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Electromobility: Challenging issues

Conference report

Conference organized by the Armand Peugeot Chair in cooperation with the Governance & Regulation Chair, the Vedecom Institute and the Maison des Sciences de l'Homme

University Paris-Dauphine, 14 December 2017

DEBATE

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Paris-Dauphine University welcomes the 5th edition of the "Electromobility: Challenging Issues" conference organized by the Armand Peugeot chair. This conference brings together high-level world-speakers and academics from the field of engineering, management, economics and political science, who will exchange their views and debate on electromobility challenges and related topics.

Through a range of keynote conferences, concurrent sessions and roundtable discussions, this workshop aims to provide a unique academic event in the Electric Vehicle (EV) eco-system. The goal is to foster discussions/interactions between different international specialists, to share expertise, and to develop a collective understanding of electromobility issues.

1 st roundtable : International experiences

Perspectives on Norway's supercharged electric vehicle policy

Erik Figenbaum
Institute of Transport Economics, Norway

The Institute of Transport Economics is an independent, non-profit research foundation employing approximately 105 men and women, from a broad range of social sciences.

An exceptionally large market

Battery electric vehicles have accounted for a steady share of new vehicles sold on the Norwegian market since 2015, at 15%, rising to over 20% in the last half-year. The period since 2015 has also seen tremendous development of plug-in hybrid vehicles, which account for 20% of the market. Consequently, four out of 10 cars in Norway have a plug. This figure rises to half the market if regular hybrids are taken into account. This has led to huge expansion in the proportion of passenger vehicles accounted for by EVs, which amounts to over 7% (135 000 BEVs and 59 000 PHEVs).

EV policy enablers

This exceptional result was made possible in large part by the vehicle taxation system. Vehicle registration taxes in Norway, computed according to car value, car weight, CO2 emissions and NOX emissions, have been very high since the 1960s. Since 1990, however, battery electric vehicles have been exempt from registration tax and, since 2001, from VAT (25%). Furthermore, they are subject to a reduced annual tax.

Over their car's lifetime, owners of EVs can expect to enjoy such benefits as much-reduced energy cost, lower cost of oil change, lower fees for annual services, local incentive packages, free access to toll roads, time-savings thanks to access to bus lanes, free parking, and reduced cost for ferries on the West Coast.

A conducive environment

Moreover, the energy costs saved are higher in Norway than in any other country, as electricity is very inexpensive thanks to hydro-electric power, while gas and diesel come at a very high cost. In France, the savings are 24% lower than in Norway and in Germany, the least advantageous country for electric vehicles, 56% less.

Much effort is currently being made on charging infrastructures. 95% of those who charge today do so at home and overnight. 75% of households can park their car on their own land, 14% can do so less than 100 metres away. To further facilitate this situation, the National Fast-Charge Support Programme, underway since 2011, has enabled fast-charging on all main roads, with at least two multi-standard 50 KW charging stations every 50 kilometres. In cities, initiatives to enable fast charging are left to the market, which has responded resoundingly: the food store chain Kiwi, Ikea furniture store and McDonald's fast food are just some of the major names that have installed charging stations in their parking lots, ultra-fast charging being set for roll-out in 2018. As to support for normal chargers, it comes more at the local or regional level, and is generally aimed at those living in flats.

User suitability and satisfaction

The strong showing of battery electric vehicles is also rooted in its compatibility with the travel needs of individuals in Norway. The current situation is the result of gradual interplay between the world-wide move toward more ecological cars, triggered by California's ZEV Mandate in 1990, and Norway's own experimentation with taxation schemes. To encourage the purchase of what was initially seen as an overly-expensive, uncomfortable, and short-range vehicle, the Government carefully rolled out measures step-by-step, until such time as high-quality vehicles could come onto the market under advantageous conditions. Today, traditional and electric vehicles offer almost the same user experience.

The typical BEV owner in Norway is a younger-than-average buyer, 80% come from multi-vehicle households, and have children under 18. They also show significant transportation needs, covering long distances to go to work and living in the outskirts of cities. They deem that the electric vehicle matches their needs as one of the vehicles in their household, thanks to reduced user costs, strong incentives, and environmental-friendliness. 88% of current owners state they would buy an electric vehicle again; only 1% would not.

Discussion with the floor

Jean-Pierre Ponsard, Ecole Polytechnique

Did you investigate the implicit cost of the policy? Could you detail the support provided for the charging network, in particular the ultra-fast systems?

Erik Figenbaum

At the start, fast charging stations were granted support on a first-come, first-served basis. When the policy aim became the ability to drive vehicles between major cities in Norway, four different tenders were issued, with charter quotas per road segment in a given region, and 100% support available for the installation.

The policy's main implicit cost lies in foregone taxes, which can however be recovered by increasing taxes on gasoline and diesel cars.

Marc Trehan, NUUVE

What challenges have you had to face with regard to the grid?

Erik Figenbaum

We have not had to deal with many challenges; even the necessary grid reinforcements are funded by the company that pays for the fast charger. Electric ferries and ships relying on shore power can be subject to much more significant issues, being located in areas with weak grids.

Marc Petit

Are users mainly residents of individual households, and if so what issues do they face?

Erik Figenbaum

Most owners live in detached houses, and thus park and charge on their own land. Those living in flats, primarily in the major cities such as Oslo and Bergen, can face more obstacles, as not all complexes are located conveniently to charging areas.

Christian Thiel, Joint Research Centre, European Commission

The total cost of ownership according to your charts showed the depreciation cost of electronic vehicles to be lower than that of internal combustion engine or plug-in hybrid cars. In most countries, the opposite is true.

Erik Figenbaum

While the residual value turned out the same after five years, the second-hand market for electrical vehicles is very strong in Norway, thanks to the incentives granted: immediate eligibility for free use of toll roads and bus lanes. As battery life has also proven very long, trust in the car's value has developed.

Dirk Lauinger, Swiss Federal Institute of Technology, Lausanne

Has Norway needed to build more hydrodams now that its electricity consumption has risen?

Erik Figenbaum

Even if all the passenger vehicles in Norway were replaced with battery-electric vehicles, the increase in energy consumption would amount to only 6%. Furthermore, renewable wind power and other forms of new generation are coming on line.

Peter Bach Andersen

It is important to make the distinction between power and energy. The simultaneous demand for power may be high due to EVs in Norway. Are there indications that individuals are starting to acquire higher charging speeds at home? In Denmark, provided the user is ready to pay the price, the usual charge level in the home can be increased from 1 KW to over 40 KW.

Erik Figenbaum

Tesla owners typically require 11 KW, which some grid operators have tried to prohibit. As that figure is still far lower than the total 50 KW required for a stand-alone house, those attempts are unlikely to succeed.

Japan and the Future of Automobile Industry

Tatsuya Suzuki
Nagoya University, Japan

Despite its title, this presentation focuses on the perspective of only one city, Nagoya, home to the Headquarters of Toyota, with Mitsubishi and Denso Corp. in the immediate vicinity.

The EV in Japan: variations on a theme

The electrified vehicle landscape in Japan, which differs significantly from that of Europe, is home to five main categories of vehicle: the hybrid vehicle, which uses engine or motor driving force and is run on gasoline; the plug-in hybrid vehicle, with also uses engine or motor driving force, but can run on gasoline or electricity; the battery electric vehicle, most frequently referred to as the “electric vehicle”, the driving force of which is motor and which uses electricity only; the battery electric vehicle with range-extender, currently attracting a great deal of attention in Japan, which runs on a small engine generator and requires electricity or gasoline; and the fuel cell vehicle, less recognised in Japan, which runs on a motor and uses hydrogen as its fuel source.

Total Motor Corporation uses the hybrid vehicle as its fundamental structure from which any other type of electrified vehicle can be developed. It contains all the components needed for an electrified vehicle: the electric motor, the power control unit, battery, generator, gasoline fuel tank and gasoline engine. To build a PHV, the charging plug is added and the body enlarged. For the BEV, the gasoline engine is removed. As to the FCV, it is augmented with a fuel cell and high-pressure hydrogen fuel tank.

