVs. In some instances, utilities are placing a separate smart meter on the charge point to offer EV-specific tariffs. In both instances, visibility into EV charging is improved.

Published 2Q 2018

1375 Walnut Street, Suite 100
Boulder, CO 80302 USA
Tel: +1.303.997.7609
http://www.navigantresearch.com

Note: Editing of this report was closed on April 24, 2018.