

The Charging market - Complex and dysfunctional or future-oriented? How does it actually function?

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The BEV (battery electric vehicle) market and the surrounding ecosystem have had a formidable growth in the last decade, but the market for BEV charging (excluding home charging) is characterized by low profitability and far too many poor user experiences. In this report, we review the literature on which business models in the value chain related to electric car charging seem promising from both a business perspective and a societal perspective. We then review the business models of the most important players in the Norwegian ecosystem for electric car charging and assess them on the basis of profitability potential, scaling potential and contribution to an expanded network for end users. We also look at how the total charging system is connected together in an intricate network. Finally, we construct future scenarios for this ecosystem and discuss the implications of them.

Background

This report is a deliverable from the project Spot-On - User-Centric Charging Services for Electric Vehicles funded by the Research Council of Norway. The report deals with research carried out in work package 2 - Current Business models in the ecosystem. The report reviews research and literature (R&D literature) on potential business models within the value chain for BEV (battery electric vehicle) charging, how the business models can be segmented, and indicators for how the success potential of such business models can be assessed. Furthermore, we look at the main business models in the current Norwegian ecosystem and how the charging market in Norway in practice works as a system.

The BEV market and the surrounding ecosystem have grown formidably in the last decade, but the BEV share of the car fleet must grow sharply for a long time to come if climate goals are to be achieved without dramatic mobility reductions. An important part of the ecosystem around the electric car market is the charging market, which must be scaled up as the electric car fleet grows. For this market to be financially sustainable in the long term, there is a need for companies that generate value for the end customer, and enough value to secure a sufficient return on the huge investments made in charging infrastructure (both hardware and software). To achieve this, there is a need for suitable business models.

The ways in which the viability of public charging infrastructure depends on the business model have been widely discussed in public, but there exists little research on it in the scientific literature, according to Zhang et al. (2018). Greene et al. (2020) point out that the way the charging market looks now, there is uncertainty about what actually are suitable business models for public charging stations, partly because utilization rates still are generally low and the roles of the public and private sector are not well defined. This conclusion is also supported by de Rubens et al. (2020). van der Kam et al. (2020) also point to the difficulty of finding profitable business models as one of the biggest challenges for the roll-out of public charging infrastructure.

Segmentation of the ecosystem

The 8 value chain steps shown in Figure S.1 can be used to present the overall picture of the value chain of the electric car charging ecosystem. The demand side, here defined as end user, is not included in the first 7 steps. We have considered it appropriate with an extended figure where the end user is included. Not only because serving the end user is the overarching purpose of the entire value chain, but also because end users are increasingly involved in producing services. They can sell charging to others by opening their charging point for payment, or even open for e-roaming. In addition, they can make their electric car available for energy management (load-shifting or V2X), and they can participate in P2P electric car sharing through services such as Getaround. In addition are authorities (state, municipalities, counties, ENOVA, etc.) such important players in the ecosystem that they should be included in the picture, together with the large key member organizations.

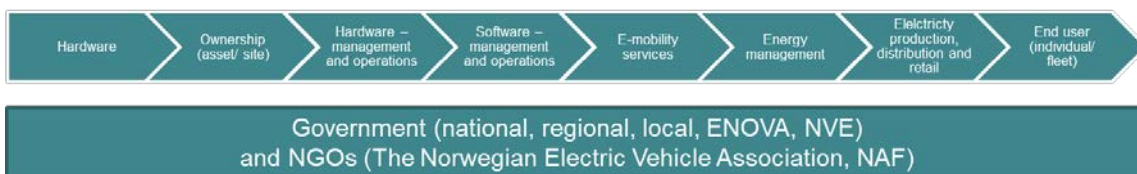


Figure S.1: Illustration of the value chain for electric car charging for use in WP2 in the Spot-On project

The 7 first steps of the value chain can be broken down into finer segments by creating a 7x4 matrix where the four key categories for electric car charging are added:

- Home charging
- Charging at workplaces
- Charging at the travel destination (shopping centers, hotels, etc.)
- Publicly available charging (which includes fast charging and super-fast charging en-route)

Many players, numerous apps and payment systems

A review of all the major market players in Norway shows that the picture of how the charging system works, and how the players interact (transactions, other types of co-operation), is quite complex, as shown in Figure S.2. The players consists, among others, of Charge Point Operators (CPOs), Electromobility Service Providers (EMSPs) connecting charger users to CPOs, land and facility owners (including municipalities), OEMs and



Importers, Mobility as a Service (MaaS) fleets, map services, energy sector actors, suppliers of charging system to housing communities and shared parking facilities, Peer to Peer charging platforms and hardware and software platforms. In addition, there are regulators and public sector agencies that influence the framework conditions, and businesses that provide other charging-related services (e.g., electricians, payment solution providers and other supporting services). All players follow their business models, which individually may make sense based on the player's role in the value chain, but the overall charging market becomes dysfunctional when 20-30 apps are needed to access all charging options and 13 different payment solutions are in use, none of which is the traditional bank card terminal.

