Beyond the plug: finding value in the emerging electric vehicle charging ecosystem

Business strategy analysis
Global Automotive Center – Advanced Powertrain
Ready, set, charge!

The rise of battery-powered electric vehicles (EVs) will entail the development of a vast amount of new infrastructure, particularly charging stations. Although the deployment of this infrastructure undoubtedly represents a market opportunity, the size of it is still difficult to estimate. Who owns the value created by the emerging EV business strategy is also still unclear. Despite initial scale advantages, small players who have what turns out to be the right solution may displace large players who make a bad choice.

This may become clear soon, either because of technological advances or through the market pressure of early entrants who prove most adept at executing their plan. If it does, the entire industry will benefit. However, should the uncertainty over the charging station business linger, it could slow down the evolution of the entire industry, and possibly even jeopardize its advance for decades.

In this document, we hope to shed some light on the charging infrastructure’s evolving value chain – its shape, its potential risk and possibilities for value-creation.

We don’t have all the answers – at this juncture, no one does – but we hope our analysis will help lead you to ask the right questions about your company’s response to the introduction of EVs. The roll out of EV charging infrastructure is essential to mass adoption of EVs and therefore could prove to be a huge social, political and economic change every bit as important to our society as the introduction of the internal combustion-powered automobile. Whether you decide to wait, enter or expand your investment in this exciting new and growing market, we hope this report will help you frame your view. We look forward to your feedback.

Michael Hanley
Global Automotive Leader
Executive summary

The charging infrastructure necessary to stimulate widespread adoption of increasingly available EVs in the marketplace remains to be built. As the mainstream OEMs begin to roll out EVs, the role of charging infrastructure evolves from being an awareness tool to becoming a commercially viable business venture.

The billion dollar question today is: How can companies package a commercially viable proposition and differentiate themselves in a non-existent, yet crowded marketplace?

Worldwide, we have identified 143 companies that have staked a claim to the emerging EV charging infrastructure, but despite all their ingenuity and activity, the shape of the value chain is still unclear. To try to decipher this chain, we closely analyzed these companies and chose 18 distinct business activities that were grouped to develop five potential business strategy variants. These business strategies are at different levels of complexity within the value chain and consequently, bring different risks and rewards to the participants.

<table>
<thead>
<tr>
<th>Business strategy variant</th>
<th>Charging infrastructure sphere</th>
<th>OEM sphere</th>
<th>Utility sphere</th>
<th>Customer sphere</th>
<th>Risk/Reward assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>The builder</td>
<td>A supplier of charging infrastructure hardware.</td>
<td></td>
<td></td>
<td></td>
<td><img src="./high.svg" alt="Risk" /> <img src="./high.svg" alt="Reward" /></td>
</tr>
<tr>
<td>The maintenance installer</td>
<td>Installation and maintenance services to charging network owners.</td>
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<td></td>
<td></td>
<td><img src="./medium.svg" alt="Risk" /> <img src="./low.svg" alt="Reward" /></td>
</tr>
<tr>
<td>The broker-operator</td>
<td>A manager of the charging infrastructure on behalf of potential network owners.</td>
<td></td>
<td></td>
<td></td>
<td><img src="./low.svg" alt="Risk" /> <img src="./low.svg" alt="Reward" /></td>
</tr>
<tr>
<td>The gridmaster</td>
<td>An agent that integrates smart grid solution for utilities with charging infrastructure management.</td>
<td></td>
<td></td>
<td></td>
<td><img src="./low.svg" alt="Risk" /> <img src="./high.svg" alt="Reward" /></td>
</tr>
<tr>
<td>The guardian</td>
<td>A provider of services ranging from charging infrastructure management to supporting EV manufacturers as well as customers (fleets and individuals).</td>
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<td></td>
<td><img src="./high.svg" alt="Risk" /> <img src="./low.svg" alt="Reward" /></td>
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</tbody>
</table>

The table above illustrates the risk and reward profiles for each business strategy variant. The risk assessment ranges from Very high to Very low, while the reward assessment ranges from Excellent to Very poor.
The five business strategies will evolve to maturity following different timetables as they face different barriers to entry. Some companies intend to operate in several of them at once, or even to be active in all of them, such as the company Better Place for instance.

Segmenting 143 business strategies allowed us to make several findings, some of which are presented in this report. Generally, we observe that:

- Most companies advertise that they offer solutions for a wide range of customers— from utilities to car rentals, to hotels and home users— but lack a differentiated package and convincing revenue model.
- Several players have not considered the role OEMs and energy utilities will play in this emerging ecosystem, and until these two central stakeholders decide where they want to sit, a stable value chain is unlikely to emerge.
- Charging station companies in the upper end of the value chain propose services that could be claimed by other, more natural players.
- To be a fast-mover is critical, but does not necessarily secure a market share. Manufacturing charging hardware will rapidly become a high-volume, low-margin business.
- Other segments of the EV charging value chain are likely to invest on services that can be offered by leveraging the growing network of charging stations. Overall, the biggest revenue opportunities will probably go to large-scale players or nimble startups who can reach scale rapidly.
- The emergence of the EV charging infrastructure will likely force OEMs to take a different look at managing the customer relationship. Some OEMs already recognize the challenge and are turning it into an opportunity.

The growth of the EV charging infrastructure is set to be an exciting chapter in the vehicle electrification process. The purpose of this analysis is to help read the market as it evolves, and also provide an initial assessment of the risks and rewards it presents.
The current state of the charging industry

**Overall market**
At the moment, stakeholders continue to wrangle over standards, each championing a favorite solution. Behind the scenes, some governments are trying to decide how involved they want to be in the roll out and whether they need to intervene.

