Towards Winning Business Models for the EV-Charging Industry
Who plays this game, what are the rules and why IT is one of the most important competences in this industry
Executive summary

When looking at the recent developments of the Electric Vehicle (EV), we see that it is creating momentum and both supply and demand of such vehicles is rising rapidly. As electric vehicles like their fossil fuel siblings need to refuel, a service industry will inevitably emerge to serve recharging needs of consumers. Like a new board game, this new industry will have new players, a new set of rules and a new playing field.

The EV charging value chain will make use of the existing value chain for electricity production & distribution as a basis and will require two new consecutive value chain elements: the infrastructure owner and the charging station operator. Together these players will form a new value chain, which is highly modular and does not convey a tangible product. This will allow consumers to instantly configure how they would like their vehicle to be recharged; which energy source to use, which producer, which distributor, etc.

The rules which govern this industry are largely dictated by technical, economic and legislative parameters. There are four rules which influence how players can position themselves within the industry: (1) a driver needs to charge approximately every 150 kilometers, (2) charging can be made possible almost anywhere by almost anyone, (3) the costs of refueling have dropped to approximately 3 Euros for a full battery and (4) the faster the charger, the more expensive it is. This set of rules will allow a wide variety of new business models to emerge and the horizon of the playing field will extend far beyond roadside service stations.

We expect to see commercial charging stations at local restaurants, shopping malls, cafés, the workplace and at city center parking lots.

The creation of value chains will be facilitated by IT, generating value for all stakeholders. It is the linking pin in all new emerging business models. As such, we believe that IT will be one of the crucial competences required to compete and survive in the electric vehicle recharging industry.

Keywords— Electric Vehicle, Charging Industry, Playing Field, Industry Structure, Rules of the Game

The e-mobility industry is taking off

As we speak, Nissan, Mitsubishi, Peugeot and Citroën are delivering their first batches of mass-produced Electric Vehicles (EVs) to selected markets. These vehicles, such as the iMiev and the Leaf, are considered reasonable alternatives to a normal fossil fuel powered passenger car and it is predicted that sales figures for these vehicles will approach a quarter of a million units sold by 2012 [1]. This promises to create momentum; more and more fleet owners as well as consumers are showing interest and the growth of this industry seems inevitable. As with their fossil fuel counterparts, EVs will need to refuel once in a while, giving rise to a commercial charging industry complementary to the existing gas station.

This article describes our vision on the inevitable emergence of an EV-charging industry, the players which will emerge within this industry, the rules which will shape the landscape and the key role of IT competence in the performance, competition and survival of businesses active in this ‘new game in town’.

Although both the EV charging industry and the fossil fuel refueling industry serve the same basic purpose of refueling vehicles, their value chains, technical constraints and economics are different. Therefore, it seems appropriate to investigate industries with similar characteristics to the EV charging industry in order to look for clues as to how it will emerge and be structured in the coming decades.

Business emerging on the new playing field

We expect that the electric vehicle charging industry will structure itself through the addition of two chain elements to the existing electricity production and distribution value chain (see Figure 1). Within this new industry we can identify five groups of players, of which three can be considered new to the fueling industry.

This outlook is based on parallels drawn with other industries, where the relevant rules of the game are similar to the EV charging industry. In the following section we will elaborate on the expected industry structure as well as each of the three new businesses, which are expected to emerge.

The EV Charging Value Chain

Similar to the existing electricity production value chain, this value chain does not convey a tangible product. Without a tangible product it is possible to deliver mass customization without additional cost. For the EV user this implies that he can instantly configure his products according to his needs and preferences; which energy source, who to produce it,
who to distribute it, etc. This characteristic of a value chain can be referred to as multi-dimensional. Additionally, this value chain can be considered highly modular because value chain elements can be easily added or removed.

We expect that the EV charging industry will offer its consumers these options, because consumers prefer freedom of choice and will often opt for solutions tailored to their own wishes and needs. To better understand consumer choice and its relation to modular value chains with multiple dimensions, we will look at the Fast Moving Consumer Goods (FMCG) industry.