Especially the different strategies related to e-roaming increase the complexity. Some major players do not want to offer e-roaming. This means that EMSPs can only offer users access to parts of the total charging infrastructure, and that some players try to remedy the situation by issuing RFID cards that can be used for identification on the chargers, given that users store the card information together with payment card information in each actors system. Users thus see a very fragmented and complicated charging market where they have to use many different actors' solutions to get full access to chargers everywhere.

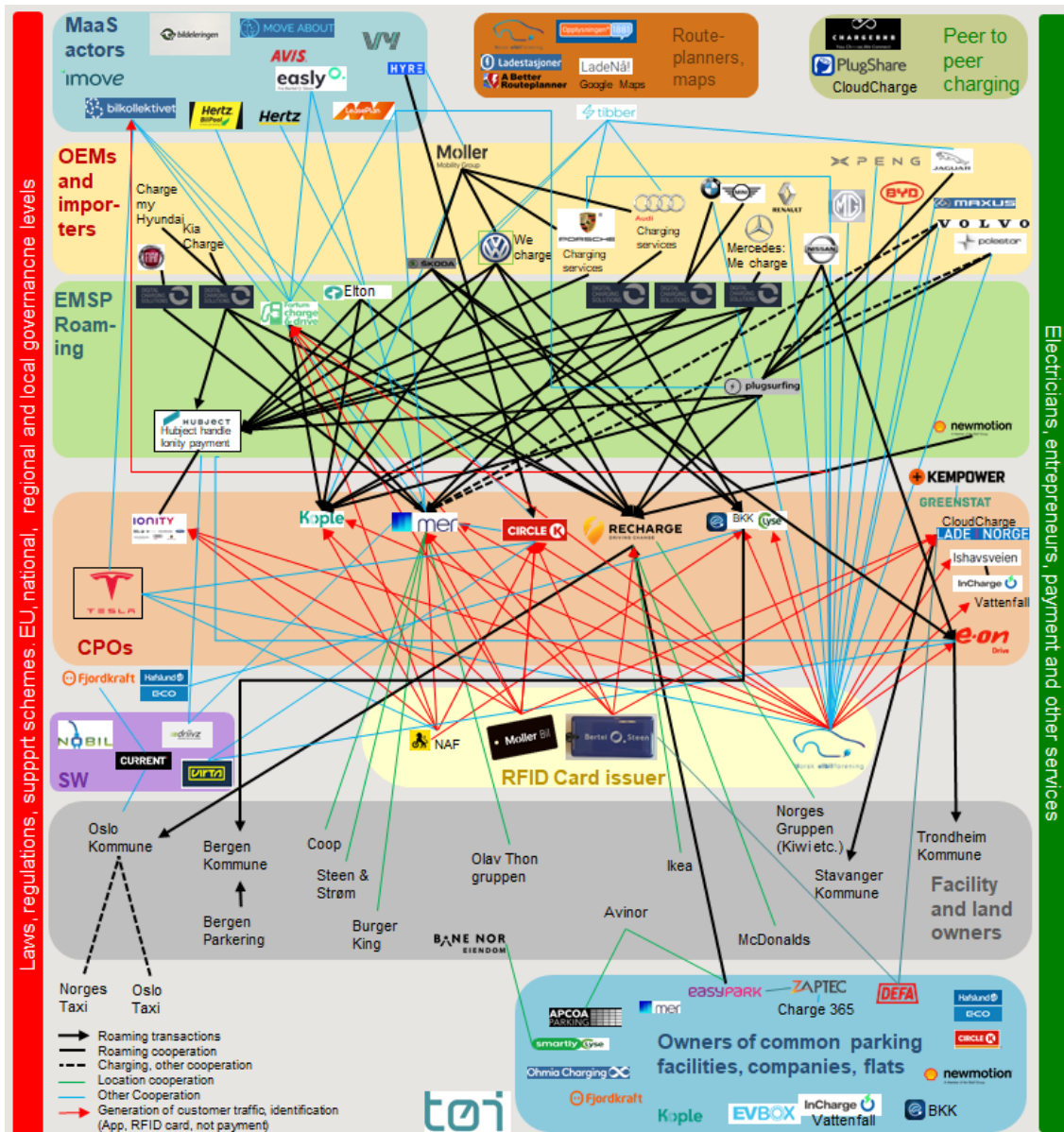


Figure S.2: Charging infrastructure ecosystem, players and interactions.