As described in our section on regional development, market strategies differ significantly between Asia, North America and Europe, and those differences may harden into different regional standards, slowing growth for all.

**Customer focus**
The most common charging configuration is likely to be chargers at both home and work. However, we identified several other potential customers such as hotels and restaurants, car rental/sharing, fleet managers and gas stations. One emerging obstacle: an unarticulated value proposition for potential hosts of charging stations, such as parking lot owners.

**Disruptive threats**
Barrier to entry is low. New entrants may emerge from multiple industries. The market also faces several possible substitutes that could jeopardize several business strategies.

**Supplier power**
At this stage, suppliers are strong players in the value chain. Some have already moved up the value chain and become manufacturers of charging infrastructure through strategic partnering.

Government and industry players both see scale and interoperability as a key to a successful roll out. Some analysts believe failure to coordinate this system could set adoption back 10 years. However, to implement an appropriate EV charging infrastructure does not necessarily mean mandating an outlet at every street corner. It means creating a profitable industry where the economics are profitable and self-sustaining to justify the investment as the market develops.
Introducing the EV charging value chain

The basic elements of the emerging EV charging value chain are clear. It must transfer energy from an outlet to a vehicle. It must track information of the energy provider and the energy recipient. It must include a payment system easy for the consumer to understand and easy for the energy distributor to integrate within pre-existing billing systems – and of course, it must meet government regulations and carmaker requirements.

However, a number of important elements remain fuzzy.

- How soon will EVs become a mass-market phenomenon - or should we ask: How far away is this from happening?
- What will the plug sizes be?
- Some charging standards are not yet globally approved.
- Whether EV charging should connect to a smart grid is an open debate.
- Some possible service offerings are contingent on the development of the smart grid, but should the initial network be built with this compatibility in mind?
- Where are the boundaries between the different stakeholders in the charging infrastructure?
- What are the commercial risks and rewards of building, owning or operating various products and services in the charging infrastructure?
- What are the potential revenue streams and the associated risks, and what business strategy is best placed to capture them?
- What are the capital and operating costs associated with the charging infrastructure?

For the purpose of this analysis, we envision the EV charging value chain as a combination of four spheres inter-connected by over 18 activities.

1. The **charging infrastructure sphere** comprises all services ranging from manufacturing the charging stations to setting up the physical infrastructure and managing the delivery of energy through the network of charging stations.
2. The **utility sphere** involves activities ranging from generating and distributing energy to billing the end-user for consumption.
3. The **OEM sphere** comprises all activities associated with the vehicle, ranging from selling to maintenance, operating and up to the end of its life cycle.
4. These three spheres revolve around the **customer sphere**, which is the private or business user of EVs, and encompasses the services they need over their ownership cycle of the vehicle.

A further dimension of analysis is that the 18 distinct activities critical to the EV charging value chain have been differentiated based on being a product (hardware or software) or a service (single or multi-year contract).

Based on an analysis of 143 companies that offer a product or service to the EV charging infrastructure, we have identified 18 distinct activities that are directly relevant for the functioning of the EV ecosystem. By looking at existing patterns and the most likely trajectories of development, we have derived the five potential charging infrastructure business strategies.
Introducing the EV charging value chain

Commercial viability of the charging infrastructure is vital to a sustainable EV market

<table>
<thead>
<tr>
<th>Component suppliers</th>
<th>Government</th>
<th>Insuarnce, breakdown/recovery</th>
<th>Peripheral services (battery recycling)</th>
<th>Battery manufacturing</th>
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<tbody>
<tr>
<td>Branded/Unbranded charging station manufacturer</td>
<td>Physical infrastructure management</td>
<td>Maintenance services</td>
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<tr>
<td>Advertising and other services</td>
<td>Charging station network operator</td>
<td>Installation services</td>
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<td>Charging station networks</td>
<td>Customer service network management</td>
<td>Charging station retailing</td>
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<td>Home charging</td>
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<td>Semi-public stations</td>
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<td>Public charging</td>
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<td>Fast charging/DC-DC</td>
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<td>Charging station networks</td>
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<tr>
<td>Energy access</td>
<td>EV fleet and public customer</td>
<td>Peripheral services (vehicle operation)</td>
<td>17</td>
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<tr>
<td>Municipalities</td>
<td>Hospital</td>
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<td>Public works</td>
<td>Fleet managers</td>
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<td>Energy consumption billing management</td>
<td>Energy provider</td>
<td>Billing capability</td>
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<tr>
<td>Smart grid management</td>
<td>Energy distribution</td>
<td>Energy</td>
<td>14</td>
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<tr>
<td>Metering capability</td>
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<tr>
<td>Network management software</td>
<td>Smart grid capability</td>
<td>Smart grid interface</td>
<td>10</td>
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<tr>
<td>Motor manufacturing</td>
<td>Other tier 1 suppliers</td>
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<tr>
<td>Energy distribution</td>
<td>Current management and diagnostics info</td>
<td>Vehicle performance and diagnostics info</td>
<td>6</td>
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<tr>
<td>Mobile/Web portal and CRM</td>
<td>Fleet management tools</td>
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<tr>
<td>OEM</td>
<td>Telematics/data management</td>
<td>In-vehicle charging infrastructure info</td>
<td>7</td>
<td></td>
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<tr>
<td>Branded/Unbranded charging station manufacturer</td>
<td></td>
<td>Related bundle of services</td>
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</tbody>
</table>

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# Searching for a sweet spot