About two decades ago, choice was fairly limited and the average village store offered as many options as Henry Ford did to customers of his Model T, as he so eloquently put: “Any customer can have a car painted any color that he wants so long as it is black.”

Some twenty years ago, the introduction of the Internet, state of the art logistics, IT, and improved infrastructure, enabled freedom of choice and a value chain offering multiple dimensions to its consumers was born. Value chain elements in the FMCG industry could easily be linked to create a wide variety of propositions, which allowed mass customization and diversification. This meant that offerings could now be tailored to a consumer’s needs, e.g. buying the product online if one does not have the time to go shopping or go for personalized service at a niche boutique. Industry growth was achieved as consumers found more of their needs served.

The existing electricity value chain already offers multiple dimensions to its consumers: choice of resources, utility provider and so on. Additionally, we will show that the rules of the game will lower the barriers for a specialized and diversified consumer front end. With an existing highly modular value chain to latch on to and a set of rules enabling more dimensions in the value chain, it is hard to imagine that businesses will pursue a “one size fits all” approach [2].

The operator of the charging station

In the previous paragraph we concluded that at the consumer front-end end-users will be presented with a more diversified product offering, spread across a wide variety of charge station operators. Additionally, we will see that the rules of the game require vehicle drivers to charge their EVs more often than they are accustomed to. Ideally, they do this when convenient. As with the retail industry, it is therefore expected to see the emergence of small niche market charge station operators as well as parties offering large mass-market solutions. Vehicle drivers will decide where to charge based on their needs and travel patterns.

The charge station operator will decide what business model to adopt and whether or not he will own the charge station himself or will lease this via a third party. Often this decision is based on whether or not this activity is part of core business. Most businesses employ a simple rule, investing as little as possible in off-core activities and leasing any equipment required for these activities. For example, IKEA could be an operator but more is likely to lease the equipment, as this is not a core activity.

The infrastructure owner

We expect to see a variety of ownership and lease constructions throughout the EV charging industry. In this section the two most generic ownership constructions are illustrated: an infrastructure company and a financial lease construction. Of course variations on these two are possible.

The infrastructure company can be seen as comparable to a telecommunication business. The company installs infrastructure and allows customers access for a contracted monthly fee, increased by a variable amount based on use.

The two most important elements that the EV charging industry and telecommunications have in common are that both businesses require relatively large investments in equipment and that the variable costs are considerably low. With low variable costs, every additional user increases profitability (and ROI) by almost the same number as it increases revenues. Telecommunication companies maximize the number of contracted network users by employing a wide variety of propositions. This was made possible by adopting a modular value chain similar to the FMCG industry.

We therefore envision EV charging corporations to emerge, offering users access to their chargers for a monthly fee.

In addition to the large infrastructure owners we acknowledged the need for financial lease constructions. These will allow any business or organization to employ a charging station for a monthly fee. This model is expected to be similar to the well-known equipment leasing structures in, for example, logistics. The intermediary turns a capital expenditure into an operating expenditure. Although maybe simple, for many organizations, the availability of this option will open up opportunities.

The charging station supplier

This could be a company like ABB. A business, which sells, installs and maintains the charging equipment which is required to start a commercial charging business. The charging station supplier supports the primary EV charging value chain and is not part of the value chain itself.
### Exhibit 1 – Invest in charging infrastructure and offer customers usage contracts

**Concept**
Start an entity providing charging services and install 200 unmanned charging stations throughout the Netherlands. Offer users the ability to use the system for a monthly flat fee using an RFID card to gain access to the system. The locations should be strategically chosen, preferably sponsored by a restaurant or shopping mall.

**Cost side**
The total investment will be approx. € 10 mln and is depreciated over a 10 year period. Capital is borrowed against a 10% interest rate, which for infrastructure purposes can be considered rather steep. Yearly running costs such as administration and maintenance are estimated to add up to around € 0.5 mln. The maximum capacity of the installed system is around 10 million charges a year. If one works with an estimated 30% utilization, a single charge would cost around € 0.80 (excl. electricity). The electricity costs are estimated to be around three euro (20kWh per charge @ € 0.15), which totals up to a yearly 9 million euro. The total yearly costs will then add up to 11.5 million euro.

