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Cambridge Service Alliance

Case Study

E-MOBILITY SERVICES

New economic models for transport in the digital economy

Case Study for Research Council UK Digital Economy Theme



Author:

Claire Weiller

Cambridge Service Alliance

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Introduction

Information and communication technologies (ICT) are changing the relationship between three major systems: transport, energy, and consumers. Examining the example of the electric car-leasing system currently implemented in Paris, Autolib', this case study shows how the digital economy is enabling new business models and the introduction of electric vehicles (EV). ICT are at the core of the change from traditional mobility as we know it, to mobility-as-a-service. The servitization¹ of mobility in urban areas is characterized by two main changes to the business model of private transport. The first is a new ownership structure, whereby end-users do not need to own a car to drive one. Second, a revenue and cost structure appears in mobility services: end-users pay a subscription fee that includes all ancillary costs such as insurance, maintenance, and refuelling, while the service company bears all of the upstream and downstream risks.

Since one vehicle can service around 15 times more users daily than a privately-owned vehicle, mobility-as-a-service business models increase the efficiency of "private" transport in cities. Other urban mobility service providers (e.g. Zipcar, Car2go) offer conventional vehicles, typically gasoline or diesel. Electric vehicles differentiate the value proposition for customers by offering a low pollution, low-noise driving technology, where the additional costs over conventional vehicles are justified from the enhancement from new ICT services.

In this report it is argued that the main source of innovative value creation is in the connection of cars to the electricity grid. The connection of vehicles to the grid enables smarter energy demand management, as well as new opportunities to store electricity in EV batteries or use them as energy regulation service providers for the distribution network operator (DNO). By enabling the transmission of information between the electricity network, the telecommunications network, vehicles, and consumers, ICT-driven business models improve the efficiency of electricity use and of mobility in cities.

Digital innovations such as smart grids² and smart phone applications are already beginning to change the way consumers manage their electricity consumption. Real-time information about electricity prices and monitoring via smart phones will enable customers to

¹ Servitization can be defined as "a process whereby manufacturers moves from product-led towards a service-oriented business model". Glossary of the Cambridge Service Forum, 17-19 Sept. 2012

² The Electric Power Research Institute defines a "Smart Grid" as "one that incorporates information and communications technology into every aspect of electricity generation, delivery and consumption in order to minimize environmental impact, enhance markets, improve reliability and service, and reduce costs and improve efficiency". EPRI, 2012



Figure 1. A representation of the smart electricity landscape. Source EPRI, 2012.

adjust their habits and patterns of use of energy-intensive appliances in homes according to their own cost and comfort preferences (Strbac, 2008). With a transition to electric vehicles, cars will be integrated into smart grids and smart homes which have the ability to automatically optimize the operation of interconnected elements and provide better services for end-users as well as for electric utilities.

To illustrate the development of such innovative business models, this report explores the case of electric mobility (e-mobility) services offered in the greater Paris area, where electric cars are available for short-term leasing to any member of the public with a subscription. Among the many emerging electric vehicle "ecosystems" in the world, the case of Autolib' is one of the first to be fully functional and established within a large European metropolis with an existing customer base. Two perspectives on this "ecosystem" are provided in this study: the existing business model and the potential new strategies.

The report begins with a presentation of the ways in which ICT enhance the value proposition for users by providing sophisticated information on the network and state-of-charge of the vehicle in the Autolib' business model. It is then suggested that while ICT do add to the customer value proposition in this business model, the full potential of ICT-enabled value creation in this emerging market, especially from the supply-side, is not yet achieved. Untapped opportunities at the interface of electricity supply and ICT include the use of EV batteries for electricity storage and grid management. These are discussed in detail in the last sections of this report. ■

Free parking on the Champs Elysees

In December 2011, the city of Paris introduced the Bluecar, a 3-door electric vehicle (EV) designed by Pininfarina and Bolloré, available for short-term use at any one of 250 stations in the city of Paris and municipalities in its vicinity. Following the successful Vélib³ bicycle-sharing program, which was subsequently copied in various cities of the world including London and Mexico City, and smaller-scale experiments in provincial cities of La Rochelle and Lyon, Paris local authorities introduced electric vehicles as a complement to public transport and alternative to private vehicle ownership. As one user commented, "it is a small miracle to get parking, let alone free parking, on the Champs Elysees"⁴. In these early days, Autolib' is realizing this small miracle in many of the busiest areas of the city.

Autolib' is managed by a syndicate of municipalities in the Paris metropolitan area and is operated by a horizontally integrated transport, logistics and infrastructure company, Bolloré. Its revenue structure is therefore still dependent on public financing. The subscription fee (see Table 1) includes fuel (electricity) costs, as well as the other costs of driving: insurance, maintenance and repairs, and parking.

From the initial 250 vehicles, the program grew to 1,750 EVs and more than 5,000 charge points at 710 stations in 2012 in the Paris metropolitan area, including 45 surrounding communes. In the final stage, Autolib' is expected to provide 3,000 vehicles and 6,600 charging stations.

38,800 subscriptions have been recorded to date⁵, of which 13,600 annual subscriptions. This grew from 15,000 subscriptions recorded at the end of May 2012⁶, of which 6,000 were annual. This significant increase in the number of users in a few months may signal the onset of an exponential adoption pattern, particularly at a time when Bolloré plans to improve and expand the service with its new round of financing obtained in September 2012 from the European Investment Bank of €75 million⁷. The low number of annual subscriptions may be due to the fact that much of the value of the service lies in its flexibility and appeal as a short-term, perhaps last-minute, solution for drivers without a car. On June 15 2012, Autolib' launched an offer

³ Vélib' is the one of the largest bike-sharing services in the world, run by the Paris Town Hall since 2007, with over 65,000 rides per day, 20,000 bikes and 1,800 stations. En.Vélib.paris.fr

⁴ Interview with Tali Trigg, Transport Policy Analyst at the International Energy Agency. 14/09/2012

⁵ Article on Yahoo Finance dated 12 October 2012. Retrieved 14 October 2012

⁶ www.michelinchallengebibendum.com

⁷ www.bfmtv.com

for the corporate market segment, after a market study estimated that 315,000 people could be interested by such an offer and several hundred firms inquired about this possibility³. An important aspect of the business model is its versatility: the charging stations can also be used to charge private EVs for a subscription fee of 180€/year.