Industrial and governmental aims for EVs

Toyota promotes each type of electrified vehicle in accordance with body size and travel distance: the BEV is best-suited to short deliveries, sharing and personal mobility; the HV and PHV are seen as good passenger vehicles; and the FCV is best for long distances and larger vehicles (routed buses, heavy trucks, delivery trucks).

The Japanese Government has set targets for electrified vehicle penetration for each vehicle type, in terms of percentage of total market share. In 2020, the HV should thus account for 25% of the total market, the PHV + BEV 20% and all low-emission vehicles 50% of the total market. In 2030, it is hoped that the percentage of low-emission vehicles will reach 70%, thereafter growing to 95% in 2050.

Structural enablers of EVs

Toyota’s prediction for 2050 is that “no vehicle will travel by gasoline engine alone”. It is not, however, as optimistic as others regarding FCV, which is believed to need more time for popularization than the hybrid vehicle, due to still lagging infrastructure expansions.

One of the major key components to consider with regard to electrified vehicles has to do with battery performance.

Another major factor determining uptake of these vehicles is the growth of energy density in lithium batteries. If all solid-state lithium batteries can be adapted for this purpose, as some believe, power in Japan may increase more.

Lay of the land and competitive odds

Toyota's hybrid Prius was released in 1999 and today 50% of new car sales in Japan are HVs. The hybrid vehicle's smooth adoption in Japan is ascribable in large part to the promotion it received from government policy, within the very structure of the automotive industry. First of all, the Toyota Prius is made up of 33 000 components, compared to the gasoline-powered Corolla Fielder's 30 000 and the Nissan LEAF Battery Electric Vehicle's 10 000 to 20 000. As such, with each of its sales, it can distribute profits to a larger proportion of Toyota's industrial landscape, which consists of over 5 000 primary subcontracting companies, nearly 26 000 secondary sub-contracting companies.

Energy price, using natural gas, oil or coal, is declining but, aside from that trend, remains difficult to predict. On that basis, while the Nissan Leaf is somewhat expensive compared to the Toyota Prius in base cost, the latter benefits from tax exemptions and incentives that put the two on an even kilter. However, in order for the EV to become less costly to use, gasoline prices would have increase to 180 yen per litre, when they amount to only 130 yen presently. It is thus unlikely that it will defeat the HV in the short-term on grounds of cost-effectiveness.

BEVs could make their mark through the growing espousal of car-sharing, which has risen from zero in 2007 to over 15 000 cars and 600 000 users in 2015. The community, while relatively small, is steadfast, using shared vehicles primarily for short distances for instance to reach the hospital, stations, banks, city offices, or schools.

Also encouraging is the spread of charging stations, with Japan being home to 5 960 of the world's 10 377 CHAdeMO fast-charging stations. They are found not in connection with households, but in shopping centres, on highways, stores, etc.

A new face to the Japanese landscape

Looking to the future, Japan wishes to shape a policy that blends vehicle types (ICV, HV, PHV, BEV, FCV, etc.) logically and reasonably, bringing out the distinctions in terms of cost, performance, usability and infrastructure.

The solutions most likely to prevail in the next 10 years are the PHV and the BEV with range extender, for their combination of short-range performance on par with that of the EV and longer driving distance thanks to engine and generator. As to whether the FCV will be able to pick up from the PHV, it will depend on the formation of a promising business model enabling the implementation of a sufficient number of hydrogen stations. Already, diversification of energy sources for future society is an important component of government policy and Japan is in need of a more economically stable and secure energy source. Hydrogen, already generated for petroleum refinement or iron refinement, can be found in said factories.

By 2030, the PHV and BEV with RE should be adopted as a possession vehicle, while the small BEV could be preferred for sharing services. Subsequently, by 2050, the BEV, PHV and FCV could become complementary.

Since the great East Japan Earthquake in 2011, the Government resolved to reform power policy in Japan, promoting decentralisation of power sources, away from fossil fuel and nuclear plants and toward solar, hydrogen and biomass. In 2016, it initiated the full liberalisation of retail electricity sales, promoting the penetration of renewable energies and speeding up the popularisation of PHV/BEV because of the additional value it offers in energy storage. By 2020, power distribution and transmission lines will be open and after 2020 the electrified vehicle will be a key player in a smart grid system including both local and regional components. The integration of the smart grid and mobility will lead to a new generation smart city.

Discussion with the floor

Paul Codani

What are the current and future CO2 regulations in Japan, as they will influence the development of EVs? What can you tell us about demand response projects in Japan today?

Tatsuya Suzuki

The Japanese Government is not pushing the EV so strongly, as the structure of the automotive industry is very important and a source of support for the nation itself.

Several field tests have been organised to integrate smart grids and mobility, in Keihanna, Northern Kyushu, Toyota City and Yokohama. In Toyota City, they involved 67 households, all equipped with electric power source, PV generator, home battery and PHV, and in 30 houses, fuel cell and charging stations for Vehicle to Home. Energy consumption and vehicle use have been observed simultaneously, with data being logged very 1 minute, since 2011.

Andrew Thompson, Veticom

It is surprising that the value proposition between hybrid and BEV is so negatively perceived in Japan. Were you to include other important designations, such as maintenance cost, asset degradation and depreciation, the picture over the entire life-time would look quite different. Adding social costs, especially CO2 emissions, would further support the case of hybrid vehicles.

Tatsuya Suzuki

Those are excellent points. Japan remains a nation of car manufacturing, more than of car usage, however and as such, protects the former.

Yannick Perez

Is the fuel-cell electric car only a way to enter the market, or the new ammunition which Toyota wishes to use to defeat the competition from Nissan?

Tatsuya Suzuki

For the time being, that model is still a demonstration vehicle, though many customers have signed up for pre-purchase.

Jan Lepoutre

How do you explain that not only Toyota but also Honda appear to be pushing the agenda on hydrogen, attesting to possible wider interest, when you showed that fuel cell vehicles will be useful mainly for trucks and longer-distance needs?

Tatsuya Suzuki

Their action stems from the Government's need to create wider variety in the energy landscape. Hydrogen-controlling technologies are furthermore one of Japan's strengths.

EU Electric Vehicle Deployment

Christian Thiel
Joint Research Centre, Italy

The Joint Research Centre is the European Commission's science and knowledge service, dedicated to providing scientific evidence in support of European policies. As such, it engages in pre-normative research and laboratory research, supporting for instance standards, inter-operability of electric vehicles, smart grids, electro-magnetic compatibility of vehicles and components and, currently, prototype 350 KW recharging points.

The switch to the EV: triggers and barriers

Many have forecasted that electric vehicles will reach cost-parity with conventional vehicles in Europe by 2020, thanks to battery-electric and plug-in hybrid vehicles. While in Norway, this is already the case, with 35% of new vehicle sales going to those two categories, in the European Union, actual deployment has reached no more than 1 or 2%. Clearly, when the conditions are right, thanks in particular to incentive policies, users make the switch. China, which posted 330 000 sales of new electrical vehicles in 2016, aims to make these 10% of its total market in 2020, or over 3 million cars.

A survey by the Joint Research Centre run in six European Member States (France, UK, Germany, Poland, Spain and Italy) showed the main barriers to broader EV adoption to be: high purchase price of electrical vehicles, concern over lack of recharging infrastructure, concern over short range and little model choice.

Policy responses to observed reluctance

Policy-makers at the European and national levels have taken action at key points in the chains to change this reluctance: the EU CO2 regulation on cars and vans triggers manufacturers to offer electric vehicles and thus meet CO2 targets; the Alternative Fuels Infrastructure Directive requires Member States to deploy a minimum level of publicly accessible recharging points; the Energy Performance of Buildings Directive caters to the many who live in multi-apartment buildings, by ensuring that charging points are installed there; the European Battery Initiative supports battery development and manufacturing in the EU; and Member State tax and incentive mechanisms improve the EV value proposition for consumers.

Indeed, incentives prove to play a decisive part in uptake of EV offers across European countries studied, in contrast to GDP per capita. The number of models available, which rose from three in 2010 to 38 in 2015, also proves a crucial condition, enabling sales at last where Norway's strong incentive programmes, in place for decades, had failed to do so.

