# CHARGING ELECTIC VEHICLES IN A LIBERALIZED ELECTRICITY MARKET

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## *ABSTRACT*

*The paper will show a proposed market model for a public EV charging infrastructure to be embedded in the Dutch liberalized electricity market. This model is being developed together with the major stakeholders in the market, e.g. energy suppliers, grid operators, the ministry of economic affairs, municipalities and mobility service providers.*

## INTRODUCTION

Assuming a liberalized electricity market as it is, the owner of an electric vehicle should be able to charge anywhere where he/she wants and simultaneously being able to buy electricity of the supplier of his/her choice on a contract basis. As a consequence, the car owner must be able to pay his/her preferred supplier at every charging location. To realize this, the current electricity market has to adept since it does not recognize mobile customers, i.e. currently every electricity customer is linked to a home or building.

## CURRENT MARKET MODEL

To understand were the expected misfit arises this chapter will give a brief overview of how the Dutch electricity market for consumers is organized. An outline of this model is shown in: Fig 1

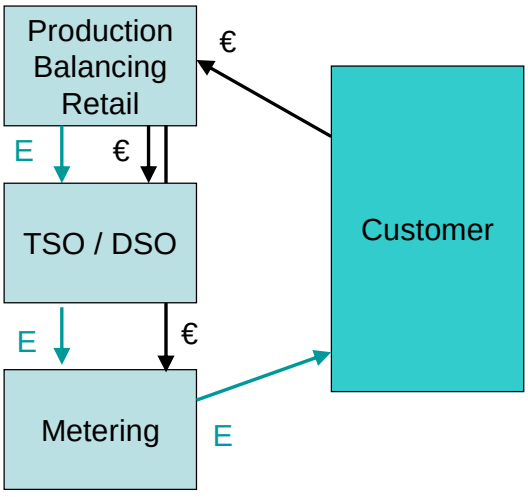


**Fig 1: Outline current market model**

In the Netherlands every role is deregulated except grid operation (TSO and DSO). The typical flow in the market model follows the next path.

A customer buys electricity from it's retailer of choice on a contract basis. The retailer on his part has an agreement for the amount of energy needed with a electricity production company. Sometimes the retail company and the production company belong to the same holding. The agreements exits of long term items, but also day-ahead programs for the electricity demand of the retailer's customer base.

On the other hand the production company plans day-ahead programs for their retailers demand. This is balancing, between demand and production. To maintain stability in the system the TSO guards the actual values throughout the day vs. the predictions in the provided programs.

The produced electricity is provided to the grid and via TSO and DSO it reaches the customer via the electricity meter that is installed on the connection point in the home.

In this model customers only have a direct financial relationship with the retailer. On a physical level only with the DSO. The other roles act 'out of sight' of the consumer.

It is important to know that at the connection with the grid a customer may change his contract with a retailer only once per day. The program responsible party is often paired with a retailer and can also be changed once per day.

It is in this restriction where the first challenge arises. Not only is it likely that at a public charge spot multiple customers will charge their electric vehicles, in a liberalized market they probably will have contracts with different 'retailers'.

OTHER MARKETS

The situation where multiple consumers on a day use public accessible infrastructures; or its end-points; is not be unique. There are other markets and specific cases that carry best practices usable for a public charging infrastructure [1]. Two examples are:

1. Using your mobile phone on a visiting operators network. E.g. in foreign countries.
2. ATM Cash withdraw at an ATM of another bank than ones home bank.

What can be learned from these markets; that both have the ability of serving various customers per day at a end-point and clearing and settling their usage; are the following points:

- Customers have a single point-of-contact for the delivered services;
- Market participants mutually offset their costs through a centralized system for clearing and settlement;
- Market participants make use of each others infrastructure when delivering services to the customers;
- Bilateral agreements between parties also exist; this is mostly the case in markets with small number of parties;
- Messages for clearing and settlement are standardized.

These findings were taken into account when a market model for a public EV-charging infrastructure was developed.

## PROPOSED MODEL

The proposed model will be gradually introduced following the number of EVs and public charge spots. At first infrastructures will be platform based; back-office systems of each company with charge spots or ID-cards will be linked to provide 'roaming' throughout the Netherlands. By 2012 a network based model, with underlying scheme should be ready to deploy on top of the existing electricity market. This model will leave the traditional electricity market as is. An outline of the defined roles is depicted in Fig 2.