**Revenue side**
Let’s sell our product the way the telecom operators do. We will offer three contract options:

<table>
<thead>
<tr>
<th>Contract</th>
<th>Monthly costs</th>
<th>Package</th>
<th>Additional charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium</td>
<td>€ 100,-</td>
<td>Unlimited usage</td>
<td>(fair use policy)</td>
</tr>
<tr>
<td>Flexible</td>
<td>€ 60,-</td>
<td>Three charges a week</td>
<td>€ 5 per charge outside of contract</td>
</tr>
<tr>
<td>Pay for use</td>
<td>€ 10,-</td>
<td>Single yearly registry payment</td>
<td>€ 10 / charge</td>
</tr>
</tbody>
</table>

Let’s assume our customer group consists of 30% premium users and half of our users go for a flexible account. If one assumes that this company is able to attract around 25 thousand customers (an estimated 20% market share in 2015, The Netherlands). Contract revenues alone would add up to around € 18 mln. The revenues from out of contract charges could easily add another million.

**Bottom line**
The “back of the envelope calculation” shows that after an initial start-up phase this business case seems to offer an interesting earnings model, since it delivers a yearly € 6.5 mln EBT [45 % margin].

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**In conclusion,** the level of complexity of the EV charging industry will be much higher than people are used to from the current fossil fuel refueling industry. Fuzzy value chains will emerge and create value by offering tailored propositions specific to customer needs.

### Rules shaping the charging industry of tomorrow

Now that we know who the players are and what the playing field looks like, it is time to introduce the rules of the game. These rules originate from the technical parameters (or limitations if you like), economical incentive systems and legislation.

#### The ability and need to recharge anywhere at any time

A typical EV currently has a range of approximately 150 km, although increase is expected. This requires a driver to recharge an EV quite often, which he ideally would do whenever convenient. On the other hand, the density of the electricity grid ensures that a driver will always have a power source at his or her disposal [3]. As we will see later on in this chapter, the electric vehicle can make use of standard household connections as well as dedicated charge stations, both connected to the electricity grid. As such, drivers can recharge their vehicle practically anywhere.

In the future we envision that people will plug-in their car when parking. For example, when arriving at home they will plug-in using the on-board slow charger and wake-up the next morning with a fully charged battery. For those locations where most of us will not stay for long, dedicated commercial Fast Charging stations will arise. The grid connection required for a typical 50 kW Fast Charging station is widely available (e.g. a typical office building has a more powerful grid connection). These stations will allow you to plug-in and leave minutes later with a full charge. Ideal locations may include restaurants, shopping centers and your place of work.

A single charge costs as little as three euros

Unprecedented since the very emergence of cars as a form of transportation is the price of refueling. The cost of electricity as well as the capacity of energy to be taken aboard is much lower than for a fossil fuel consuming car. Although this forms a clear ‘game-changing’ element, this element will go unnoticed by many who will see this as purely an improvement of their operating expenditures.

Entrepreneurs will notice that the costs of topping-up a battery (typically 20 kWh @ € 0.15 /kWh) reaches the threshold of equaling the price of a cup of coffee at Starbucks. This trait has the potential to change the way we think about refueling our vehicle and will offer a wide range of companies a new way of attracting customers. Think about offering customers a free charge when visiting your store similar to parking validation, an offer that your customers will consider as an expensive gift. Don’t forget, two generations or more have been imprinted with costs in the order of what is fifty euro’s today. Therefore it is expected that many new business models will arise using this trait to their advantage.

One can install a commercial charging station for as little as thirty to sixty thousand euros (August 2011).
Exhibit 2 – Increase retail sales through offering free charging

Concept Let’s assume for now we are in food retail and would like to attract EV owners to our store. We currently have 300 medium sized stores with total gross revenues of 3 billion euro, operating at 4% profitability and an estimated market share of 20%. At each store we will install a single charging station.