EU Member State policies and performance review

The Alternative Fuels Infrastructure Deployment Directive (2014/94/EU) included a call for States to notify the Commission of their national policy frameworks: current status of alternative fuel vehicles and infrastructure, estimates of future sales and infrastructure, and planned or existing support measures. While the degree of information received and filing times were anything but homogenous, they do enable some conclusions to be drawn.

Germany and France present similar profiles, with respectively just under and just over 100 000 EVs on the road today, but high estimates as to EVs in use by 2020, at around 1 000 000. The UK and the Netherlands match Germany and France respectively on numbers of EVs on the road today, but have set much lower estimates as to how many will be in use in 2020 (400 000 in the former case, 150 000 in the latter).

As pertains to publicly accessible recharging points, for which the Directive 2014/94/EU deems appropriate a ratio of 1 (I average) per every 10 electric vehicles on the road, the countries classified far from the mark by 2020 are the UK (1:32), Austria (1:28), France (1:27), Germany (1:23), and Ireland (1:26). The best ratios are planned for Hungary (1:9), the Netherlands (1:8), Italy (1:7) and Portugal (1:6). In some cases this is though achieved because of low future electric vehicle estimates. The picture is much brighter where fast-charging infrastructures along motorways are concerned, thanks to swift developments in this area presently.

Member States with ambitious aims for electric cars show that these can have a very beneficial impact on CO2 emissions, energy security and air quality. Austria and Ireland demonstrate this, with high estimated figures for 2030, and already today, better performance than several of their European counterparts in the most challenging areas.

The breakthrough predicted in the next five years for the interesting alternative which EVs offer could well become reality, provided they are supported by policy measures – and thereafter prove capable of living on without those.

Discussion with the floor

Yannick Perez

Does Norway, which has been so successful in integrating EVs into its landscape, have the requisite 1 charging station for every 10 vehicles?

Christian Thiel

The ratio in Norway may currently be closer to 1:15. It is important to keep in mind that the number of detached houses is very high, in contrast to the suburban and urban areas without any parking lots. The Directive addresses the latter, as the mass market in Europe.

Erik Figenbaum

The official number of charging stations in Norway is 9 000, with 1 000 fast chargers. 75% of households, or 1.5 million distinct units, however, can charge at home. Given that many can also charge at work or manage by charging only once per week, the need for public charging stations is not what it might be in other countries.

Marc Petit

The deployment of public charging could be useful also in enabling grid services.

Christian Thiel

The Directive is actually very forward-looking, including measures to facilitate smart-charging and ad hoc recharging without mandatory fixed contract.

Eric Brousseau

I was surprised that none of this morning's speakers mentioned self-driving vehicles and ride sharing systems, given the importance which issues such as congestion and inter-city mobility have taken on.

Christian Thiel

For lack of time, I did not mention the Third Mobility Package or initiatives such as the Connected Intelligent Transport Solutions. The JRC has also looked into this high-priority area, publishing a report called, "From Connected to Autonomous Vehicles, the Revolution of Road Transport". While not predicting, as some have, that mobility will be solely a service in the future, we are exploring various responses to different scenarios.

Peter Bach Andersen

Norway's experience shows that some of the perceived barriers to EV uptake, such as lack of infrastructure, are not actually problems.

Christian Thiel

A few months ago, one newspaper was reporting on the lack of public recharging points in Oslo, where the ratio was 1:27 or 1:30. The Government has also started to incentivise plug-in hybrids, impacting sales of battery electric vehicles, precisely so that potential concerns about charging points do not slow down the desired energy transition. By choosing the route of "policy-bundling", Europe wished to cater to all user needs, as well as take into account operator capabilities, today and in the future.

Erik Figenbaum

The installation of charging stations in established cities is not only costly and laborious, but also administratively complicated. This is one of the reasons for which some parking houses have been converted to BEV-only facilities.

Michael Jacobides

Surveying the users may not provide the best insight on barriers to customer adoption, especially when modern-day tracking and data collection techniques exist, and taking into account such factors as hedonics.

Christian Thiel

The chart that I presented showed only in a very reduced form the analyses that were made. In general, policy design and implementation is informed by a multitude of various inputs. Besides, I have not seen many studies on consumer behaviour, in particular from the European perspective, that is mine, in all its heterogeneity and complexity. On a personal note, during my twelve years in the automotive industry, a leading concern was purchase price. This could lead to high emphasis on reducing costs per unit, which could become the focus of cut-throat negotiations down to the 0.1 cent level.

2nd roundtable : EV ecosystems analysis

Towards a Theory of Business Ecosystems

Michael Jacobides
London Business School, UK

Upheaval and re-formation

Business activities were once well-delineated, sectors easily grasped and the boundaries of organisations and industries well-established, whether banking and insurance, telephony, or entertainment. These boundaries were furthermore reinforced by tradition, reputation and expertise. As the combined result of changes in technology, regulation and globalised competition, stable boundaries and professions have been disrupted and sectors are being reshaped down to their foundations.

Computing is the canonical example of this development. It was once vertically dominated by a few major players, with IBM, Control Data and Digital Equipment Corp controlling everything from product design to assembly, the operating system, software, sales and service. Now, each of these areas thus has its own horizontal champion, who reigns across the globe. The rules and roles of the division of labour are changing, bringing out new patterns of value migration.

It would be incorrect, however, to assume that all sectors have been disrupted in the same way. Whereas computer OEMs historically captured most of the value available on their market, under the new model, their shares of both EBITDA and market capitalisation have plummeted. Automotive OEMs, in contrast, with their intrinsically more hierarchical structure and captive suppliers ready to execute any order at the snap of a finger, have been able keep their grip on profits and earnings. Nonetheless, they too may soon have to relinquish their stronghold, due to two main factors.

First of all, the shift from traditional distribution to mobility services could change not only the organisational principles of the automotive industry, but also the way in which people buy those services. Secondly, the new products and services we are seeing today are the combination of an extremely heterogeneous yet interdependent set of needs and competencies that are very unlikely to be mastered by one company on its own.

When ecosystems come about

Today, players trying to dominate their own as well as other sectors readily seek to build ecosystems around them: the energy and automotive sectors, previously separate, are starting to collide, as players such as Tesla, Google, eON and Enel each try to take their respective due in transportation, mobility and energy system management.

The largest IPO to date in this respect has been that of Alibaba, in which one word appeared no fewer than 60 times: ecosystem, though no common agreed definition of the said term has yet been established in the business context. Beyond that semantical investigation, it is also worth asking why ecosystems are relevant from the theoretical standpoint. What novelty do they offer in terms of mechanisms compared to related, existing literature? When and under what conditions do firms or markets give way to ecosystems? Will the prompts be given by the regulatory framework? By technological determinants? By the global push for convergence and fewer boundaries?

The relatively-well accepted definition put forth by Adner, in 2017, stating that the "ecosystem is defined by the alignment structure of the multi-lateral set of partners that need to interact in order for a focal value proposition to materialise" is interesting, but describes more that which is observed, rather than the reasons for which it is seen. The inclusion of the "alignment structure" furthermore creates the risk of incorporating an outcome into the definition.

Instead, what is needed is a definition that is backward-compatible with theory, able to demarcate the new in the economic representation and be situated with respect to theory. Thus, an ecosystem should describe a structure, separating incentives from alignment and cooperation. A "theory of ecosystems" should explain why ecosystems have become more dominant. Our research work will discuss modularity and types of complementarity, positing that ecosystems provide a balance between the need for coordination between interrelated organisation and autonomy.

Developing the conceptual framework

Modularity is important because it enables independence and inter-dependence; no central agent needs to be in charge of managing every inter-dependent relationship. In a world in which all applications written for Apple iOS cannot run on Android and vice versa, everything is non-fungible. In a fully-fungible landscape, in contrast, every player has a stake and interest in ensuring the success of the collective enterprise. Furthermore, complementarities can be generic (elements fungible across many applications, in production or consumption) or specific (elements involve some degree of customisation or specialisation to achieve complementarity). The less one can shift from one group of connected players to another, the tighter the inter-dependence of that particular ecosystem.

Equally important are complementarities, of two sorts: unique (item A is needed for item B to operate); and super-modular, where the value of object X increases in world Y. Depending on the type of complementarity, there can be greater excitement and value in the eco-system around it.