The Autolib' model makes sense in the context of Paris, a high-density city of 105 km² (compared with London's 1,570 km²). The 250 km range



Figure 2. A Bluecar in Paris

of the Bluecars for city-driving and 150 km in highway-driving mode is sufficient for nearly 100% of drivers' average daily needs (in London, 90% of car journeys are less than 10 miles). With speed limited to 50 km/h in the city center and 130 km/h on the highway, the 130 km/h offered by Bluecar is appropriate for its purpose. Currently, 58% of Parisians do not own a car (Kaplan, 2011).

What were the motivations behind the launch of the Autolib'scheme? The first is probably the goal of the French Etat to support innovation and technological leadership from its automobile manufacturing sector, the second largest in Europe. The automobile industry in France represents 17% of total R&D spending (€5 billion) and more than 12% of France's exports⁸. French automobile manufacturer Renault, one of the forerunners of the EV market, launched four EV models in 2011 (for all EV models released up until 2012, see Appendix Table 3): the Fluence ZE (185 km range), the Kangoo ZE,

⁸ www.finpro.fi



the Twizy, and the Zoe (100-150 km range). Autolib' is a marketing message to the public that the transition to EVs is occurring, aiming to stimulate commercial demand for EVs. In 2011, electric vehicle sales in France were the second highest in the world after the US, with 2,630 units sold (Appendix Table 2).

	Year	Month	7 days	24 hours	Shared subscription for 4 users (16h/month)
Subscription	€12/month	€30	€15	€10	€165/month
1st half hour	€5	€6	€7	€7	€7,5 beyond the 16th
2nd half hour (pre June 2012)	€4	€5	€6	€6	-

Table 1. Rates for Autolib' subscription and rental

The second motivation is the environmental concern with reducing tailpipe emissions in the transport sector. In France, 75-80% of electricity generated is from nuclear power. In 2011, the carbon intensity of electricity production was less than 100g CO₂/kWh, much lower than its European neighbors that average 443 gCO₂/kWh. France is also a net exporter of electricity.

Finally, the Autolib' service is provided with the intent to reduce congestion in the city center by reducing car ownership.

A public-private partnership

The Autolib' project was commissioned in 2009 by the Paris Town Hall under Mayor Bertrand Delanoë, member of the Socialist Party in office since 2001. Legally, Autolib' operates as a company of the Bolloré Group and is managed by a municipal syndicate of 47 communes in the Paris region, the 'Syndicat Mixte Autolib'. The industrial conglomerate Bolloré, which has subsidiaries in the areas of transport, infrastructure and logistics won the bid for the Autolib' project against five other organisations: VTLIB' (Veolia Transport urbain), a joint partnership between Avis-SNCF-RATP-Vinci Park, Interparking (a Belgian company), Extélia (Groupe La Poste) and ADA, a car rental company.

The strategic advantage which led Bolloré to win the contract was the fact that it was a single vertically-integrated company that could provide every part of the Autolib' service, from vehicle and station development to customer contracts and services. Bolloré was willing to bear all the risks of the project⁹ on behalf of the syndicate and customers. Bolloré operates in a joint venture with Pininfarina for the design of the electric Bluecars, and with company Cecom in a €14 million contract¹⁰ for the manufacturing. The lithium metal polymer batteries are made in Brittany.

Cost savings: A value proposition

It has been estimated that Autolib' drivers can save about € 7,000 per year by using the service rather than buying a car in Paris – a total of €315 million over all users per year (Kaplan, 2011). Indeed, mobility-as-a-service is hugely efficient relative to ownership. Cars in Paris are driven only about 5% of the time and stay parked the remaining 95% of the time. This simple statistic reveals how sensible urban mobility services are. Every Bluecar can provide 15 times the use than an individually-owned vehicle. A trip from North to South of Paris requires only about 15% of the battery charge of a Bluecar. Local incentives such as preferential parking, road tax exemption, registration tax exemption, and access to bus lanes add to the value proposition. This public service is offered for the many travellers who cannot afford to buy a private car and need to travel to areas in the greater Paris region that are not well connected with public transport.¹¹ New drivers with licences of less than 3 years can sign up for Autolib', while car rental companies often request a minimum age of 25 or licence tenure for rental contracts. A risk associated with Autolib' is that negative reviews of the service hinder rather than encourage EV adoption.

A business model without a profit?

Some of the main elements of a business model, whether from an accounting or a strategic perspective, are the profit and loss streams (e.g. Chesbrough, 2010; Osterwalder & Pigneur, 2010). So far, Bolloré has been operating the Autolib' project at a loss. It has been estimated that Autolib' could lead to a loss of €60 million over its 10-12 years of operation if the service underperforms relative to

9 Interview with Maryline Marilly at the Electric Vehicle Symposium 26, 08/05/2012
10 14/03/2011 Pininfarina seals joint EV production deal (Int'l, New Prod. & Tech.)
11 Annick Lepetit, Deputy Mayor of the Socialist Party and chair of the Autolib' syndicate