Cost side The equipment is leased through a financial leasing construction with a company offering a charging station for € 500.- per month. If we assume that a car will, on average, reach the store with a 40% depth of discharge and a total capacity of 25kWh, a single charge will on average cost around € 1.50.

Revenue side Let’s assume that this additional service attracts 30 thousand new customers on a weekly basis to do their weekend grocery shopping (an estimated 1% new customers equaling 20% of the estimated number of EV users in the region). Weekend groceries can easily add up to a mere € 70, which translates into an extra gross yearly revenue of € 125 mln.

Bottom line The total yearly costs of offering a full charge to these customers adds up to € 4.1 mln, while the additional created nett revenues add up to € 4.3 mln. Without any capital expenditure the retailer creates an extra quarter of a million in EBT.

As mentioned earlier, EVs need to recharge more often than we are currently accustomed to and therefore drivers will prefer to recharge when convenient. Technically we found that the dense electricity grid makes it possible to create a charging station at almost any location. Commercially, this becomes feasible due to the low costs of a fast charging station. At about thirty to sixty thousand euros (August 2011), a commercial fast charging station can be considered significantly less expensive than a conventional filling station. As this can easily cost a million Euro to build (think about fuel tanks and piping which needs to be installed underground).

Time is money
The faster one wants to charge his or her EV, the more expensive the charging equipment gets. In this paragraph we will discuss the various charging options available and how these options complement each other.

Today’s technology offers two methods of charging an electric vehicle: either using an on-board charger also called AC (or slow charging) or using an off-board ‘DC’ charger (fast charging).

The on-board charger must be relatively cheap, lightweight and small in order to easily fit into an electric vehicle without incurring extensive costs. This charger typically takes around 8 hours to recharge the vehicle and can be connected to any standard household outlet.

The off-board or fast charger is much more expensive and equals the size and mass of a FIAT 500. This means that the fast charger will not be integrated on-board and will thus exist as a separate (and fixed) station and therefore allow it to be shared with others. It is able to produce much more power and can currently charge the vehicle in around 15-30 minutes.

We envision that these two methods of charging can be employed as follows: For reasons of convenience it is expected that drivers will most often opt for fast charging if one is granted access to such a facility. If this option is unavailable, drivers will use AC slow charging when they know that they will leave their car connected for at least 6 hours. For all other events where they will stay for a shorter period, drivers will decide on whether or not they will take the effort of connecting the vehicle (as this will only add a 10-15% state of charge per hour).

In daily practice, this means that drivers will generally use the slow charge option at night when they have their car parked at home. During the daytime they will recharge their car at locations they visit along their way, using commercial fast
charging systems. Only at locations where people pay longer visits, slow charging stations will be used.

The legislative barriers to initiate a charging business are minimal.

There is a wide range of locations where one is allowed to place a fast charging station. Chargers can easily be placed at or close to commercial areas such as shopping malls, restaurants, cinemas, and concert halls or inside parking garages. To install a fast charging station you will need to install equipment approved by the local authorities and you have to take care of the applicable regular construction permits. Compared to the construction of a new gas station, the number of legislative restrictions remains minimal. When combined with the relatively low amount of capital investment needed, the barrier to entry to the EV charging industry is relatively low. This will open the refueling domain to the small/medium sized companies segment, as envisioned by the outlook of a multi-dimensional value chain. “You don’t have to be Shell or BP anymore to start your own service station or offer your customers the convenience to refuel when shopping”.

**IT is a key competence in this industry**

Instead of listing and describing every possible competence a player in this industry might need or might consider crucial to develop, we would like to share our vision on one key competence, which will be important to any player active in this industry. We expect that without the proper IT solutions to connect your business within the EV charging value chain, it will be difficult or practically impossible to generate value.

We will start by discussing why IT is needed to connect your business within the value chain. Secondly a vision on the competence level of IT is developed for each of three phases of industry development: the introduction phase, the growth phase and the maturity phase.