Grouping 18 business activities into five strategy variants

<table>
<thead>
<tr>
<th>Charging station activity set</th>
<th>Definition/Example</th>
<th>Business strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>18</strong> Peripheral services: battery related</td>
<td>Information management on battery swapping, recycling and second-life applications.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>17</strong> Peripheral services: related to EV owners</td>
<td>Information management on vehicle sale, leasing/financing and maintenance services. May also include insurance and breakdown related services.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>16</strong> Engineering services</td>
<td>Consulting services, offered to charging infrastructure owners based on technical capabilities, software development services and testing.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
</tr>
<tr>
<td><strong>15</strong> Fleet management tools</td>
<td>Software for corporate EV fleet customers including advanced performance, consumption and cost-related features.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>14</strong> Smart energy grid management</td>
<td>The IT system enables the energy provider to dynamically source and distribute a mix of renewable and non-renewable sources of energy based on price, customer (private or business), time of day and other criteria.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
</tr>
<tr>
<td><strong>13</strong> Charging station network management software</td>
<td>Ability to connect, control and monitor any of the charging stations in the network. May also control and monitor the usage of the network by different EV owners.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>12</strong> Metering capability in network of charging stations</td>
<td>Ability to measure and communicate the amount of energy dispensed by consumer, time of day, etc.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>11</strong> Billing capability in network of charging stations</td>
<td>Ability to generate an invoice on private/business customers based on usage of charging stations.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
</tr>
<tr>
<td><strong>10</strong> Smart charging</td>
<td>Controls the measure of energy dispensed to a vehicle remotely. This is done by monitoring the level of charge in the vehicle, the time of day, price of energy, load on the grid, etc.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>9</strong> Smart grid interface</td>
<td>Compatibility of charging station network with flexible/smart energy grid systems.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>8</strong> Mobile/Web-based customer portal</td>
<td>Mobile/Web portal and customer relationship management.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>7</strong> In-vehicle charging infrastructure information</td>
<td>In-vehicle information for EV drivers (e.g., public/semi-public charging stations, cost of electricity).</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>6</strong> Vehicle performance diagnostic for OEMs</td>
<td>Monitors and communicates vehicle performance and diagnostics information for drivers and OEMs.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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<tr>
<td><strong>5</strong> Installation</td>
<td>Physical installation involving groundwork, wiring, testing, etc. and also connecting the charging station to the grid.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
</tr>
<tr>
<td><strong>4</strong> Maintenance and servicing of charging stations</td>
<td>Contracts between station owner and maintenance service provider for conducting routine maintenance and servicing charging station network on a regular basis over the contract period.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
</tr>
<tr>
<td><strong>3</strong> Charging station retailing</td>
<td>Companies that only brand and sell charging stations.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
</tr>
<tr>
<td><strong>2</strong> Branded charging station manufacturer</td>
<td>Manufacturer of charging stations that sells these chargers under its own brand.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
</tr>
<tr>
<td><strong>1</strong> Unbranded charging station manufacturer</td>
<td>Manufacturer of charging stations that allows other companies to brand the charging station device.</td>
<td><img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /> <img src="rating_icon" alt="Rating" /></td>
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</table>
Searching for a sweet spot
Five possible business strategy variants are likely to co-exist

Industry structures develop in particular ways for two reasons – either around the needs of the customer or around the convenience of the supplier. The EV charging value chain will be no exception.

Each of these models moves up the value chain from the most basic elements (hardware manufacturers) to the most high value (EV maintenance contracts). Yet from the second step up, these businesses may own or outsource the lower-value elements. Indeed, the station itself may just be a positive externality, with the player’s value partly derived by their understanding of or proximity to charging station architecture.

None of these five strike us as having breakthrough value propositions. Most have relatively low barriers to entry. Few look stable and defensible. As a result, we believe that this is a business that will be won or lost early, and conducted on a grand scale. It may be possible to gain leverage through some kind of real estate-like component, much like other recent physical technology roll outs, such as cell phone coverage and cable TV, but only to a player able to cultivate good relationships with power companies, municipalities and parking lot owners.

Next, we’ll look at these five possibilities, and assess the risks and reward profiles of each business strategy.
Evaluating the five business strategies
Business strategy one: the builder

The builder. This player would simply create the infrastructure hardware necessary for charging batteries in an urban, residential or corporate setting. The operations of both the vehicles and the electrical companies would be beyond its scope – a bit, perhaps, like an internet modem developer.

Any infrastructure involving high-voltage connections is likely to be highly regulated, which means that the technology itself could not be used as a barrier to entry. Two possible exceptions:

a) If regulatory certification for safety reason limits new entrants, or
b) if another player in the value chain, such as a vehicle OEM or a power company, supporting a particular candidate as an industry standard can lock out other players.

Charging station activity set

1. Unbranded charging station manufacturer
2. Branded charging station manufacturer
3. Charging station retailing
4. Maintenance and servicing of charging stations
5. Installation
6. Vehicle performance diagnostic for OEMs
7. In-vehicle charging infrastructure information for EV drivers
8. Mobile/Web-based customer portal
9. Smart grid interface
10. Smart charging
11. Billing capability
12. Metering capability
13. Charging station network management software
14. Smart energy grid management
15. Fleet management tools
16. Engineering services
17. Peripheral services: EV owners related
18. Peripheral services: battery related
Position of the builder in the EV charging value chain

The builder offers branded/un-branded hardware in the charging infrastructure sphere.
Business strategy one: the builder

<table>
<thead>
<tr>
<th>Product market domain</th>
<th>Product</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hardware</td>
<td>Software</td>
</tr>
<tr>
<td></td>
<td>One-time contract</td>
<td>Multiyear contract</td>
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</tbody>
</table>

Customer

<table>
<thead>
<tr>
<th></th>
<th>Private</th>
<th>Corporate</th>
<th>Retail/Semi public</th>
<th>Public</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home owners</td>
<td>Fleet managers</td>
<td>Car rental/sharing</td>
<td>Municipalities</td>
<td></td>
</tr>
<tr>
<td>Condominium owners</td>
<td>Corporate employee EV parking</td>
<td>Hotels and restaurants</td>
<td>Utilities</td>
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<td></td>
<td>Commercial parking lots</td>
<td>Government facilities</td>
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</tbody>
</table>

Highlighted regions determine most predominant sector of activity.