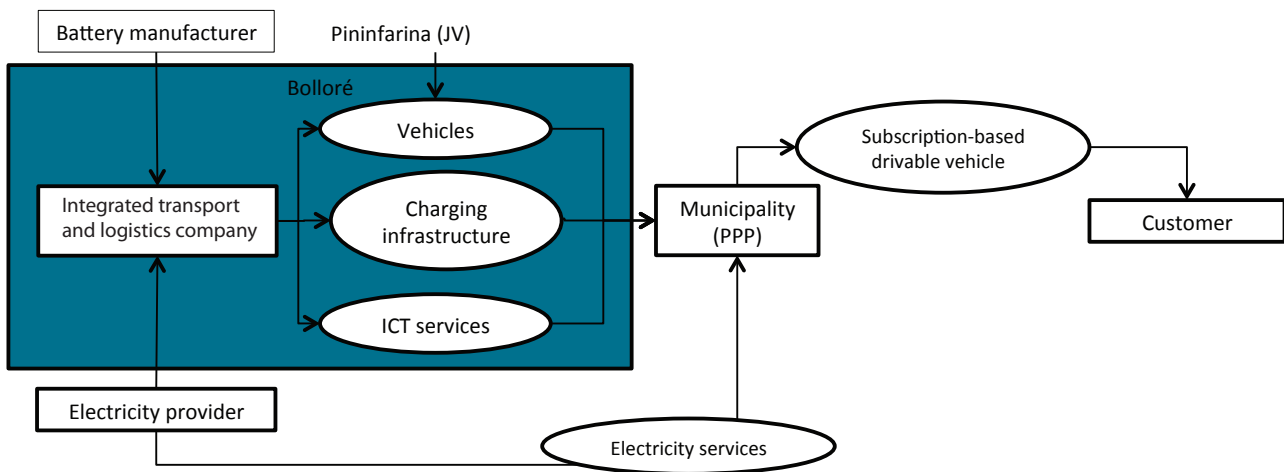


Figure 3. A public integrated EV-sharing service: The Autolib' scheme

expectations⁸. The region Ile-de-France subsidized the project for €4 million at its debut and the European Investment Bank provided a €130 million loan for R&D in early 2011. The annual operating expenditures are estimated to be about €80-100 million and the total investment cost, €1.5 billion¹². The single most expensive component of the Bluecar, the lithium metal polymer battery, costs between €18,600 - €23,250 for the 150 - 250 km range, assuming current prices of 620 - 775€/kWh of electric storage capacity¹³. For the moment, the company's increasing expenditure in the electricity

storage business (batteries, over-capacity, electric vehicles, and Autolib') are compensated by income from other activities of the business, in transport and logistics, which benefited from high volumes worldwide¹⁴.

In a press conference in May 2012, Bolloré stated it would take 80,000 subscriptions to break even financially, which the company expects to reach in 2018. If it fails to subscribe a sufficient user base to become self-sustaining, there is a risk the Autolib' service will remain dependent on public financing. However, Autolib' is seen by Bolloré as a "pilot project" that will lead the market by example and potentially result in many other contracts. The Bolloré Group profits from the auxiliary supply contracts that result from the Autolib' project. Net income remained relatively stable in the first half of 2012 (Figure 4).

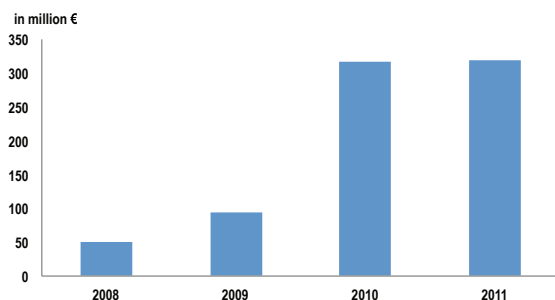


Figure 4. Bollore's net income 2008 - 2011

The Autolib' business model of public car-sharing has a strong value proposition to customers in terms of cost savings relative to vehicle ownership. However, the main benefits from the service are in the ICT functionalities that significantly enhance the value proposition, which are discussed in the next section. Despite its current operating financial loss, the digital economy offers many options for Bolloré to profit from ICT-driven business models around charging infrastructure and software, energy management, and from the "big data" it is able to collect on EV usage and driving behavior. These are discussed in [the following section](#). ■

¹² Morald Chibout interview 09/12/2011.

¹³ Interview with Tali Trigg, Energy Analyst Transport Sector, 21 Sept. 2012.

¹⁴ Financial report 1H2012

Value creation strategies: EVs in the digital economy

Many of the value-add services of e-mobility with Autolib' lie in the ICT. Full journeys can be planned in advance with the Autolib' system. Autolib' vehicles can be booked up to 24 hours in advance via mobile phone or the internet. Parking spaces at the station of arrival can also be booked in advance. The GPS in Bluecars allow users to locate all Autolib's stations including the nearest ones, with information on how many vehicles and parking spaces are available. In-vehicle equipment provides precise information on the state-of-charge (level) of the battery in the car and on the equivalent time and distance left. Signing up for Autolib' can be done online with the submission of a valid driver's licence. Users receive a text message with the amount spent after each trip. Furthermore, a contact person is always available to answer questions in case of any issue from a direct line in the vehicle. This customer-care service is particularly valuable to develop trust between users and the new technology in the early days of EVs.

As the market for electric vehicle develops, telecom operators are expected to play an increasingly important role in the provision of charging services, for example by offering EV charging options through mobile devices to their customers (ABB, 2012). The parallel between mobile phone services and mobility services has been explicitly made in the design of EV services business models. Better Place, a start-up company based in the Silicon Valley, voiced the

analogy of their vision of EV services with mobile phone services:

"On the analogy of telecommunications networks, [an integrated infrastructure and software service company] would be positioning itself to be the AT&T of EV systems — while car manufacturers like Renault-Nissan and Toyota will be the Nokia and the Motorola." (Andersen et al., 2011)

Indeed, the mobility service company provides access to a network of recharging points and vehicle stations and the subscriptions take a similar form: a fixed monthly fee, with extra costs for additional time. Similarly to mobile phones also, the customer can expect a bundle of services and features (operations and maintenance, fuel, insurance, GPS, help-line). Will there be a day when both services are provided by the same company, an integrated telecoms and energy service provider?