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**Table 1: Slow versus fast charging**

<table>
<thead>
<tr>
<th></th>
<th>Slow Charging only</th>
<th>Commercial or Fast Charging combined</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration</strong></td>
<td>Typically 8 hours</td>
<td>Typically 20 minutes</td>
</tr>
<tr>
<td><strong>When to choose</strong></td>
<td>Long stay:</td>
<td>Short stay:</td>
</tr>
<tr>
<td></td>
<td>- Night time charging</td>
<td>- For events like client visits for work, shopping, going to the gym, football training, visiting a concert, etc.</td>
</tr>
<tr>
<td></td>
<td>- When parked for 8 hours or more (at work, during studies or at school)</td>
<td>- Emergency charging for range extension</td>
</tr>
<tr>
<td></td>
<td>- Emergency charging in case of no other options</td>
<td></td>
</tr>
<tr>
<td><strong>Standard connection</strong></td>
<td>AC:</td>
<td>DC:</td>
</tr>
<tr>
<td></td>
<td>- Basic household plug</td>
<td>- CHAdeMO (600V 125A)</td>
</tr>
<tr>
<td></td>
<td>- CE (230V single phase or 400V three phase)</td>
<td>- Combo coupler (600V 200A)</td>
</tr>
<tr>
<td></td>
<td>- Mennekes (400V three phase)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- SAE J1772AC (120V/240V single phase)</td>
<td></td>
</tr>
<tr>
<td><strong>Charger</strong></td>
<td>Small</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td>- Placed on-board of the car</td>
<td>- Placed off-board</td>
</tr>
<tr>
<td></td>
<td>- Cheap (+€500-1500)</td>
<td>- Expensive but shared with others</td>
</tr>
<tr>
<td></td>
<td>- Light (+10kg)</td>
<td>- Heavy (&gt;400kg)</td>
</tr>
<tr>
<td><strong>Price of charging station</strong></td>
<td>Low; ranging from virtually zero for a household installation without security and payment terminal to €5k for location with all that</td>
<td>High; ranging from €30k to €60k (including typical installation costs)</td>
</tr>
</tbody>
</table>

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IT creates the value chains within the EV charging industry.

When discussing the businesses operating within the playing field, we learned two things: (1) end consumers can be offered the opportunity to instantly configure how they like their vehicle to be recharged (multi-dimensional) and (2) building blocks can be easily added or removed from the value chain (modularity). This is only possible if the IT systems of players within the value chain enable this.

In the following sections we will present an anecdote about Cisco systems to illustrate how important this connectivity might be and we will further detail the IT demands of each of the stakeholder groups in the value chain.

In 1984 Cisco systems was founded by a married couple working as computer operations staff members at Stanford University. Although Cisco was surely not the first entrant to the market of routers, it was able to grow tremendously, leaving many competitors in its wake. So how was it able to do this, what did Cisco do differently?
Cisco saw that it was not the router itself, which would make them successful: it was the communication platform that came with it. Companies needed to be able to use the product right off the shelf and let it connect their businesses to others, without having to worry about things such as different communication protocols.

At that time this feature had a tremendous impact. For example, enabling a supply chain, which encompassed three companies each employing a different communication protocol, was very difficult with a generic router product.

What can we learn from this anecdote? Chargers will be the devices creating value chains for companies building a business in the commercial EV charging industry, similar to how the Cisco communication platform shaped the router industry. If the charging infrastructure your business owns or leases is unable to connect to others in the value chain, its utterly useless or will require a large one-off IT investment. The Cisco example demonstrates that growth and value creation in these industries is fueled by connectivity within the value chain.

It is of course expected that the IT requirements will differ between businesses, but in more general terms we will make a distinction between stakeholders upstream in the value chain and stakeholders downstream the value chain.

Upstream stakeholders are in the business of generating and distributing electricity. Their main concern is the stability of the electricity grid (demand-response management), and therefore need to control the supply and demand of electricity. There are two methods to do this: implementing a peak price and/or throtting the charger output. Access to these control mechanisms is vital to these stakeholders.

Without these controls they cannot manage costs, revenues and their supply chain. To allow for this level of control, the IT platform of the charge station needs to possess an (open) interface for these features. Only this will allow the upstream companies to build or acquire the required software applications to give them the needed level of control.