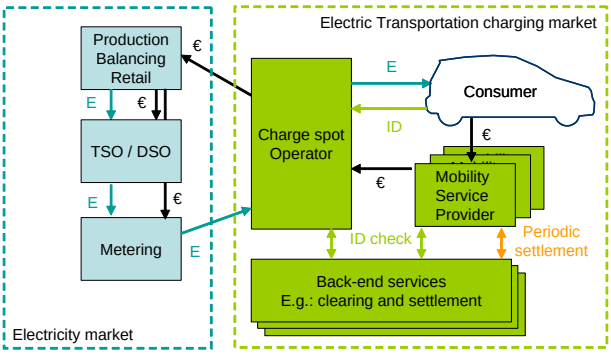


**Fig 2: proposed market model**

The fundametal basis is formed by separation of the infrastructure (charge spot operator) and service provider (mobility service provider). They are facilitated by separated back-end services, e.g. clearing and settlement of the consumed service.

These roles will be added on top of the current 'traditional' electricity market, marked blue in Fig 2. This will be sufficient when only ID-ing of customers and basic payments should be made for the charge sessions. More complex service will be treated in the chapter Smart Grid Integration.

### Charge spot Operator

The Charge spot Operator is a party which maintains the actual charge spot and holds the connection to the grid. And therefore the connection with the old market roles. In most cases the Operator will have a contract with the local municipality. It will also have contracts with the service providers that are enabled on its charge spots. The operator charges the service provider for the used services of their respective customers at a charge spot. In this structure lies a potential thread: local monopolies for operators. Typically at a parking space only one operator will be available. Most likely this will be the case for a designated area or even a whole city. Such monopolies can become subject to regulation in the future to prevent abuse of this unique presence in an area.

### Mobility Service Provider

The Mobility Service Provider holds the contract with the end customers. They can offer various services, which will be around (dis)charging electric vehicles. The most basic case would be providing kWh's, but also kW's and time-to-charge may become parameters of contracts. Further in time the Mobility Service Provider could aggregate its customer base on the back-end in order to act on the imbalance market as 'one' resource in the grid.

At this time it is still pending if these Mobility Service Providers should be subject to same rules as energy retailers.

## SMART GRID INTEGRATION

The proposed market model will be capable of coping with charging EVs in a basic way. However while the transition towards a higher number of EVs continues and the developments on Demand Side Management will continue a new integrated model for the electricity market and an EV charging infrastructure should be discussed towards the end of the 2010's. This model will add roles to the existing electricity market; e.g. aggregators or local balancing agents.

The development in Smart Grids and in particular smart charging EVs will most likely lead to more interaction between the actors in the energy supply chain. [2] In a liberalized market, additional energy can be traded on different platforms such as markets for energy, (grid)capacity, or ancillary services such as smart charging.

Along with these additional activities, new opportunities and challenges (risks) are introduced into system operation. The opportunities apply to those who will use the additional functionalities and processes (such as retailers, consumers and/or renewable and conventional generators).

The challenges in the grids need to be managed accordingly by the grid operators, with the support and commitment of other participants. These challenges will lead to changes in the regulatory framework and accompanying legislation.

## INTEGRATION OF RENEWABLES

Large scale intermittent generation from renewable sources will be connected to the transmission and distribution grids in the future. The three key challenges for the DSOs are: connecting additional generation (DER and RES), enabling active demand/customer side participation in the market and keeping the distribution grid stable and balanced. In distribution grids the DSO role will gradually shift from distributing power on a top-down basis, to a role in which maintaining voltage quality and balance is central while electricity flows in both directions.

It lies on the virtue that the DSO in the future will be interacting more frequently than today with TSOs, consumers and electricity producers. It even may lead to a more active role based on market principles like flexible grid tariffs and new service level agreements.

In this case the DSOs may start performing tasks which now belong to the TSOs on a national level. A rearrangement of roles and responsibilities is inevitable.

## CONCLUSIONS

The introduction of electric vehicles leads to both challenges and opportunities. While the number of electric vehicles will increase adaptation of the market model will be needed ; including regulation and legislation.

This adaptation will be done in steps instead of mayor changes at once.

## REFERENCES

[1] Netbeheer Nederland/EnergieNed, 2010, *"Study Market Model Charging Infrastructure for Electric Transportation "*

[2] EU Commission Task Force for Smart Grids, 2010, *"Expert Group 3: Roles and Responsibilities of Actors involved in the Smart Grids Deployment"* EG3 Final Deliverable.