Ecosystems are groups of firms that deal with non-generic or super-modular complementarity, which intertwines fates, provides co-dependence and allows for coordination without any need for vertical integration or unilateral hierarchical control. New problematics arise in this new landscape, with decisions to be made on the desired degree of fungibility, and the very desire for an ecosystem as opposed to standardisation in the policy approach to interdependencies.

When Tesla wished to become part of the joint venture around charging infrastructures in Europe, developed by Porsche, Ford and Volkswagen, it was told to kindly wait to be invited. Such cases raise questions both for strategists and for policy-makers, required to address the potential impacts of such an ecosystem's existence or necessary dissolution to become a set of interdependent players.

Our research is aimed at finding distinctions in the literature and identifying impacts on such areas as collaboration or value capture. The ecosystems which Apple, Facebook, Google, Microsoft and Amazon wish to create, so as to be at the centre of every user's experience, are grand visions from the perspective of the strategist, but less so from that of the policy-maker or consumer.

Discussion with the floor

Jan Lepoutre

The difference between traditional supply chain and ecosystem appears to be the maintenance of control by a small number of players at the top of the line. Yet the smaller companies are also striving for control, albeit within their ecosystems.

Michael Jacobides

The "ecosystem" is not the warm, caring, interconnected and ecologically-friendly place its name would imply. Control and value creation are no less important to its participants. Previously, the supply chain was a one-way street, the overly large number of inter-dependencies being unmanageable without active intervention. With the emphasis now on a host of new digital requirements, the possibility of unbundling is greater. Strategic control and a stronghold on value will still be possible, though to a more limited extent. Most importantly, the tactics will change.

Eric Brousseau

In the "Old World" of industry, the main policy tools to manage collective infrastructures were competition policy combined with policy regarding the provision of public goods. In the "New World", the policy tools seem to be the design of modular architectures and the management of inter-operability standards among components of integrated service oriented multimodal infrastructures. The only way to control those building the tools is to control the design and the gateways.

Michael Jacobides

The European Union has pushed more than the US authorities in this regard, as demonstrated by the recent cases against Google, Apple and Facebook. The US Department of Justice and the Anti-Trust Division still have reflexes, however, triggered namely by the Herfindahl-Hirschman Index and power balances. A first step toward progress would consist of mapping out the impact with other ecosystem players. Secondly, one would look at the governance issues in ecosystems: what determines the entrance criteria to any ecosystem? What are the implications within the automotive industry, for welfare, governance or exploitation, to name only a few?

How firms manage bottlenecks in EV business ecosystem

Yurong Chen
Armand Peugeot Chair

Understanding the features specific to the automotive ecosystem

As the traditional focal firm of the industry or ecosystem, car-makers have always needed to coordinate with suppliers and complementary contributors to offer products to customers.

In the nascent auto ecosystems, growth and performance are constrained only by bottlenecks, which are distinctively located far from the core competencies (e.g. battery). The EV ecosystem is furthermore unique for its structure and the interdependence between components. According to the existing literature, focal firms in ecosystems serve as the architect, setting a system-level goal, establishing standards and interfaces, but also standing out as the leader that recruits and motivates partners to join in the ecosystem and fight for the system-level goal. Examples include the Amazon platform which sets rules for players wishing to join it or, illustrating failure to fulfil its role, Windows Phone.

Bottlenecks are the components that technically constrain the ecosystem, due to poor quality, high cost or short supply. Solving the bottleneck problem requires innovating within a space to create value, for instance using intellectual property or architectural advantages to rise to a monopoly position and capture value. This first assumes entering the bottleneck's activity.

In the setting of the battery electric vehicle ecosystem, focal firms are expected to manage bottlenecks at three points: where ecosystem components are interdependent; when bottlenecks are far from the focal firm's existing core skills; and during shifts in bottlenecks.

The EV ecosystem consists of four different components: the battery, home charging, public charging and the vehicle body component. The focal firm assembles these to produce EVs and an offer to the end-customer. The charging infrastructures and incentives for EVs depend in large part on location.

The two main bottlenecks in the EV ecosystem are the battery (due to high cost, poor quality, low energy density and short supply) and the charging station (as a result of its low availability, poor quantity, low charging speed and high cost).

Four key players, four contrasting strategies

Tesla, Nissan, Renault and BMW, the four firms chosen for this work, are all top focal firm players in the BEV ecosystem and started their projects in this area at around the same time, in 2007. However, the strategies they adopted were different.

During the ecosystem's emergence, from 2007 to 2012, all four engaged in an initial period of experimentation and groundwork to bring complementary partners on-board. Tesla, with its flagship Model S, did so by adopting a bottleneck strategy: it innovated, using matured laptop cell technology to reduce cost and recruited partners in non-BN areas. During the "ecosystem maturing" period, from 2012-2015, Tesla switched to a system strategy, entering and innovating in battery bottlenecks, non-bottleneck areas and charging bottlenecks, in step with market developments, as well as adopting an open interface standard of charging.

Nissan similarly adopted a bottleneck strategy for its Flag upon entering the ecosystem, building a joint venture on battery supply, setting standards on the interface between the charging station and vehicle, promoting the CHAdeMO standard with partners and recruiting preliminary partners in charging bottlenecks. However, in the maturing phase, it proved less competitive on battery bottlenecks. Thus, when the bottleneck shifted to the charging station – it should be recalled that the price of EVs had dropped to 27% of what it had been in 2010 – Nissan had already exited the battery bottleneck. On the charging bottleneck, on the other hand, it was more active in initiating partners to innovate.

BMW, in preparing to manufacture i3, experimented with user acceptance of EV and related charging behaviours. Its findings having indicated that a 100-mile range and hence overnight charging would be adequate, it had less incentive to innovate on bottleneck and recharging components. At the same time, it recruited partners to modularise the interface between charging components, focusing on payment compatibility of the charging methods, in contrast to its counterparts. In the matured ecosystem, it also made the interesting decision to innovate in a non-bottleneck component, specifically lightweight material for the vehicle, which in turn mitigated some of the financial requirements of the battery bottleneck. It lastly focused on recruiting partners for the charging bottlenecks. When the bottleneck shifted to the charging structure, BMW, like Nissan, motivated innovation from partners on this.

As to Renault, it adopted a starting strategy different from all the rest, having been pushed by bottleneck complementers to enter the EV ecosystem. As such, it had higher motivation to recruit partners in the charging bottleneck. In the subsequent periods, it used the more common strategy of recruiting partners and modularizing the interface of the charging bottleneck.

How do focal firms manage bottlenecks in the ecosystem?

When components are assembled or bundled upstream, players tend to innovate with qualified partners, or work on non-bottleneck components to mitigate other requirements. Downstream bottlenecks are addressed through solutions assembled or bundled by end-customers when the product is in use.

Firms can recruit or motivate partners to innovate in bottlenecks; they can also modulate the interface between the bottleneck and the focal product, or enter and innovate in the bottleneck component with a qualified partner. This was the strategy chosen by

BMW and Renault, and is referred to as the “component strategy”.

The bottleneck strategy requires more investment than does the component strategy, but offers potential for high profits, by capturing high-level bottleneck components. Firms that use this type of strategy must be able to identify bottleneck trends, excel in adapting to bottlenecks to be competitive on the market, recruit qualified partners for both bottleneck and non-bottleneck needs, or modularise between the bottleneck and focal product, should shifts be required in the future.

The system strategy, while the most costly and skills-intensive, offers two key advantages: an all-encompassing approach that enables high performance across the ecosystem; and less vulnerability in the event of bottleneck shift.

Discussion with the floor

Willett Kempton

Industry players have taken a very different approach to the charging bottleneck. Tesla almost incomprehensibly built all their own charging stations, exiting its areas of skill and making tremendous investments to do so, the only automaker to be in the market segment of building and managing all their own charging stations. All the rest of the automakers have chosen shared paths that involved standard connectors and multiple charging station providers.

Yurong Chen

Tesla's super-charger station strategy resembles its choice on the battery pack and mature lap-top cell, only assembled, to enable high-performance. It may be anticipating changes in battery pack capability. At one point, BMW and Bosch developed a 3 000-euro solution for DC fast-charging, below the rate charged by other players. Renault's current decision to innovate on the lower-cost end is probably aimed at motivating other players to join.