"The business is in the software"¹

The impact of ICT will not be limited to the customer segment of the EV ecosystem. Companies entering the business of charging infrastructure for electric vehicles are increasingly convinced that the value in the business model lies in the software rather than in the charging stations and infrastructure. Developing a user-friendly software that will be popular and encapsulated within the right

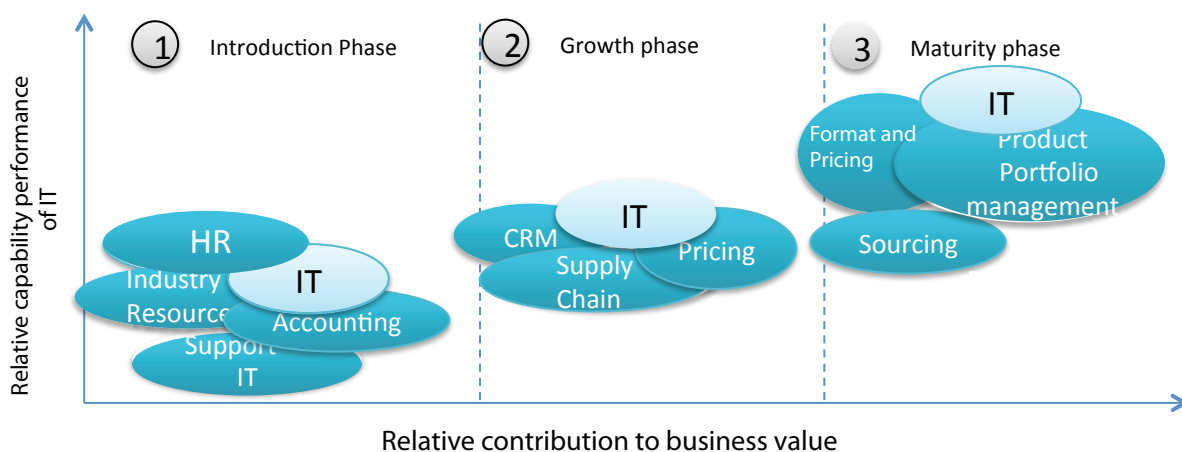
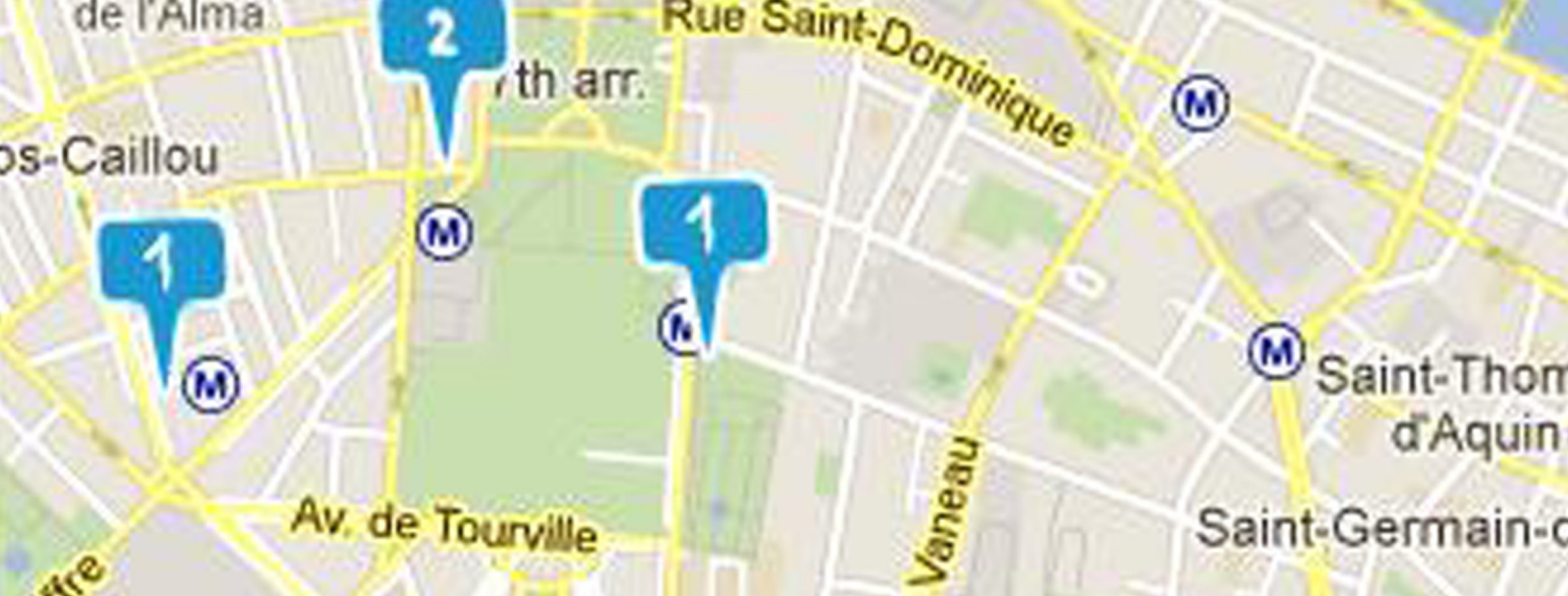


Figure 5. Capability map for a charging station operator and the relative performance of information technologies (IT). Source: Adapted from ABB, 2012

¹ Flora Heathcote, Commercial Director at PodPoint, a UK start-up company in the business of EV charging. Interview at Smart Grids Conference 14/06/2012, Cambridge.



design of charging station will be key for providers to differentiate themselves from their competitors.

This idea is well-developed in ABB's white paper "Towards winning business models for the EV-charging industry". Three phases of maturity of the EV industry are distinguished. During the introduction phase (1), ICT plays a minor role in companies' success and is more of an enabler that is necessary to operate the charge station. The basic ICT functionalities of a charging station would be the integration of point of sale, billing applications and navigation aids. Phase (2) is a growth phase of the EV industry, with rising adoption and e-mobility services. In this phase, market players will need to manage effects such as the increased load on the electricity grid. ICT's role will extend to provide players with a competitive advantage through applications and platform interfaces for grid management, maintenance and remote diagnostics of charging equipment and the visibility of charger status to users. In the industry maturity phase (3), as competitive pressures intensify, most ICT applications will aim to control costs and increase revenues, e.g. by modelling the battery life and developing consumer-oriented applications. Following this view, the contribution of ICT to business value in the Autolib' ecosystem could be in stage 1 and has the potential to evolve to be exploited further. Innovative applications of ICT in business models are discussed in the next sections.

Energy management

With the ICT embedded in vehicles, charging stations, and the electricity distribution grid, e-mobility systems provide new opportunities to manage energy demand for driving, which do not exist with petroleum vehicles.