Value proposition

Competitive positioning

- High technology: Cost advantage, Technology differentiation
- Low technology: Commodity, Capital/Infrastructure intensive

Activity set
- Unbranded charging station manufacturer
- Branded charging station manufacturer
- Charging station retailing

Opportunities
- Tangible demand for charging devices is expected in the next three to five years.
- The unbranded charging station market can be attractive if the device is to be constantly updated with leading-edge technology and design.
- The right partnership with an OEM or city administration may prove very profitable.

Threats
- Companies active in this sector will face the commodity challenge: low cost/high volume but will also have to revamp their product to stay in business, which is to be capital intensive.
- Potential alternate technologies such as induction charging can replace need for standard charging stations.
- Low-tech nature of hardware reduces differentiation and competitive advantage.
- Selling charging stations as such will limit the target audience significantly in the mid-term because several users will require more than a device to satisfy their needs (they will need network connection, billing capability, etc.).
- High exposure to supply chain may cause a supplier to become a competitor.
- Higher capital expenditure will be a heavy burden for independent players with low market capitalization.
Our takeaway

• Business strategies that rely exclusively on hardware charging stations are not likely to keep up with the pace of change in the market. Players in this area will need an important strategic partner to succeed.
• Builders will have few opportunities for differentiation outside specific regional voltage requirements. True advantages are more likely to grow out of alliances with OEMs, but this is a rapidly diminishing opportunity. We recommend that the builder seek a specific customer target niche and customize its offering based on explicit needs it might have.
• Devices could be customized for particular specialty niches.
• In collaboration with city administrations, charging stations may be set up near metro and public transportation stations, integrating EVs into the municipal transportation scheme.
• Rather than concentrate on permanent facilities, some entrants might develop portable charging stations that EV owners could take with them, reducing the need for permanent infrastructure.
• Companies operating this business strategy may choose to own, outsource or even have a panel of banded - unbranded charging station manufacturers.
The maintenance-installer. This company would install and then manage the operational reliability of charging stations. This might sound a little like the filling stations of today, but the special nature of battery charging (i.e., it may take hours) will likely demand a very different kind of infrastructure, perhaps integrated into parking lots.

For home installation, the low maintenance that such facilities will require and the lack of differentiation would likely limit the possibilities to build customer loyalty.

This is a very different story for owners of public/semi-public charging networks. Maintenance contracts are significantly more important for them as downtime will result in lost revenues.

Charging station activity set
1. Unbranded charging station manufacturer
2. Branded charging station manufacturer
3. Charging station retailing
4. Maintenance and servicing of charging stations
5. Installation
6. Vehicle performance diagnostic for OEMs
7. In-vehicle charging infrastructure information for EV drivers
8. Mobile/Web-based customer portal
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13. Charging station network management software
14. Smart energy grid management
15. Fleet management tools
16. Engineering services
17. Peripheral services: EV owners related
18. Peripheral services: battery related
Position of the maintenance-installer in the EV charging value chain

The maintenance-installer benefits from contracts to service the growing population of public/semi-public charging stations.
Business strategy two: the maintenance-installer

**Product market domain**

<table>
<thead>
<tr>
<th>Product</th>
<th>Service</th>
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<td>Hardware</td>
<td>One-time contract</td>
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<td>Software</td>
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**Customer**

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<th>Private</th>
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<td>Home owners</td>
<td>Fleet managers</td>
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<tr>
<td>Condominium owners</td>
<td>Corporate employee EV parking</td>
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**Geography**

| Local | Regional | National | Global |

**Value proposition**

- High technology: Cost advantage, Technology differentiation
- Low technology: Commodity, Capital/Infrastructure intensive

**Short-term revenue source**

- High volumes: Subsidies, Low margins
- Low volumes: High margins

**Activity set**

- Charging station retailing
- Maintenance and servicing of charging stations
- Installation

**Opportunities**

- Home chargers that can be installed with fewer additional electrical upgrades than other charging solutions have strong potential moving forward.
- The growing need to educate buyers may open up new business opportunities surrounding the business of the maintenance-installer: while retailing, installing or servicing charging device, supporting utilities in energy saving campaigns may, for instance, generate new business.

**Threats**

- In the US, home installation projects have so far proven time consuming and more risky than initially anticipated.
- The maintenance-installer will find it hard to expand geographically. It will have to comply with installation regulations and service requirements that are likely to vary significantly by region, at least until the market is established.
- This market niche is also likely to disappear for some target markets (for instance home charging), as utilities may decide to bundle it into their service package.
- Selling charging station as such limits the target audience significantly as it access only a limited number of stakeholders in the value chain.
Our takeaway

- The value of maintenance contracts may increase over the years as the number of charging stations in operation is likely to expand in the future.
- Charging stations are set to evolve rapidly, which will also force the maintenance-installer to constantly adjust its service offering.
- It is difficult to imagine EV consumer ownership without a home electric vehicle supply equipment (EVSE) installation. Both will have to be carefully coordinated to avoid disappointment among enthusiastic early adopters.
- The maintenance-installer is best positioned to help accelerate standardization. It should carefully navigate the risk associated with the lack of standardization in order to manage inventories while providing ready services.
- Strategic combination of installation device with a green energy supply or off-peak energy management support may attract environmentally aware consumers. For instance, some stations may generate on-site power from green energy sources built into the structure, such as photovoltaic panels.
- Investments in technicians merged with a good service model are to be strong differentiator in the market.
Beyond installing and maintaining the charging stations, the broker-operator would manage the energy delivery as well. This company would manage the energy use, the costs of that energy and the amount that needs to be billed to the customer.