Michael Jacobides

Your work appears to show that different technical choices both underpin and alter the result of ecosystem approaches. It could thus be used to encourage players to set out on the EV path, knowing that they will be able to choose between different potential partnerships and costs, knowing their individual expectations as to the capabilities of their brand or distribution.

Yasmine Assef

I would be happy to offer you additional insight about Renault's strategy and charging initiatives, your presentation having been somewhat limited on these respects. As to ecosystem, we are working not only with energy partners, but also on connectivity. EV is a real opportunity not only for the environment, but also for car manufacturers, provided it is properly integrated.

Yannick Perez

The first bottleneck lies in mass-market manufacturing of such cars.

3rd roundtable : Field experiments

Dominique Jamme,
Commission de Régulation de l'Energie

To discuss the EV is to address change, global warming and CO2 emissions reduction, and in turn the de-carbonisation of our economy and our societies. Most recently, very good results have been achieved, with the production cost of renewable energy, PV, onshore- and offshore-wind decreasing dramatically and becoming affordable and even competitive in many places. The cost of electricity storage is also falling rapidly and is expected to become increasingly affordable. It is essential that this happen, making it possible to overcome the problem of intermittency, if the share of renewable energy is increased. Development of electric cars appears to be on a good start, with the decrease in cost of batteries. This is also good news for our climate objectives, especially in countries with low CO2 emissions.

We now need to hope that the cost performance of EVs continues to be such that it can win over large audiences. Other outstanding questions relate to the interaction of electric cars under development and the power and electricity systems, i.e., charge management.

Vehicle to Grids in the US: A review

Willett Kempton
Delaware University, USA

<u>A promising horizon: Vehicle to Grids in US and Europe</u>

E-storage is being driven in part by cheap renewables, which have in turn motivated storage, demand-size management and transmission grids. In the face of low-cost renewables, it proves less expensive, in many windy areas and some very sunny areas, to build new renewable structures from scratch than to keep thermal plants running. Benefiting from these facilities, storage as well as EV charging control have proved very lucrative solutions. Thus, while grids will not fade, smart retirements of power plants can be observed already.

Storage can be enabled by new purpose-bult facilities, with batteries, power electronics and system connection. Most promising in low cost is inherent storage – that already found in devices and systems, and thus does not need to be purchased. With the EV, inherent storage potential amounts to up to 20 KW hours and offers the added benefit of a predictable use schedule, enabling large excess storage to be purchased ahead of time. In OECD countries, they are used on average for only 1 hour per day, and are idle the rest of the time, ready for charging or dis-charging based on the needs of TSOs, DSOs or other national systems. The vehicle owner can be compensated using surplus funding in the system, or in free fuel.

Energy storage in buildings is another very low-cost option: walls and furniture are inherent storage. Or, low-cost ceramic brick can store and release high-temperature heat, with only a 100-euro charging system is needed to activate this potential.

The early US R&D and demo projects show the above assumptions to work in practice and to have market vlalue, EVs proving to be very cost-effective grid resources. The TSO markets throughout Europe and two-thirds of the United States are competitive, including bidding, even though interconnection remains difficult. In the primary and secondary reserve markets, EV storage is a low-cost resource, even early in the process, and taking into account the related first-time technical costs. From the technical standpoint, the resource is very high-quantity, whether in terms of TSO or DSO.

<u>A regulatory framework for a storage system in motion</u>

The regulatory environment proved trickier to address. Contrary to assumptions at the start of the project, the EV is not regulated as the storage resource, despite its containing the battery. The charging station must be defined and registered as the "power plant", despite its producing no power, and be open to visit by an electrical inspector. Another complication is that TSOs and DSOs do not register and certify power plants that drive to work or take trips. Similarly, they assume that power plants require at least 1-3 years' building time, and structure their paperwork cycles accordingly—by contrast, the aspiration with EV storage is to register one vehicle every three days. Lastly, they are not used to "power plant" capacity changing from day to day, and thus require that potential capacity be committed to stay constant for 4 hours, 24 hours, or even 7 days' time.

The safety standards meanwhile (derived from IEEE1547, or UL 1741 in the US) both require that the EV be permanently affixed to a building, when this of course deprives an EV of its primary function of transportation. Rather than resorting to a circumventing descriptor, e.g., labelling the EV a solar invertor not connected to a building, we have worked in conjunction with OEMs to developing standards for on-board chargers, culminating in SAE J3072, a new standard for on-board grid-tied inverter systems.

Where metering is concerned, after a significant amount of interaction, the regional grid operator agreed to KWH metering on buildings, with a standard DSO metre and KW metre in the charging station capable of measuring down to a fraction of a second. This mass-produced device is now MID-certified and in use for sub-metering and DSM projects. It is a step toward the standardisation of charging stations, enabling interaction with the information system and registration of work with the aggregator.

Under our US grid operator, PJM, two statuses are currently possible for the EV: as a demand resource, in which case it would be denied eligibility for backfeeding. We are currently working through each approach in order to determine which is best for EVs, and at the same time suggesting some refinements in the rules going forward.

Testing the commercial ground

In commercial operations, Nuvve is working with partners in infrastructure, electrical, and vehicles, and several universities, developing four field project trials. These include partners New Motion and TenneT in the Netherlands, PSA, Nissan and Mitsubishi, and TSO National grid in England and Wales.

Early commercial field trials have shown that pre- and commercial grid-integrated vehicles can operate under current conditions and have enabled the launch of more locations. Technology is ramping up, despite some growing pains, to be ready for deployment in a much more developed system of charging and backfeeding. We focus on two-way flow because it offers about 13 times more value than controlled charging.

Policy barriers waiting to be overcome

Some European Union countries require that energy storage sources be put up for bid for seven days, when this resource is constantly in motion, and, for example, if batteries are full, down-regulation is impossible. EVs can provide a better and longer-lived resource if two-way flow is used. Moreover, a storage device both consumes and "produces" energy, in order to meet grid needs at each time range. Market in response to a grid signal, subject to both tariff and tax. In several countries, storage now pays network charges for each KWH consumed and then pays again for each kWh "produced", which is not really fair and makes the business model more difficult.

Sub-meters have proved difficult to integrate in some countries. In one case, the TSO required a second DSO metre, which greatly increases the cost of installation.

Discussion with the floor

From the floor

If the grid operator were part of the commercial arrangements, would that simplify the problem of needing to pay taxes, etc.?

Willett Kempton

We are very closely working with the DSO and TSO in all jurisdictions in which we operate. There is no separation; we require approval for everything. You mentioned a smart metre designed for DSO tariffs: this does not meet the requirements for the TSO. Questions frequently arise about smart metres, but the set of functions and certifications needed are completely different. The DSO must metre everything to be charged to the customer.

Floriane Petipas

How much energy is lost upon charging and discharging?

Willett Kempton

That loss is an inevitable cost of doing business. In a very inefficient system, it can eat up all the revenue. Every move in either direction results in a loss of at least 7%.

Dominique Jamme

The difference between peak and low-load hours can be 10 times the price.

The Parker Project in Denmark: First results

Peter Bach Andersen
DTU, Denmark

Project background

The selection of electric vehicles on the market is broadening, as well as their performance and value for money. We now hope to see the introduction of new performance measures, in addition to range, acceleration and charging time, such as: grid support, the possibility to use the vehicle for emergency power in the region, energy autonomy (interplay with home batteries), compatibility with vehicle to load applications, and others. All these characteristics form the “Grid Integrated Electric Vehicle” (GIV), a vehicle purposely designed with certain capabilities that prepare them for participation in grid services.

This work has been ongoing since 2008, with an increasing focus on this electric vehicle grid integration. Technologies have matured, moving considerably up the TIO scale (piloting and demonstration), with more and more projects. Joining the Parker and Aces projects, dedicated to exploring EV integration, it is a pleasure to see projects in France and the US, and more and more overall, in this category.

The Parker project was launched as a two-year undertaking, focused on presently-available electric vehicles to assess their capability to take part in very advanced smart grid services. Alongside the main investigators, NUVVE, Insero and DTU, the project benefits from the collaboration of EVSE OEMs such as Nissan and Mitsubishi, which guarantee its applicability. In addition, it works with the world’s first V2G hub, Frederiksberg Forsyning, and can access the very valuable data from that field pilot.