One of the major characteristics of electricity is that it cannot be stored and therefore has to be continuously balanced in wholesale electricity markets. Transmission and distribution network operators continuously monitor physical supply and demand in the power system during the day, and adjust production and load accordingly. Retail electricity users are usually shielded from intra day fluctuations in the price of electricity, i.e. their demand is highly inelastic with respect to price. However, utilities such as EDF Energy in the UK and Southern California Edison in California are beginning to provide special tariff structures that differentiate prices between peak and off-peak hours, to encourage smart charging behavior. With advanced

digital technologies, customers can stay informed of electricity prices in real-time and decide when to charge their vehicles accordingly, or select automatic programs for EV charging. This service will be offered via mobile phones, internet, and smart meters installed in homes.

Considering a household's energy demand, vehicles would be one

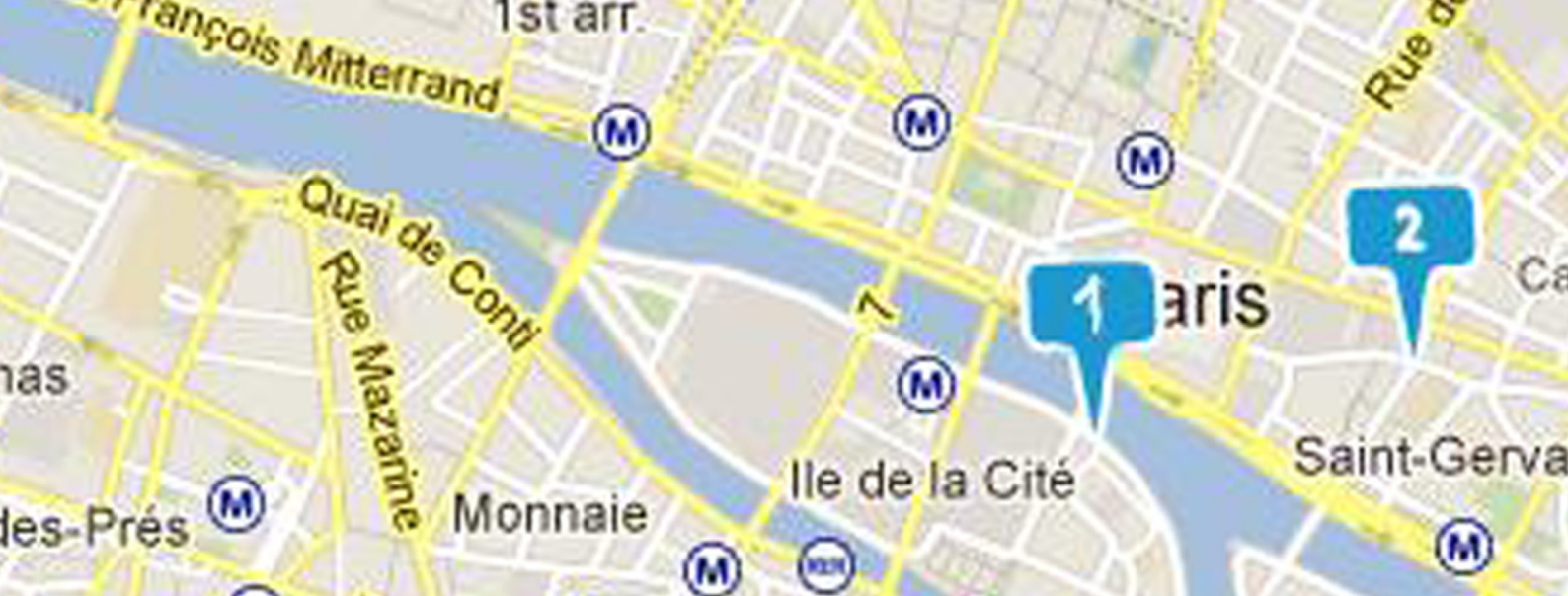


Figure 6. ABB Terra 51 EV fast-charger, Photo: ABB.

of the most flexible resources in terms of electricity demand: as long as they had sufficient battery capacity for the next trip, customer comfort is preserved.

"One could imagine different tariffs and demand-response schemes for different categories of device and usage, with core services such as heat and light dealt with in one way but optional use such as washing machines or TVs handled in another". (IBM Smarter Energy series, paper 7)

With the Autolib' business model, customers are shielded from the cost of electricity altogether, since recharging is included in the subscription. However, in other business models, ICT can enable



many options for electricity demand management from electric vehicles in a way that reflects the costs of electricity production. At this stage, Bolloré is responsible for managing the charging patterns of its fleet in the most cost-effective way.

An “intelligent” EV charging network would also change the way customers pay for their fuel use. Instead of the simple “pay at the pump” model at gasoline stations, users will have a choice of different payment types when using charging stations outside of the home. One option is to add EV charging to drivers’ monthly electricity bill, along with the rest of their household consumption. A system-wide ICT architecture and data network needs to be in place to enable this option (IBM, 2012). Alternatively, prepaid charging cards could be used, similarly to cell phone “pay-as-you-go” credit. In Ireland, for example, IBM and the Irish electricity provider ESB are partnering on the development of an integrated charging IT system for EVs². The initiative aims to enable drivers to access the 1,000 or so charging points across the country with an ID card. ESB Networks, which is currently rolling out the public charge points around Ireland, will use IBM’s ‘Intelligent Electric Vehicle Enablement Platform’ to operate and manage these charge points.

Data management

Currently, charging infrastructure and software providers such as ABB, IBM, and Siemens, but also smaller ones like PodPoint in the UK, are collecting data on the use patterns of EVs and of charging stations. At such an early stage of the market, these databases are hugely valuable market research tools to understand demand and driving behavior. Autolib’ can easily collect commercially valuable data on its users through its system.

Other examples of initiatives by the industry to collect user data include the online database created by General Motors, voltstats.net³. GM launched the Chevy Volt⁴ on the US market in 2010 and has been collecting statistics on usage from drivers who voluntarily signed up for it – these were usually EV enthusiasts and early adopters.