One of the broker-operator's key strengths lies in its managing and monitoring abilities. One partial segment to this business strategy may be to companies that provide the tracking analytics for cell phone usage. However, the business may be more compelling than that. As a middleman, the company would be in a position to extract better terms with both the utility and the consumer, or at the very least, create analytics that could add value to power companies. This additional data could also be used to create bundled offerings based on a household's complete energy consumption profile.

Companies operating this business strategy may choose to own, outsource or even have a panel of partners for activities 1 through 5.
Position of the broker-operator in the EV charging value chain

The broker-operator offers to manage the complete charging infrastructure sphere on behalf of potential network owners.

- **Core activities**
  - Product
    - Hardware
    - Software
  - Service
    - One-time
    - Multiyear service contract

- **Additional activities**
  - Related bundle of services
Business strategy three: the broker-operator

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<th>Product market domain</th>
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Highlighted regions determine most predominant sector of activity.

### Opportunities
- The broker-operator has a wide array of service to be packaged for an extensive range of customers.
- Need to educate buyer: currently, it is hard to imagine that potential EV charging station buyers can see a compelling reason to enter this business. The broker-operator should be able to help understand how to monetize the opportunities at hand, thereby strengthening its role in the value chain.
- Buyers need to have a network connection in place to purchase charging station without data management processor.

### Threats
- Revenue models are not yet fully tested for all activities offered by the broker-operator.
- Potential buyers are likely to expect several services to be free.
- Some of the services will be core propositions for other stakeholders in the EV industry.

### Value proposition
- Competitive positioning
  - High technology
  - Low technology
  - Cost advantage
  - Technology differentiation
  - Commodity
  - Capital/Infrastructure intensive

### Activity set
- Vehicle performance diagnostic for OEMs
- In-vehicle charging infrastructure information for EV drivers
- Mobile/Web-based customer portal
- Smart grid interface
- Smart charging
- Billing capability
- Metering capability
- Charging station network management software

### Short-term revenue source
- High volumes
  - Subsidies
  - Low margins
  - High margins
- Low volumes

Beyond the plug: finding value in the emerging electric vehicle charging ecosystem
Our takeaway

- The key competence owned by the broker-operator is the ability to involve billing to the charging process. One of the broker-operator’s strengths and value in the market will therefore be to help identify and quantify the value of a potential charging infrastructure project. But billing as such may also become a commodity and should not be considered as an ultimate safety net against other business strategies as car makers might end up having compelling mechanisms on board via telematics. One way to counter that risk could be to seek an active role in the telematic industry, thereby solidifying a function for OEMs.
- The business of the broker-operator requires significant investment in systems and communications tools.
- The diagnostic capabilities of the broker-operator may also be useful to insurance companies and other data-centric businesses.
- The broker-operator will find it hard to cover all business highlighted under his activity set; success will depend on strong alliances with energy companies, many of which tend toward non-entrepreneurial cultures.
Beyond the plug: finding value in the emerging electric vehicle charging ecosystem

Business strategy four: the gridmaster

**The gridmaster.** This player would also manage energy, but in a different way. Beyond monitoring the charging process, the gridmaster would use the batteries of parked cars as a resource.

One of the most difficult aspects of electric energy production is that most energy is generated for immediate use, not for use at a later date. As a result, generators producing energy must be able to handle the highest peak load times even if most of these spikes are infrequent. Renewable energy has this problem as well in that the amount of energy created by the most popular renewables - such as solar or wind - vary tremendously, and they are not always in sync with usage peaks.

A gridmaster would help lessen these twin problems by making the entire network more efficient, using these parked car batteries to first store and then draw down energy to help smooth load requirements.

This market player provides energy storage and generation solutions, as well as off-grid or off-peak charging, with a premium paid for convenience.

Companies operating this business strategy may choose to own, outsource or even have a panel of partners for activities 1 through 13.

### Charging station activity set

1. Unbranded charging station manufacturer
2. Branded charging station manufacturer
3. Charging station retailing
4. Maintenance and servicing of charging stations
5. Installation
6. Vehicle performance diagnostic for OEMs
7. In-vehicle charging infrastructure information for EV drivers
8. Mobile/Web-based customer portal
9. Smart grid interface
10. Smart charging
11. Billing capability
12. Metering capability
13. Charging station network management software
14. **Smart energy grid management**
15. Fleet management tools
16. Engineering services
17. Peripheral services: EV owners related
18. Peripheral services: battery related
Position of the gridmaster in the EV charging value chain

The gridmaster differentiates by integrating the smart grid solution for utilities with charging infrastructure management.
Business strategy four: the gridmaster

**Product market domain**

<table>
<thead>
<tr>
<th>Product</th>
<th>Service</th>
<th>Customer</th>
<th>Geography</th>
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<tbody>
<tr>
<td>Hardware</td>
<td>Software</td>
<td>Private</td>
<td>Local</td>
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<td>One-time contract</td>
<td>Corporate</td>
<td>Regional</td>
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<td>Multiyear contract</td>
<td>Retail/Semi public</td>
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<td>Home owners</td>
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<td>Fleet managers</td>
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<td>Hotels and restaurants</td>
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<td>Commercial parking lots</td>
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<td>Corporate employee EV parking</td>
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<td>Government facilities</td>
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</tbody>
</table>

Highlighted regions determine most predominant sector of activity.