Nissan, NUVVE and Enel launched the commercial pilot in Frederiksberg (Greater Copenhagen), a gas and heating infrastructure. It includes 10 Nissan eNV200 electric vans and 10 ENEL V2G units. As these are commercial fleets, the usage pattern remains fairly predictable, facilitating bidding into the market.

In accordance with the principle of frequency regulation, the cars respond to frequencies by varying up to 50 Hz, to restore the balance between production and consumption. In the presence of high frequency, when production exceeds consumption, the vehicles charge, and vice versa. Given 14 hours of availability per day, they generate a market compensation availability payment of 120 euros per month per vehicle. In Denmark, the cost of these cars to drivers amounts to only 40 euros per month.

Three areas of exploration

Grid applications

The project’s first area of exploration lies in grid applications, defined as any new services offered by the current-day electric vehicle that alters the timing, size or direction of the power and energy exchanged between the battery and the grid. These services go beyond pure recharging, for instance to high-level services such as frequency containment, emission reduction thanks to information on marginal production, voltage support to the local distribution system or any combination of these in "stacked service".

The project applies these services both in laboratories, to validate cross-brand technical feasibility and battery usage, and in pilot settings, which helps determine user patterns compared to expectations and actual technical or economic barriers.

We read usage patterns in terms of For the two main stakeholders, "time is money"; however, they have differing view as to where that money should lie. For the grid service provider, the car is a battery. Thus, the more power it offers and the longer time it does so, the higher the revenue. The service provider's main concern pertains to the availability and constraints of using the battery for services. For the user, in contrast, the prime concern is that the car be sufficiently charged precisely when needed. Adjusting the energy deadlines and energy targets based on user patterns can result in up to 2 to 3 hours of extra service provision per day. Supplementing can also be accomplished by instant charging.

Grid readiness certificate

The Parker Project's work will also contribute to foundations for the grid readiness certificate, by helping develop a common definition of the technical capabilities needed to support services. These will be expressed as a given degree of controllability, performance and observability on active power, reactive power or grid formation. Current efforts are focused on frequency regulation of active power.

If the car, grid and standards between them are developed with the right capabilities, all cars can be ready for very broad area of different services in the future.

Scalability and replicability

The focus on scalability is aimed at understanding the total market's potential support capacity for vehicle to grid, the potential impact thereof on the system, and the possible market barriers. As to replicability, it implies understanding the effects of the V2G beyond the borders of Denmark, in different markets, services and user segments, as well as with regard to a wider variety of standards and charging options (beyond CHAdeMO, AC versus DC). Based on Insero research, the countries where V2G introduction would be easiest currently are France, Switzerland and Norway, followed by Sweden, Finland, Denmark, the Netherlands and Belgium.

The Parker Project team is currently working to solve several barriers specific to Denmark as well: energy tariffs and taxation, addressed by differentiating between energy used for driving and energy for services; the requirement for settlement metres, possibly addressable by a whitelist for EVSE metres approved for settlement; and the frequency energy bias, potentially overcome by allowing a dynamic operation point or relaxation periods for storage-based providers.

Our purpose is to understand the role of the grid-integrated vehicle and promote its development over the next years, to culminate in extended specifications on vehicle capability, grid performance and specifications.

Discussion with the floor

Dominique Jamme

Your considerations on user profile are particularly interesting, given that most individuals may not want their vehicle or “battery” to be managed by third parties.

Marc Petit

Communication between aggregator and vehicle through the EVSE is relevant at the laboratory scale; in commercial use, communication takes place between the aggregator and the user.

Peter Bach Andersen

We look at the car and charger as a set, a combined capability. The DC charger contains the invertor and thus provides the frequency regulation. Reactor power provisions are also the charger’s responsibility. The charger would thus have to support all capabilities of the EV plus those of the DC charger.

Paul Codani

In 80-90% of use cases, the car and charger are owned by the same party. The future communication standard between the EV and EVSE will enable the EV to contain embedded electronic contracts, so that it can identify itself upon plugging into a charging station, send the electronic contract to the EVSE, and have it sent it to further players.

GridMotion project in France

Paul Codani
Groupe PSA , France

In advocacy of smart charging

It is widely hoped that EV penetration will increase significantly in the near future thanks to technological improvements, increasingly-shared concern about air quality, and critical developments in power systems. The latter are already being spurred on by energy market deregulation, decentralisation, integration of renewable energy sources and the arrival of demand-side management. If the much-awaited penetration becomes reality, EVs could however introduce additional stress on the grids, thus making smart-grid integration of electric vehicles, i.e., control over charging and discharging patterns, a necessity.

EV smart grid integration can help reduce grid investments, improve the quality of supply for EV users, provide new energy services to EV customers reducing total cost of ownership, and create opportunities for all stakeholders. For example, smart charging strategies applied to an overloaded transformer could help delay or prevent replacement, If the charging periods are synchronised with low-CO2 periods for electricity generation, our societies could move closer to the goal of low-carbon mobility from well-to-wheel.

Smart charging use cases differ from country to country and by type of technology. The four main identified are: vehicle-to-load, in which the EV acts as an interruptible power supply, powering loads otherwise not collected to the grids; vehicle-to-home, where the energy strategy is based on local decisions, with charging/discharging rates determined based on local strategy; vehicle-to-building, which is the same as the aforementioned, but across an entire site; and vehicle-to-grid, where electric vehicles report to and are controlled by a central aggregator, which values the EV flexibility on the electricity markets. These use cases offer value for EV drivers, and are not in contradiction with one another.

A multi-segment, multi-partner project methodology

The GridMotion project is starting medium-scale experimentation on the field, with the following targets: learning about technical aspects such as communication between EV, EVSE, and backend systems; marketing to real customers using non-financial triggers and producing business models; regulatory issues as potential barriers; and customer acceptance of downsides such as charging times, risk, etc.

It looks at two segments: BtoC customers, i.e., actual PSA customers who have already purchased electric vehicles and are interested in smart-charging strategies; and BtoB customers, who have purchased more than a threshold number of PSA electric vehicles, and at whose facilities Enel charging stations will be installed for smart charging and discharging strategies. NUVVE is in charge of anticipating future fleet conditions, providing direct energy with future flexibility capabilities, which Direct Energy converts into energy market bids. NUUVE then controls charging and discharging patterns in real time. We are strongly interconnected with the Parker Project and aim for synergies whenever possible between them. ProxyServe will handle installation of charging stations.

All participating customers have now been identified. From January, the smart charging and discharging stations will be installed, after which a period of tests without valorisation on the electricity market will start, to enable tests on solution robustness.

This will be followed by a phase of valorisation on two electricity markets. The first is the day-ahead and intraday energy markets. Offers and demand bids will be submitted for 30-minute periods, charging when electricity prices are low and discharging when they are high, to find an optimal bidding strategy. Various models will be tested, taking into account unidirectional versus bi-directional charging.

The second market is frequency containment reserves, also known as primary frequency control. The project will study a participation mechanism through common markets with Germany, the Netherlands, Switzerland and Belgium, involving weekly bids with payment made on availability. Potential earnings based on average 2017 price amount to 135 euros per KW and per year, assuming full availability and compliance with market rules.

Obstacles primarily regulatory in nature

The business case appears attractive today thanks to high potential earnings, though the limited market size should be taken into account.

Regulatory issues include the requirement to issue offers by the week, a definite challenge given the difficulty of predicting EV fleet behaviour even over a time horizon of five days. If rules could be adapted to accommodate an hourly market, lower minimum bidding amounts and bid granularity, the framework would be much more conducive to releasing the full potential of the EV fleet.

Other regulatory issues include the RTE requirement that measurement take place at the site level, rather than at the charging station or in the EV, to ensure there is no compensation between the flexibility offer and another source. We recommend that charging stations be sub-metered or that an exception be created for EVs, as a heating system can be turned off. Lean-key certification for the provision of grid services would offer another angle.

Discussion with the floor

Floriane Petipas

Have you considered putting the EV to use within the framework of France's recently-passed regulation on flexibility services for DSO?

Paul Codani

I would be interested in knowing more about this.