Another example of a highly developed database for charging stations is NOBIL in Norway, which is currently one of the largest markets for battery-powered vehicles with 3.6% of passenger car sales in August 2012. The database has been developed as a collaborative

2 analysis.evupdate.com/ 27-september-3-october-2012
3 www.voltstats.net

4 93 miles-per-gallon (2.5 L/100km) fuel economy

project between a government entity (Transnova) and the national association of EV-users (Norsk Elbilforening)⁵. The aim of this open database is for all agents in the EV charging industry to contribute standardized data to facilitate the creation of new services. Data from the charging stations include payment types, owner, time limit and charging capacity of every charging station in the country, and can be updated in real-time.

ABB, a leading provider of charging stations (Figure 6), developed a remote access application called Galaxy for its corporate customers managing an EV fleet. The web-based application is “designed to interact seamlessly” with any of the client’s electric vehicle charging stations. Customers can capture information in real-time regarding charger availability, level of demand around a specific charger, provide authorization/billing and integration services as well as smart grid communications to control charging during periods of reduced load and electricity costs⁶.

Big data in the digital economy is playing an increasing role as a source of value and profit in service business models⁷. By entering early in the e-mobility market, service providers such as Bolloré and its partners gain an early-mover information advantage. The knowledge and experience with EV customers hold an intangible but surely immense value towards improving their own business model and service. ■

5 Kvisle, H.H. 2012 The Norwegian Charging Station Database for Electromobility (NOBIL). Proceedings of the EVS 26 Conference 2012.

6 ABB website

7 Cambridge Service Alliance, 2012 (<http://www.cambridgeservicealliance.org/events/cambridge-service-week/2012-2/big-implications-for-big-data.html>).

McKinsey Global Institute, 2011. Big data: The next frontier for innovation, competition, and productivity.

Creating more value from e-mobility in the digital economy

The potential for value creation from electric vehicles in the digital economy is far from being fully achieved. This section extends the discussion of ICT-driven business models for electric vehicles to other innovative applications that are currently being discussed in the industry and academic literature, including:

- controlled, “smart” EV charging,
- (renewable) electricity storage in vehicle batteries,
- the provision of regulation services for secondary energy markets, and
- the integration of electric vehicles in home energy systems.

Each of these can only be achieved in the context of an “intelligent” energy network enabled by the deployment of smart metering and smart communications technology (Andersen et al., 2009). Digital technologies will enable communications between vehicles, charging infrastructure, grid operators, renewable power producers, and home energy management systems.

1. Optimizing charging times

The impacts on electricity demand of electric vehicles can be summarized in three main effects:

- increasing the overall demand in electric energy,
- instantaneous power demand will require balancing of local distribution networks, and
- improved utilization of the power grid, if vehicles are charged at periods of low electric demand.

ICT will be valuable in order to optimize EV electricity demand. Indeed, controlled EV charging will provide a double benefit:

- 1) to customers by reducing their fuel bills and
- 2) to utilities by optimizing the utilization of the power system’s capacity.

The greatest risk and challenge to be solved by ICT is if customers expect faster charging. Charging infrastructure developers are currently working on increasing charging power rates to levels from 50 kW to 120 kW. Such high instantaneous power demands on the grid will require special management and balancing strategies to

Exhibit 1: Fast-charging

- TEPCO, the largest Japanese electric utility company, is developing a charging standard, ChadeMo, that allows EVs to recharge to 80% in less than 30 minutes at 50 kW.



- In comparison, home power outlets provide around 2 kW
- This technology solves the problem of long-distance travel and fits seamlessly into customer driving habits
- However, connecting a few EVs on a residential power distribution grid poses a huge risk of a blackout due to the demand spikes it would cause.
- The effects are likely to be exacerbated by the fact that EV adoption will happen in “clusters”, due to “follow me” behaviours.
- Demand surges will also cause price spikes.
- ICT will be able to control vehicle charging depending on the state of the grid at the time the EV is plugged in.
- ICT and smart charging algorithms will allow EVs to schedule charging during times of low demand on the electric power system, when prices are low such as during night-time, while respecting the charging requirements of vehicles for the next trip.



ensure the security of the network. This will be particularly true if the peak EV demand occurs at the same time as the overall electricity peak, which is quite plausible. The role of ICT in managing such risks is illustrated in Exhibit 1.

Academic research in the field of electrical and information systems engineering is currently developing such algorithms (EPSRC, 2011; Clement et al., 2009). The optimization of vehicle charging schedules must consider physical network constraints, system and local demand and prices, and the potential interaction with low-emitting and renewable generation technologies (Galus et al., 2010; Wehinger et al., 2010; Momber et al., 2010).

The integration of electric vehicles in the power system may also improve the capacity utilization of installed generation and transmission capacity (Parks et al., 2007; Kintner-Meyer et al., 2007; Denholm & Short, 2006).

2. EV batteries value for energy storage

As previously discussed, a critical feature for electricity market design is that electric energy is currently not storable. Electric vehicle batteries have the potential to change this and to serve as both an energy resource and load.

Integrated into “intelligent” power networks, EV batteries can be particularly valuable to store intermittent renewable energy production from new technologies such as wind and solar power.

Eventually, EVs will move from being passive storage devices to being able to release energy back to the grid or to the home – this is called vehicle-to-grid (V2G) or vehicle-to-X (V2X). The V2X concept includes the delivery of energy to the home, in smart home energy systems, or to any other direct energy load (Beer et al., 2011). With V2G/V2X, vehicles become energy suppliers as well as consumers (e.g. Kempton & Tomic, 2005). EVs and ICT are part of a vision of the future electric industry landscape formed by the Smart Grid and distributed energy generation (such as solar panels in homes).

3. Home energy systems and building services

Leading business solution providers such as IBM and vehicle manufacturers such as Toyota are collaborating on concepts of smart home energy systems with electric vehicle connections. ICT are key to these new business models (Exhibit 2).