**Value proposition**

Competitive positioning

- High technology
  - Cost advantage
  - Technology differentiation

- Low technology
  - Commodity
  - Capital/Infrastructure intensive

**Activity set**

- Smart energy grid management

**Short-term revenue source**

- High volumes
  - Subsidies
  - Low margins
  - High margins

- Low volumes

**Opportunities**

- Software solutions for the power sector are needed. Players are emerging but more can be done.
- Utilities need better data management systems at an affordable price that will help them better serve their customers.
- Software and monitoring costs might be offset by peak hour energy management advantages.

**Threats**

- It is nearly impossible to assess the practicality of this idea, because the smart grid software that might support it is not yet mature.
- Battery-swapping systems may catch on instead.
- Fast-charging may become the norm, limiting the need for all-day/all-night connections.
- OEMs may resist installing two-way charging technology into their vehicles.
- Utilities may snatch the space for themselves.
Our takeaway

• Creating an EV charging infrastructure is an ambitious goal. Building a smart grid is equally ambitious. To do both at the same time might multiply the value of each but will also increase the magnitude of investment and managerial effort required.

• Given the lack of understanding of market demand and ROI, companies focusing on a smart grid deployment will need to work closely with companies that can help make smart grid adoption more affordable and immediately appealing to utilities. One example would be to seek an alliance with data management software makers who can demonstrate a clear ROI.

• In the end, the gridmaster’s success will depend on the creation of a three-sided value proposition that appeals as much to the automobile OEM and the power provider as to the consumer.

• Standard-setting could create a barrier to entry in this sector.

• The role at the utility level may help secure business immediately.

• Trading “green” energy credits to support EV charging with renewable sources will be an attractive complement for the gridmaster once this market establishes.
Beyond the plug: finding value in the emerging electric vehicle charging ecosystem

Business strategy five: the guardian

The guardian. With or without ownership of the back-end power infrastructure, the guardian extends its service offering to the owner of the EV (business or private), in addition to other stakeholders in the EV charging ecosystem.

At this stage, the key differentiators from other business strategies are the value-added services that may be peripheral to the charging infrastructure, but are critical in the overall EV ecosystem.

In particular, the guardian has a more strategic role in the management of the charging network, and therefore exposure to greater risks (as well as upside potential) compared to the broker-operator, which is a relatively back-end operations management role.

Companies operating this business strategy may choose to own, outsource or even have a panel of partners for activities 1 through 14.

Charging station activity set

1. Unbranded charging station manufacturer
2. Branded charging station manufacturer
3. Charging station retailing
4. Maintenance and servicing of charging stations
5. Installation
6. Vehicle performance diagnostic for OEMs
7. In-vehicle charging infrastructure information for EV drivers
8. Mobile/Web-based customer portal
9. Smart grid interface
10. Smart charging
11. Billing capability
12. Metering capability
13. Charging station network management software
14. Smart energy grid management
15. Fleet management tools
16. Engineering services
17. Peripheral services: EV owners related
18. Peripheral services: battery related
Position of the guardian in the EV charging value chain

The guardian takes the unique position to offer services to all spheres, including the EV customer.
Business strategy five: the guardian

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<th>Product market domain</th>
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<td><strong>Product</strong></td>
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<th>Geography</th>
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<td>Local</td>
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Highlighted regions determine most predominant sector of activity.

### Opportunities
- No other opportunity touches so many different industries as the guardian’s business strategy, which will touch the OEM, telecom, software and even insurance industries. Controlling the record of the EV’s operation and the data flows surrounding its operation, the value of the guardian could combine the usefulness of building control systems and buyer loyalty cards with the potential to be a kind of “app store” for your vehicle.
- The guardian has the unique opportunity to customize the vehicle and energy access package based on the customer - business or private.
- Unlike other business strategies, the guardian can help establish regional and (or) national standards for the charging infrastructure, and manage a network of gridmasters and broker-operators.

### Threats
- OEMs are increasingly moving toward a service offering that might compete with the activity set of the guardian.
- Demand for these services might be different than current market developments suggest.
- Concerns about privacy might lead to limits on the data harvest.
Our takeaway

- This model could be a sweet spot, but the successful player will require access to EV OEM systems, data that few of today's tech-savvy OEMs will part with easily. The leaders are likely to either grow out of an industry with close ties to OEM servicing, insurance or navigation.
- The guardian's value proposition will be most effective when serving a fleet of EVs, hence private EV owners may not be its initial target customer group.
- Identifying cost reduction opportunities for potential customers, then proposing adequate implementation integrated in a charging network could also prove a to be good business complement.
- The guardian can consider offering selected EV owners specific peripheral services such as vehicle leasing, subscription-based energy access packages.
- The guardian could also offer peripheral services related to the EV's batteries, such as operating a network of swapping stations and (or) recycling centers.
Methodology

The foundation for this study was established through multiple internal and external interviews and detailed secondary research. Once the structure of the EV charging infrastructure industry was established, market participants were identified from a variety of sources ranging from trade shows across various geographies, pilot projects and also national and regional industry association listings. In total, 143 companies were selected and categorized by the following parameters:

- Country of origin
- Strategic partner
- Hardware manufacturer (yes or no)
- Charging station specification
- Core business of parent company
- Activity set (please refer to view the 18 activities selected to categorize the companies' business plans)
- Customer target

The most common market entrant into the EV charging landscape is from the power supply equipment manufacturing sector, involving companies that manufacture and (or) market power supplies, converters, inverters and chargers. Twenty-six of the 78 manufacturers identified come from the power supply equipment manufacturing sector, and nine companies from the manufacturing sector for components for electrical power supply, such as cables, switches and plugs. Together, they represent 45% of market entrants in EV charging station manufacturing.