Floriane Petipas, Bouygues Energies & Services

The possibility exists under Article 199, for demonstration projects.

Dominique Jamme

All three of our speakers have emphasised the frequency regulation as the best business opportunity at the current time. I question this because, first, excessive fluctuations in frequency may be disastrous to the basic safety of the system. France has a good framework for demand response, industrial and distributed; for frequency regulation, however, there is no contribution from the distributor and only a few qualified industrial players. Secondly, need in France is limited, at around 600 MW, and will not increase much. If all potential players bid for the service, the prices will collapse and in any case it will remain a niche market.

Paul Codani

We have identified value at a given point and will start there. We are aware of the safety-related constraints, but wish to prove to RTE our ability to support these functions.

Willett Kempton

Regulatory requirements are based on analysis of physical needs. Storage can serve purposes other than primary reserve. Some TSOs set out their market and operate solely on that basis, while others go further, putting together actions in anticipation of potential saturation. We have attempted to model very high penetrations of wind and solar, working with two different PhD students, on very large systems around 70 GW and 120 GW, respectively. Depending on the model, to have enough storage, half of the light vehicles could need to be electrified and controlled to meet storage needs, or depending on assumptions, up to all of them could be needed.

Dominique Jamme

One Sunday a few weeks ago, the German system showed deeply negative energy prices for fifteen hours, due to excess wind and other constraints. Had large storage capabilities been in place, great value would have accumulated.

Willett Kempton

We hope that the two can grow at the same rate.

Yannick Perez

You claim that regulatory issues are complex because EV fleets are not registered in a manner suited to their characteristics. Why do you not provide the definition of the regulation you would like to see?

Willett Kempton

For the time being, we have proposed two definitions for EVs as Grid Integrated Vehicles (GIVs). They can be defined as either “electric generation resources” or as “storage resources”. We also refine that to incorporate into such definitions whether those EVs are providing to service to the grid, as demonstrated by a contract with a utility or an aggregator. We also work on laws providing for deduction of returned energy from consumed energy. Regardless, we will continue our work, guided by the over-reaching aim of enabling charging and discharging in a way that benefits the grid.

Peter Bach Andersen

In Denmark, the Battery Plant Regulation describes specific requirements for such facilities. The concept of “battery plant” does not offer a perfect definition, but does bring us one step closer to our aim.

Marc Petit

What about the status of storage plants?

Dominique Jamme

Storage plants raise different and complex issues, from the perspective of government and the regulator both. If every charge of the batteries gives rise to taxes, the system will not be seen as positive. France has not instituted distribution-level tariffs for producers, as that would involve metering, identifying specific installations, private networks, etc. The best solution would be to define storage, then define specific regulations for it. Regulators generally do not like to cater to exceptions, however.

Michael Jacobides

Are other players providing alternate structures? How do you view your strategy depending on the activities in which you are involved?

Paul Codani

There are other competitors, including stationary batteries, and projects in France to use electronic boilers and heaters. The energy storage system is intended for mobility first and foremost. The investment cost is reduced compared to the first-life battery or secondary life battery.

Willett Kempton

Whenever competing a storage resource in markets, it is important to be able to underbid market by a considerable amount. For example, natural gas generators doing primary reserves will run at half their capacity so they can ramp up or down to balance frequency. Competing with district heating, that is at a very low operating cost to add reserves. It could undersell storage, but it cannot enable many types of grid services. In the future, to reach the aim of 90% renewable energy, all of these sources will be needed, plus an entirely available GIV fleet.

Roundtable: the future(s) of electromobility

Introduction of the Roundtable: EV in France in 2035

Thomas Veyrenc
RTE, France

The French Generation Adequacy Report was published in November 2017. Required by law, it provides neutral analysis on the electricity mix, based on possible future scenarios for the power system. For each, it explores developments in consumption, generation, CO2 footprints and cross-border electricity trade. After lowering our starting assumption of 15 million electric vehicles to 8 million, at the insistence of 40 out of 50 major stakeholders consulted, we returned to our initial hypothesis, when the French Ministry of Ecology issued its policy, banning traditional vehicles by 2040.

The study was based on six major parameters, including consumption, CO2, gas and oil prices, the intentions of neighbouring countries, and the development of renewable energies, making sure to take into account the timescales over which trends could play out, as well as variations between groups of individuals.

The rise of electromobility was charted out in accordance with four different trajectories: the lowest assumed 3.5 million units by 2035, the mid-range assumed 5 to 8 million units by 2035 and the highest charted out 15 million units by 2035, or 40% of the vehicle fleet. Modelling looked at avenues with natural charging, on-demand charging (to be avoided), charging according to price signal and pure smart charging based on energy prices.

We believe the targets set recently by public authorities can be accommodated in the power system and do not foresee challenges in providing the additional 35 TWh energy required within 15 years' time. Smart car charging appears necessary to mitigate the effect on major consumption periods.

It will be important to determine whether the additional value gained is worth the cost paid. Service and flexibility to the power system will be in competition with other forms of flexibility, for instance. V2G can be brought on board but may not be absolutely necessary, rather only "nice to have". Our study published last July on the implications of demand response in competition, within the context of smart grids, will now be upgraded to integrate vehicle to grid.

Discussion with the floor

From the floor

What energy mix did you assume in your scenarios?

Thomas Veyrenc

The five scenarios are extremely different, assuming anywhere from 55 GW to 8 GW of nuclear power. We worked toward to pre-set principles, for instance "achieving 50% nuclear power generation by 2025": in this instance, it assumed closing down 24 nuclear units. In a second scenario, nuclear units were replaced only by renewable energies: it is feasible to bring the latter to 40% of total energy and nuclear to 50% of energy by that time. In the other scenarios, nuclear units were: replaced by renewables and gas stations; addressed according to economic principles (55 GW of nuclear capacity); or shut down at 40 years of operation.

Paul Codani

How will you incentivise users to accept the constraints inherent in the smart charging policy that is so important to you, to achieve your target charging patterns?

Thomas Veyrenc

This can be achieved through economic signals, developed with suppliers, as well as regulatory action.

Michael Jacobides

The most significant problem comes from individual inertia and consumer irrationality. A great deal of nudging is needed before price signals are effective. The devices marketed by the GAFAs and which organise their lives are providing just that.

Thomas Veyrenc

End consumers will not, on their own, follow apps in anticipation of the best time to charge. An intermediary will be needed whether aggregator, supplier, regulator, etc. Perhaps we should be proactive, enabling default charging at night, or at least not at peak hours.

Yannick Perez

Are the various scenarios containing less nuclear power, a significant amount of nuclear power and large numbers of EVs on the road so easy to implement? EVs may not be as easy to manage as boilers, and might indeed deserve to be treated as more.

Thomas Veyrenc

We studied five scenarios, 50 variants and 15,000 possibilities. In the scenario assuming all nuclear units would be closed down by 2035 and 70% of energy would come from renewable energies, there is no competition between flexibilities. We found there would be a need for large numbers of gas stations, demand response and storage. Vehicle to grid can provide a benefit in this scenario, though it should not be seen as competition for another form of flexibility.

From the floor

Are national-level winter evening peaks expensive because of the generation capacity needed, or due to grid congestion? In the former case, how do you consider energy interconnection?

Thomas Veyrenc

France is one of the countries in which electrification has been pushed to the highest level. In all our de-carbonation scenarios, there will be more electricity and thus, in all countries, some peak load. High peak load with high renewables and high nuclear has an excellent impact on CO2 emissions.

While the transmission grid would not be impacted, the distribution grid may struggle. The outcome depends on the point at which charging issues arise. The more interconnections there are, the more resources there will be.

François Colet

In determining your input data on normal charging and smart charging, did you take into consideration the fact that vehicle size is increasing, with possible impact on charging frequency? How did you calculate grid fleet versus private car?

Thomas Veyrenc

Were I to repeat this study, I would include far more parameters, to gain even greater precision in modelling.

Panellists Contributions

Christophe Bonnery
Enedis, France

France ratified an Energy Transition Act last year, stepping up the nation's commitment in this area. It now addresses the market in terms of four value chain segments: generation, transmission, distribution and electricity supply. Within the unbundled system, Enedis is responsible for electricity distribution, and is as such the player most affected by this transition: whether by the prosumer activity which the transition encourages, enabled by smart meters, in particular Linky meters, by renewable energy sources, or by electric cars.