Some business models seems more promising than others

Several reports and research articles review specific business models that are considered promising. These promising business models can be located at different steps in the value chain, for different market segments and / or extend over several steps and market segments. We distinguish between whether a study only refers to a business model and whether the study describes the business model as promising.

All reviewed business models are categorized within 34 categories. In 42 studies reviewed, business models from these categories have been discussed 141 times. Of these reviews, there are 54 reviews that can be characterized as "promising". The 12 most discussed business models in the reviewed literature are shown in Table S.1.

Table S.1 The 12 most discussed business models in the literature, ranged from most to least discussed, and those presented as promising.

Business model	Total	Promising	Promising / Total
CPO	21	7	33%
Asset owner	16	4	25%
Electricity supplier	10	5	50%
Site owner	9	3	33%
Energy management (load shifting, V2G etc.)	8	3	38%
Software- and platform -suppliers	7	4	57%
BEV sharing (MaaS)	7	3	43%
EMSP	7	2	29%
Electrical Distribution System Operators (DSOs)	7	1	14%
Hardwareproducer	6	3	50%
Installation and maintenance	6	2	33%
Aggregator or e-roaming hub (network orchestrator)	5	3	60%

In the literature review of methods for assessing business models, scalability and profitability emerge as the basic criteria. This is repeated in most reports reviewed on this topic, as well as research articles such as Madina et al. (2016). Spöttle et al. (2018) have already made a scheme to give a score on the criteria profitability and scalability, and also include an assessment of contributions to availability with the criterion “contribution to public charging infrastructure”, which we also consider useful to combine with the other two criteria. Our assessment criteria are thus:

- Profitability
- Scalability
- Contribution to public charging infrastructure

We have evaluated more than 40 business models in use in Norway in all 7 steps of the value chain according to these criteria. 7 business models were highlighted as particularly interesting (Actor in parenthesis) :

1. Integrated location owner + CPO + EMSP + charging system supplier for housing cooperatives/condominiums, private households and companies, semi-closed but cooperates with other CPOs (Circle K)
2. Integrated CPO + EMSP + charging system supplier for housing cooperatives/condominiums, companies and pop-up charging, open for roaming (CPO services for municipalities / counties) (Kople)
3. Roaming EMSP with map services (Elton)
4. Manufacturer of hardware and software - all segments (up to 24 kW) (Easee and Zaptec)
5. Provider of platform solutions for CPOs, EMSPs, installers, electricity producers and grid companies, which enable operation and management, smart charging and (eventually) V2G (Current)
6. Electricity supplier EMSP (without roaming) + supplier of hardware and software solutions for charging at homes, housing cooperatives/condominiums, workplaces and destinations (Fortum Charge & Drive)

7. Integrated CPO + EMSP + charging system supplier for housing cooperatives/condominiums and companies, semi-closed. Can also be asset owner (and in some cases site owner) (MER and BKK)

Time will tell which business models will deliver on long-term profitability and scalability. The ecosystem for electric car charging is developing rapidly and there is great uncertainty about what this ecosystem will look like in e.g. 10 years. Develop-ments can take many directions, but we have considered the following future scenarios as representations of what the ecosystem will look like in 5-6 years.

1. Business-As-Usual with many and probably increasing number of players
2. Consolidation into large, vertically integrated semi-closed CPOs
3. Interaction- and roaming platforms connect all charging players with all charging customers
4. "The people wants to roam freely!" - roaming becomes the industry standard
5. Car manufacturer (OEM)-controlled future where charging is closely integrated into the car's navigation system
6. Plug and charge, the cars identify themselves automatically and payment is seamless
7. Regulation requires a splitting into pure CPOs and eMSPs
8. BEVs get longer range that allows charging mainly at home and at destinations
9. The EU sets the standard for ensuring seamless charging across national borders in Europe
10. The technology giants will take over

This bouquet of scenarios was reduced to 5 main scenarios in Figure S.3, differentiated across the degree of consolidation in the market becomes and whether the market development is steered from charging players or outside players.