Players by company background

**Industrial background of companies analyzed**

- Automotive manufacturer
- Automotive supplier
- Electric utility company
- Electrical components manufacturing
- Electrical security equipment manufacturer
- IT/software
- Power supply equipment manufacturing
- Startup companies focused on EV charging
- System integrator
- Telecom operator
Reviewing the state of play

All over the world, the EV market and charging infrastructure are coming rapidly to life. Governments, car companies, blue chips, startups - a variety of players are now struggling to build a universal EV charging infrastructure.
## Regional developments in the EV charging infrastructure

### North America

### Initiatives and projects
- Coulomb is beginning to roll out a projected 4,600 charging station network in Austin, Detroit, Los Angeles, New York, Orlando, Sacramento, San Francisco, San Jose, Redmond and Washington D.C., supported by three leading OEMs: Ford, GM and smartUSA.
- GE, both a big corporate energy buyer and a technology producer, now says it favors the development of Level 2 fast-charging with networked information.
- Fleet owners will likely be the early adopters. Coulomb’s customers to date are mostly business (39%), municipalities (37%) and automakers (2%).
- Energy companies are still largely uninvolved in the emerging EV charging market, partly because they are limited by regulation. This is somewhat worrisome as the biggest revenue opportunities are likely to be in the energy management of charging.
- Schneider Electric, another major electrical parts supplier, recently announced its own total EV charging solution.

### Government and industry support
- The EV Project is probably the largest initiative to date supporting vehicle electrification and charging infrastructure deployment. The 36-month project started in 2009 with ECOtality awarded a US$99.8 million dollar grant from the U.S. Department of Energy. With various partners involved, the value of the project is approximately US$230 million. The goal is to deploy over 14,000 chargers in 18 major cities and metropolitan areas located in six states of the United States. Qualifying EV drivers will receive a residential charger at no cost. Perhaps even more importantly, the EV Project will collect and analyze data that are to evaluate the effectiveness of charging infrastructure, and conduct trials of various revenue systems for commercial and public charging infrastructures. These lessons learned will be of unmatched value once shared with the broader community. ([www.theevproject.com/](http://www.theevproject.com/))
- Deregulation among utilities needs to happen now in order to create sustainable business context for charging station companies in the near future. Unlike Europe, utility commissions in the US do not seem to have appropriate market understanding and flexibility to support more rapid expansion of an EV charging infrastructure.

### Potentially disruptive projects
- GE is installing its own charging stations to supply the need generated by the several thousand EVs it plans to purchase. Such market-making activities require a high degree of cooperation between manufacturers and producers.
- At its Mountain View, CA., headquarters, Google is letting a startup called Plugless Power install an inductive system that will charge electric car batteries wirelessly, across an air gap.
- Lear, a GM Volt supplier, is marketing a “Volter,” a charging station and portable charging cordset for the Chevrolet Volt.

The list above is for illustrative purposes only. It is not exhaustive.
### Regional developments in the EV charging infrastructure

#### Europe

| Initiatives and projects | • At the 2011 Geneva Motor Show, ABB introduced a CHAdeMO-compliant fast-charger DC prototype that charges more than ten times as fast as a conventional charger. At the same show, it unveiled an AC standard charger.  
• London is rapidly becoming a charging capital. By 2013, an estimated 1,300 publicly accessible charging stations will be installed around the city. This spring, Hertz added electric cars to its London fleet, and set up its own network of 16 charging stations.  
• UK charging station startup Chargemaster has announced experiments with an interoperable radio-frequency identification (RFID) card that allows drivers to recharge in several cities. |
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<tr>
<td>Government and industry support</td>
<td>• The Green eMotion project, an initiative of the European Commission and 42 partners from industry, the energy sector, EV manufacturers, municipalities, universities and research institutions, is working to develop and to demonstrate a commonly accepted and user-friendly framework consisting of interoperable and scalable technical solutions in connection with a sustainable business platform. Possibly included in the framework: smart grid developments and urban mobility concepts. The four-year project started in March 2011. (<a href="http://www.greenemotion-project.eu">www.greenemotion-project.eu</a>)</td>
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<tr>
<td>Potentially disruptive projects</td>
<td>• As opposed to energy producers elsewhere, European utilities like the idea of using charging stations as a strategic tool (to expand geographically or build customer relationships).</td>
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The list above is for illustrative purposes only. It is not exhaustive.
Regional developments in the EV charging infrastructure

Asia

| Initiatives and projects | • In China, State Grid Corporation, the dominant power distributor, plans to build more than 2,350 EV charging stations and 220,000 charging poles by 2015.  
• The CHAdeMO initiative, an association created by TEPCO, a Japanese utility and now involving several car makers, is currently working on establishing a global charging standard for DC quick charge.  
• According to China’s draft energy vehicle development plan 2011-20, EV pilot cities should include vehicle charging facilities in their overall city construction plan with charging facilities installed for no less than 20% of new public and community parking spaces.  
• China Southern Grid and Better Place have signed a strategic agreement on battery swapping in April 2011 to promote battery swapping in China. |
| Government and industry support | • Chinese local governments are very actively supporting charging facilities construction. Over 100 charging stations were installed in at least five major cities since 2010. |
| Potentially disruptive projects | • State Grid and China Southern Grid are the only two power distributors in China. Considering their monopoly position, financial strength and government backing, the fact that these two companies are now promoting battery swapping could prove to be disruptive for China and eventually for the world because of China’s share of the global auto sector. |

The list above is for illustrative purposes only. It is not exhaustive.
Despite the activity, disruptive technologies could slow the development of charging systems

Several companies currently participating in the implementation of the EV charging infrastructure industry may see their value proposition jeopardized by disruptive players who could potentially emerge in the market place at a faster pace than anticipated. For example:

**Battery improvements**
Battery technologies will continue to evolve quickly. Significant battery performance improvements are likely to extend capacity between charges and (or) the speed of recharging. This could modify distance between charging stations and the overall density of the infrastructure.