A revolution is underway: electricity will no longer flow top down, but in a distributed mode. This affects the investments Enedis makes, not only in terms of allocation (current total investments amount to 4 billion, all distribution operators included), but also time and place. To determine its strategy, it will take four drivers into account: security of supply, volume, geographies and economic triggers.

There has been a surge in the electric car market since end-2016, with 90 000 vehicles registered in France, and 14 000 charging points. In 2019, we plan to have up to 100 000 public charging points, and 154 000 in 2020, alongside the 1 million EV target. With each household owning an electric car, Enedis will have to accommodate for as many new "boilers", plus fast-charging points (each equivalent to 20 washing machines), and ultra-fast charging stations (each equivalent to at least 20 new households). For the time being, France lacks homogeneity in its coverage and level of services provided.

Christophe Bonnery

We are developing pilot projects, including BienVEnu, to demonstrate the flexibility and interest of commanding charge periods. We also discuss with manufacturers, equipment suppliers, and smart load device makers. The contractual nature of these arrangements does not allow me to say more.

A Speaker

Just 10 months ago, blackouts were being predicted and very worrisome information was spreading about the billions of euros in new investments that would be needed. Now, electric vehicles are emerging as a major step in the electrical transition policy. We need to provide for flexibility in addition to the grid, specifically through deeper discussions with manufacturers.

Christophe Bonnery

It is technically and financially feasible to integrate the number of cars projected, provided we know the direction in which we are heading.

Jan Lepoutre

Are you discussing the electricity grid with the electricity producers as well, as their investment periods are probably also structured over the long-term?

Christophe Bonnery

We discuss with all stakeholders, generators large and small, as well as those enabling decentralisation, and those working toward greater flexibility.

Thomas Veyrenc

You discussed only mainland France, not the overseas territories.

Christophe Bonnery

EDF is in charge of the system in Corsica, not Enedis. The cost of production on that island is very high, as is the level of CO2 emissions. Thereafter, it becomes a matter of learning to manage the system, with the related need for storage.

Willett Kempton

Autonomous vehicles will almost certainly be electric vehicles, if only for safety reasons.

Where grid services are concerned, sellers of these vehicles would like these to be parked and serve as resource 95% of the day. From the societal perspective, autonomous vehicles could be used by systems as well as by humans and be shared, perhaps reducing resource availability to the grid, but also enabling less use of steel, rubber, etc.

With the autonomous vehicle, there is also the possibility of motion. In the event of a shortage on the grid, 1 000 vehicles could be directed to secondary sources of energy and the resulting mobile storage enjoyed. 2-5% of the time, wind must be curtailed for lack of transmission, the alternative being mobile storage to those locations. It is similar to the tractor-trailers currently used by distribution utilities to bring in power in the event of major line outage.

François Colet, Vedecom

The deployment of autonomous vehicles could also be subject to multiple scenarios, albeit with fewer possibilities: only premium, privately-owned, autonomous vehicle; general autonomous privately-owned; shared car; shared robo-taxi. The decision will change demand on the city and the location, as well as open up services related to the grid. The autonomous vehicle should be linked automatically; it would be non-sensual otherwise to have to involve a human, and much more convenient (weekly, from each location).

Christophe Bonnery

I confirm that autonomous vehicles will be electronic. A second game changer is the shared vehicle, on a different time horizon, the former appearing to be later than the first.

Willett Kempton

Business models for car sharing are under revision and testing. The DRiveNow program using BMW i3's, for instance, does not require the driver to park and plug in when returning the car. Instead, when users seek vehicles on their application—if the EV is over 30% charged, the car is offered for use per hour and per kilometre; if less, use is free of charge, to incentivize customers for plugging in cars with low charge. This mechanism creates a built-in incentive and, as a result, the cars are always sufficiently filled.

Floriane Petipas

Bouygues considers the impact on the city. As the autonomous vehicle may be electric and shared, it would diminish capabilities for vehicle-to-grid, but also offer more stationary storage. Also as a result of shared vehicles, there could ultimately be far fewer parking spaces, completely changing physiognomy of cities.

Bruno Flinois, Clem

As a player expert in EV-car sharing, I am very pleased with the French Government's signal that 15 million cars could be electric by 2035. Smart charging is an aim, not only for grids but also for the use of EV. The use of smart-charged EVs is ecological in principle, but if started at the wrong time, will not enable ecological mobility.

The BienVEnu programme with Enedis (http://www.bienvenu-idf.fr/) has been very important in showing that EV can be used in local and collective settings, at viable costs.

Willett Kempton

Enabling V2G requires regulatory change, interested automakers, infrastructure providers, and aggregators, but not significant costs. In light of this, why worry about whether it is necessary versus only "nice to have"?

Thomas Veyrenc

We would like to sidestep past errors. To enable residential demand response, a great deal of time was spent accommodating consumers of different sizes, grids, suppliers, etc., and balancing all jurisdictions. Even the Constitutional Court took up the topic, for what was ultimately a nominal outcome. We spent so much time on the regulatory opening needed to enable the business model, but ended up only with 100 MW of residential demand response. If V2G proves interesting and all the necessary regulatory adjustments can be sped up, we will take that path; otherwise, we have more urgent tasks at hand.

François Colet

V2G could prove more relevant elsewhere in the world for the time being. Jordan and Sri Lanka do not have the best grids, but are using electric vehicles. Without V2G capabilities, no electric mobility will be possible.

Thomas Veyrenc

I do not discount this, but wish to know more about V2G first. I find that regulation is often put before economics. In reality, when the economics make sense, i.e. the value is proven, quality regulation can follow.

Christophe Bonnery

Customers want high-quality electricity, free of shortages. Therefore we need to provide a robust network with some redundancy.

Michael Jacobides

I agree, but the "economics" are seen too narrowly. The main issue in this regard is the extent to which demand exists and how it will manifest. The bottleneck lies in the monetary incentives offered. Most OEMs will say that human beings' interaction with mobility is the main source of change, i.e., the emotive understanding and impact on status.

Ford, Daimler, Uber and others are looking for solutions in the patterns of usage, so that they can create sufficient economies of scale for electric vehicles. There is much to be gained from revisiting the promise of these vehicles, rather than continuing with traditional modes that leave opportunities by the wayside. It is much more valuable to identify the heterogeneity, drivers of growth and competitive structure, and to focus not on the technical problems, when most issues are in the institutions, pricing and business model.

Romain Beaume, Nexans

Nexans offers a good example of opening up to a new ecosystem. Nexans developed new business models and embarked on multiple projects with DNOs. These projects were related to smart grid initiatives, & they were for Nexans an opportunity to create links and synergies between EV charging solutions and smart grid developments.

Practically, we have rolled out charging stations in northern France, within an innovative transport scheme. We realized that innovative mobility solutions is a very promising path, and then decided to design products in accordance with the specific needs for shared mobility.

Integration of EVs can go hand in hand with that of renewable energies. We encourage new approaches not only to those buying hardware, but also all those involved in the territory and who contribute directly or indirectly to funding schemes.

Eric Lalliard

Do you see area-specific responses? Will we be in the same place in 20 years?

Floriane Petipas

We have tested building blocks in these projects, and know that the clients want something different. We will produce a set of solutions and adapt them as needed over time.

Christian Thiel

The European Union has far more policies in place than those being discussed today. Its broader aim is to reduce the negative externalities of transport or in general the economy. Paris has had "electromobility" for one century, in the form of the Metro system. Similarly, rail freight in most cases is nothing more than electro-transport. Policies have to be carefully formulated so as to address market failures. Ultimately, the best policy is the one that can refrain from interfering in a market that is working.

From the floor

At its maximum, the French electric vehicle grew to 32 000 cars, then declined. How do you see the future trend?

Eric Lalliard

The market can fluctuate very unpredictably. We are working on the assumption that it will grow progressively.

Bernard Sahut

In this entirely new situation, we are obliged to make assumptions. The future is not a book which we can open to a certain page to check how it will look. We can only make sure that we are in a position to respond to the majority of assumptions.

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