Exhibit 2: Toyota Smart Center

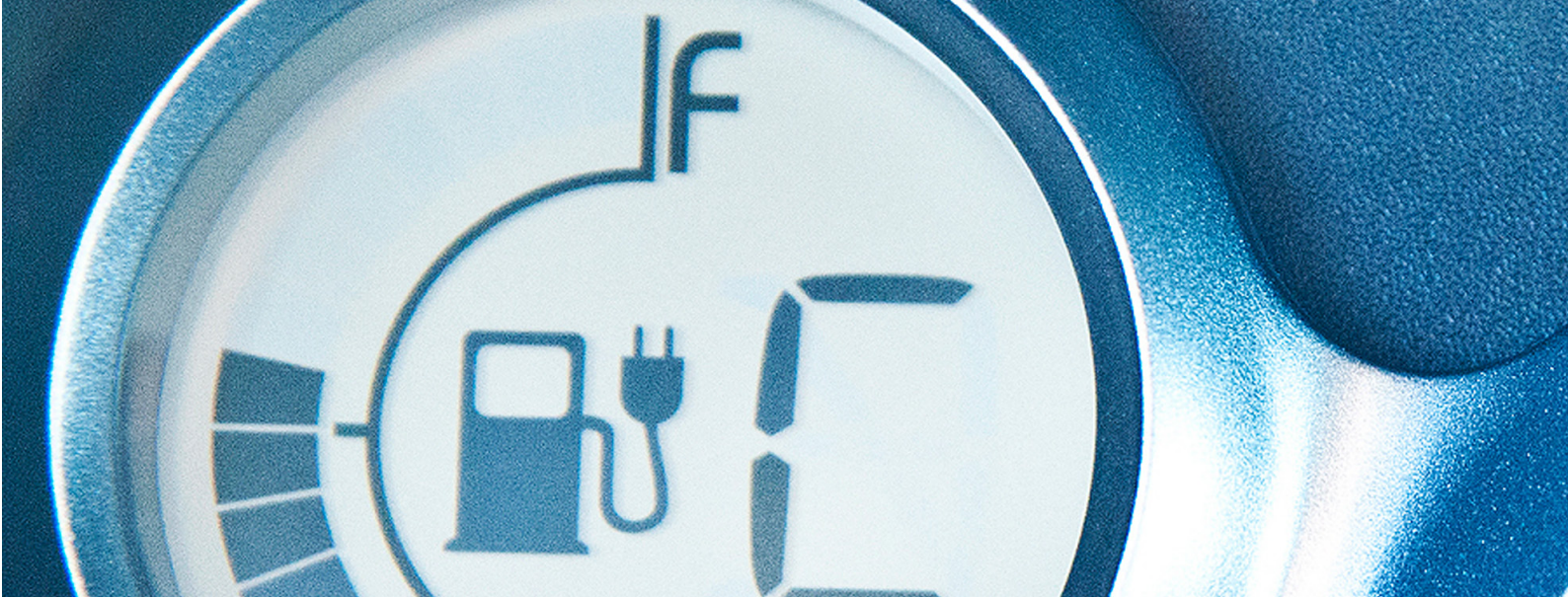
- Toyota Home Energy Management Systems (HEMS) use information transmitted from an EV connected to households on:
 - * remaining vehicle-battery charge,
 - * household power consumption,
 - * weather forecast data
 - * electricity rate information from the power company.
- The objective is to minimize CO₂ emissions and reduce electricity costs
- This is done by coordinating vehicle recharging and household energy consumption
- Users can remotely check with their smart phones the current battery charge of their vehicle and the distance it could travel
- Other services include adjusting the charging time or turning the air-conditioning on or off to ready the car for use.

4. Competition in electricity retail (and choice)

The introduction of ICT in electric mobility services will make it easier for customers to choose between different electricity contracts and payments and different suppliers. ICT and software will be a differentiating feature between charging solution providers.

This increase in offer transparency will benefit the consumer and certainly lead to more competition in the market. New alternative energy suppliers are likely to enter the market (Exhibit 3) including private land owners such as restaurants and shopping centers, new EV charging companies, and telecoms companies.

Furthermore, it is likely that businesses will begin to offer recharging facilities for advertizing purposes, i.e. that shopping centers will offer to give away free electricity for charging to attract customers. Indeed, “major retailers might consider it a relatively small price to pay for customer loyalty” (IBM, 2012), especially since at current electricity



prices to large consumers, a full battery charge could cost as little as £5.

5. Battery secondary use

Used battery packs will need to be recycled and then can be used to provide services in a “secondary life” to micro and macro grids, thus maximizing the overall economic value of batteries. Drivers could be compensated for the disposal value of their battery, which would allow them to replace them before their actual end-of-life and benefit from improved new available technology. An example of a business model where this is the case, and a discussion of the role of ICT in this context, is provided in Exhibit 4. ■



Exhibit 3. Competition in downstream electric vehicle services

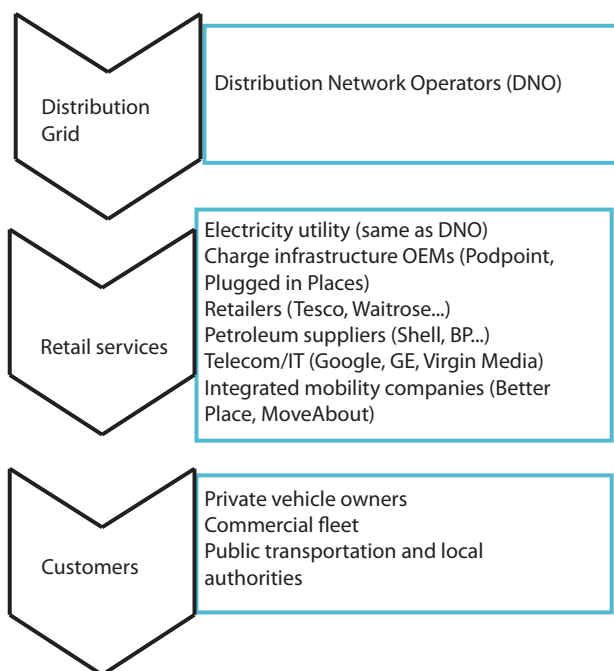


Exhibit 4. Better Place and the secondary value of battery packs

- Better Place is an e-mobility service company founded in 2007 in Palo Alto
- The Better Place business model is based on the concept of battery-swapping: automatic replacement of depleted battery in 4 minutes without getting out of the car
- This is done at battery swapping stations
- Customers are charged a “per mile” subscription fee, rather than “per hour”, thus offering the service of travel similarly to a cellular network subscription (Andersen et al., 2009).
- The model is strong for long-distance travel, though the company is beginning operations in densely populated areas: Israel, Denmark, Japan, Hawaii
- This business model supposes an investment in large stocks of batteries for the replacement system. These batteries can also be used as aggregated storage systems, controlled by ICT interfaces with the grid operator, particularly towards their end-of-life when they are less valuable for driving.