**Battery swapping**
Alongside the battery, battery swapping should not be underestimated as an option. It is currently witnessing a lot of attention in China, and given the magnitude of this country’s potential demand and research intensity, it may play a role in the EV charging environment in the future.

**Expansion of onboard vehicle systems**
Software applications operating on an in-vehicle information system or mobile device are designed to enhance safety, connectivity and mobility. They could also provide solutions overlapping with the service portfolio of advanced charging station companies.

**Evolving charging technology**
Charging technologies are still being developed. DC charging, for instance, is already considered for Level One and Two charging. New generations of fast charging are also likely to rapidly emerge in the marketplace.

**Inductive charging**
Inductive charging is not currently affordable, safe or efficient, but is being investigated as a charging solution among key companies and countries. Requiring no wires or other connections, inductive charging could represent a significant safety improvement, and could significantly reduce the market as it would probably share the same customer target as DC charging companies.
Beyond the plug: finding value in the emerging electric vehicle charging ecosystem

The Ernst & Young role
## The Ernst & Young role
### Current and future questions

<table>
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<tr>
<th>Governments</th>
<th>City administrations</th>
<th>OEM suppliers</th>
<th>Utilities</th>
<th>Restaurants, hotels, public parking owners, etc.</th>
<th>Current stakeholders of the EV charging value chain</th>
<th>Other stakeholders (IT, telecom, insurance companies, etc.)</th>
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</thead>
<tbody>
<tr>
<td>How can we use EV charging infrastructure to include more renewables in our energy plan?</td>
<td>What options are available to our municipality and how do we choose the best one for our region?</td>
<td>How global is the EV charging phenomenon? What JV could make sense here?</td>
<td>How is the EV charging infrastructure ramping up? What charging options are available?</td>
<td>Do we have the appropriate business supporting EV charging?</td>
<td>Where do we fit in the EV charging value chain? Where is competition heading?</td>
<td>What value can we bring to emerging trends in the EV charging industry?</td>
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<td>How do we design an appropriate incentive scheme to mobilize industry players?</td>
<td>With whom should we team up to provide services emerging from EV infrastructure?</td>
<td>What charging components are needed for the various vehicle powertrain types?</td>
<td>Are we missing an opportunity or do well in waiting for the landscape to become better defined?</td>
<td>What value do we bring to the business?</td>
<td>What complement can further support our value proposition?</td>
<td>Can we be a complement to this industry? Is there a market we can create?</td>
</tr>
<tr>
<td>Can we create a cluster in our country (or region) to focus on R&amp;D supporting the evolution of EV charging?</td>
<td>Should we begin to send out RFPs for EV charging infrastructure or wait a bit longer?</td>
<td>Can we design something needed in the EV charging value chain for OEMs or other stakeholders?</td>
<td>Given the appropriate partnership, how could EV charging help us save energy and better serve our customer base?</td>
<td>What strategic advantages should we aim at? How do we build the right business strategy covering business risk and rapid market change?</td>
<td>Should we expand our scope offering?</td>
<td>How do we measure the value creation potential of the company we want to partner with?</td>
</tr>
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</table>

### The investor's response

| Are public private partnership (PPP) initiatives shaping up in markets of interest to us? | Is the EV charging industry to change the market value of some automotive suppliers? How do we assess the value creation potential of the EV charging industry for suppliers? | Do utilities present a potential new investment area? | How do we value a EV charging business idea? What benchmark do we use to calculate an appropriate IRR? | How do we benchmark the appropriate WACC with my investment target? | How do we measure risk impacting the rate of return when several industries merge? |

### Questions related to cash flow

- What are the capital needs and key revenue streams associated with the business strategy and their risks?
- What cash flow scenarios for business and model scenarios to assess profitability and ROI can be built?
- What assessment of building, operating and outsourcing options for activities across the EV business strategies can currently be made?
- What pricing models are suitable for the various business strategies at hand in the EV charging infrastructure landscape?
The Ernst & Young role
The Advanced Powertrain Initiative

Between volatile oil prices and global warming concerns, new vehicle technologies are emerging to address transportation needs of the next century. Ernst & Young’s Global Automotive Center has created a dedicated team focused on this evolution, which will create tremendous opportunities for the entire automotive industry.

Working closely with Ernst & Young’s Global Power & Utilities Center and Cleantech Group, the Advanced Powertrain Initiative is dedicated to assisting new entrants and well-established players as they bring such next-generation power systems as electrical powertrains to market.

As a trusted advisor to companies for generations, we know that technological revolution only looks inevitable afterward. Sometimes, change can be tantalizingly close only to fail because of structural problems within the industry. This is certainly true for EVs.

Our aim, both in this report and in our research program, is to help companies make the most productive choices they can as this sector develops.

Helping you profit from the new world of EVs

In recent months, Ernst & Young’s advanced powertrain team has offered advice to a variety of players concerned with the development of EVs, including:

- Cities looking for a sustainable EV infrastructure strategy
- Policy-makers designing EV industry support mechanisms to jump-start the market
- Utilities looking for new revenue streams and greater client engagement
- Companies that need business valuations for EV-related assets
- Fleet managers evaluating new powertrain architecture
- Finance executives assessing the tax and finance implications of leasing EVs
- Manufacturers looking for government incentives for R&D and other projects
- Entrepreneurs trying to craft a winning business model
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