Players downstream in the value chain are in the business of operating a charge station. In very simplified terms they have two things to manage: (1) their margin (2) the utilization of their station.

To control margins the station operator wants to be able to throttle output or adjust sales prices accordingly to his purchasing price of electricity.

To manage the utilization of the charge station, an operator needs: features to serve customers (control over POS terminal, start charging, stop charging etc.) and features to acquire and retain customers (charger information available to navigation systems, customization of offering).

The charge station supplier will need to offer an interface that allows operators to latch onto, which allows station operators to build or acquire their own software applications and have control over their competitive advantage.

In conclusion the quality and number of features offered by the interface will, similar to Cisco example, impact the successfulness of the charge station supplier and will drive the competitiveness of charge station operators.

What level of IT competence is required within each phase of market development

For each of the three industry maturity phases, different competencies are of varying importance to the industry as a whole and to the different players. We will use the framework from figure 6, to sketch the scenarios we envision for the competence level of IT within the EV charging industry.
During the introduction phase (1), it is expected that IT plays a minor role in the successfulness of companies active in this industry. We expect IT to be seen as an enabler, a necessity to operate the charge station. The platforms and applications of all parties will need to do the minimum to compete, which is creating value chains. This is relatively simple because the number of dimensions to be handled will remain limited in this phase. We expect therefore the very basics such as: integration of point of sale, billing applications and navigation aids.

When the industry is moving towards the growth or scale phase (2), the adoption of EVs rises and the effects of e-mobility will become noticeable. To compete effectively within this phase, players will need to manage these effects, for example, the increased load on the electricity grid. In this phase IT can provide a competitive advantage with applications and platform interfaces aimed at: electricity grid control, maintenance and remote diagnostics of charging equipment and the visibility of charger status to users.

Once the charging industry matures (3), businesses will need to increase their efforts to grow further and maintain or improve profitability. We therefore envision the majority of applications aimed at cost control and revenue improvements will emerge and gain a foothold during this phase of market development. One can think of examples such as the modeling of battery life via charge process parameters (control costs) and consumer oriented applications for cross selling (grow revenues). Although the aim of the applications is clear, they remain difficult to imagine and clarify based on well laid out arguments.

What should I do next?
Many industry experts agree that the coming decade will be the period in which electric transportation initiated its growth curve [3]. The signs in the industry are clear. Last year alone, the worldwide investment in industrial Li-ion battery production facilities was in the order of tens of billions USD. Nissan is building a production facility in the UK for fifty thousand EVs, solely aimed at the European market. These investments prove this momentum and create a lock-in to make it happen.

Under the motto “You’ve got to know the rules if you’re going to play the game”, this article was written to serve as food for thought for three groups of readers: entrepreneurs eager for new profit pools, investors looking for opportunities in the EV charging industry and readers active in adjacent industries wishing to expand their core business. We hope that for these groups of people this article offers some insights into this new industry and some initial ideas with which to start: building that new business, running a successful due diligence or realizing spins-off from your current core business.

Exhibit 4 – How does IT enable the creation of value chains?
Let’s assume for now that I am an EV driver visiting a Starbucks store. At their parking they offer free usage of their fast charging station, the only thing I have to pay is the amount of electricity that I use. Shell has for example supplied these charging stations to Starbucks and is sourcing the electricity at RWE. Consumers are still offered to choose which type of electricity they would like to acquire. I choose to use conventionally generated electricity and start to charge my car.

The IT systems will first of all need to identify and authorize me (e.g. RFID, maybe through a roaming contract). The charge station needs to configure my product according to preconfigured settings together with my choices. It will need to report sales quantities for these product elements to each of the utilized value chain entities. To manage the electricity grid, the IT systems will need to enable power throttling to the utility provider to manage grid peaks and to the charge station operator to manage its utility contract.
References

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ABB EV Charging Infrastructure
This product group has expanded rapidly over the last year through both organic growth and the acquisition of Epyon, a 6 year old high tech spin off from Delft University of Technology. The product group currently employs around 80 people.

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