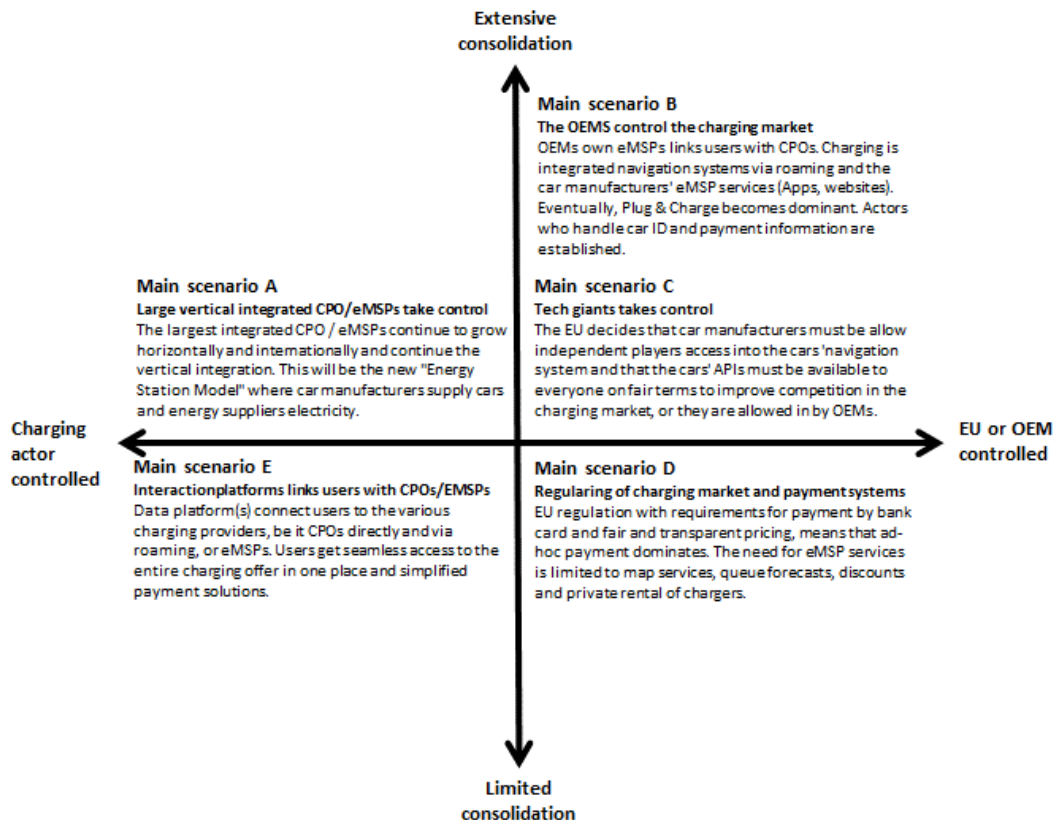


Figure S.3: Main scenarios for the future development of the Norwegian charging market

The discussion concludes that it can be useful to have a mix of main scenarios A and B in mind when making a strategy in the electric car ecosystem, and to be aware of the snowball effect of an increasing number of players offering e-roaming. Better customer experiences can also be achieved through interaction platforms, or regulation of the market if the market itself is unable to establish an overall acceptable customer experience.

This report does not give a basis for comprehensive and detailed recommendations to decision-makers. The charging market is developing rapidly and regulators would need good reasons to step in and disrupt the ongoing competition and innovation with new, specific regulation. Our general assessments beyond this are limited to:

- The Norwegian Competition Authority should keep an eye on the consolidation in the CPO market, especially when combined with vertical integration, and intervene if some players end up abusing a dominant position, both vis-à-vis competitors and customers.
- As long as public sector agencies such as municipalities, counties or ENOVA support investments in charging infrastructure or are owners themselves, they have the opportunity to demand or emphasize solutions that provide maximum accessibility and shape BEV drivers' expectations of increased accessibility, such as e-roaming protocols, providing real-time information to NOBIL and transparency towards eMSPs. i.e. access to status data for the chargers and the opportunity for roaming. This can help stimulate the market in a more user-friendly direction.