Conclusion

Introduced in Paris in December 2011, the Autolib' initiative is the second largest electric vehicle sharing service in the world.¹ The service offers reduced costs of driving in the greater Paris metropolitan area through subscription contracts that are time-based and inclusive of insurance, refuelling, and maintenance.

The case of Autolib' showcases the strengths of ICT-driven business model for mobility and electric mobility in urban areas in particular. First, communications between vehicles, charging stations, and users allow for new functionalities and customer service. Customers are able to plan journeys in the most efficient way, for example by booking vehicles and parking spaces at their departure and destination stations. The advanced logistics in the e-mobility system create an optimized service, enabling maximum use to be obtained from each vehicle. A major innovation in this business model is the risk distribution that is shifted from the end-user to the company and the municipality. Finally, the network of data in this e-mobility service is a huge resource for condition monitoring of the vehicles, and also for service improvements in light of habits and preferences expressed by the service users.

Autolib' also illustrates potential new sources of value creation in the ICT business model, beyond the benefits of the service to the retail customer. By collaborating more closely with the electric utility and DNO, ErDF, the company running the service, Bolloré, can improve energy demand management for its vehicles. Indeed, a parked fleet of electric vehicles that is connected to the charging network and a data network can be charged in a "smart" way, at times that make use of spare capacity in the electric grid and even that benefit it. EV batteries can offer storage services for secondary energy markets (regulation and ancillary services), particularly if they are aggregated in large battery stocks after their "life" in cars (Bradley et al., 2011). All of these strategies "can be directly mapped to financial gains" (Kohrs et al., 2012)

The case discussion highlights some of the weaknesses of the Autolib' service business model. Firstly, the full benefits of ICT and of integrating EVs into a smarter grid cannot be seized because they take effect only on the supply side. Provided with an all-inclusive subscription, Autolib' users are not made aware of the variability of electricity prices and impacts of their vehicle use. One of the roles of Autolib', as an early EV initiative, is to inform and raise awareness in the public and incentivize future behaviour in the market. Autolib' is

¹ After Hangzhou, China

likely to require a change in attitudes towards driving.

Second, Autolib' is limited in terms of possibilities for innovation due to the standardized vehicle model, the Bluecar. The use of a single car model is the most efficient economic solution for this car-sharing system but it limits innovation and competition-driven improvements in design and technology which could promote further use and success of the service. Finally, this model separates electric transportation from residential electricity consumption. Autolib' users are informed of their electricity consumption for driving, but are not exposed to the potential opportunities offered by using electricity as a fuel: use for storage and power supply in the home, and new choices in electricity supply contracts and product offerings from utilities.

In the early electric vehicle markets, the importance of policy as a driver cannot be forgotten. Autolib' receives subsidies from Paris public authorities and is strengthened by the federal government's support of the automobile and energy industries in France, which both stand to benefit from the innovation of the electric vehicle. However, France is not the only country where policy seems well under way to support the commercialization of electric vehicles as low or ultra-low emissions pathways for transport. Many cities in the world are following suit in offering electric mobility services, including Oslo, Barcelona, and Los Angeles. The rising popularity of car-sharing services and electric vehicles suggests that business models that combine both may soon gain sufficient momentum to grow independently of public support. ■

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Appendix

Table 2. Total electric and hybrid electric vehicle sales by country in 2011

Country	2011 sales (units)
US	17,345
France	2,630
Germany	2,154
Norway	2,038
UK	1,000

Table 3. Electric and plug-in hybrid electric vehicle models

by Incumbent companies:

Company	Country	Vehicle	Type	Electric range (km)	Price	Release Date
Renault	France	Florence ZE, Kangoo ZE, Twizy, ZOE	EV	185 (Fluence) 100-150 (ZOE)	\$32391 \$25013 \$8741 \$19635	2011
Nissan	Japan	Leaf	EV	160	\$40000	2010
Toyota	Japan	RAV 4 EV	EV	128-160	\$42000	Q3 2012 (exp, CA)
Toyota	Japan	FT-EV III	EV	150	\$23188-\$35000	2012-2013 (exp)
Mitsubishi	Japan	iMiEV	EV	128-160	\$42000	2009 (Japan)
Honda	Japan	Fit	EV	160	\$36,625	2013
Ford	US	Focus	EV	128-160	£39,200	2011
Daimler	Germany	SmartCar	EV	115-160	\$34000	2007 (Europe)
REVA	India	REVA i	EV	80	\$7578-\$8120	2008 (India)
REVA	India	REVA L-ion	EV	120	\$8977	2009 (India)
Toyota	Japan	Prius	PHEV	23e	\$28000	2012 (exp)
General Motors	US	Chevy Volt	PHEV	40-80	\$41000	2010
Ford	US	Escape	PHEV	48-56	\$38000	2012 (exp)

by start-up companies:

Company	Country	Vehicle	Type	Electric range (km)	Price	Release Date
Telsa	US	Roadster	EV	393	\$109000	2008
Telsa	US	Model S	EV	257	\$57400	2012
Th!nk (bankrupt 2011)	Norway	Think	EV	120-160	\$34000	2008 (Europe)
BYD	China	e6	EV	290	\$35000	2010 (China)
Chery	China	M1	EV	120-150	\$26000 \$34000	- 2010
Zotye	China	2008EV	PH EV	200	Leasing for \$393/month (Hangzhou only)	2010
Miles Electric Vehicles	US	ZX40S	EV	64-80	\$19900	2010
Fisker Automotive	US	Luxury sport PHEV	PHEV	80	\$95000	2010
BYD	China	F6DM	PHEV	64-96	\$22000	2009



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