Electromobilité : Bilan et perspectives
Yannick Perez

To cite this version:
Yannick Perez. Electromobilité : Bilan et perspectives. Séminaire invité Sciences Politiques, Jan 2017, Paris, France. <hal-01660253>

HAL Id: hal-01660253
https://hal.archives-ouvertes.fr/hal-01660253
Submitted on 31 Dec 2017

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Electromobilité : Bilan et perspectives

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Motivations (1)

- EVs are very broad and interesting economic subject to study.
- Regulation driven change: more and more stringent rules toward CO2 emission per manufacturer fleet
  - Dieselgate shows that it is really difficult objective
- Urban Local pollution standards are also becoming stronger
  - No old diesel car (or buses or trucks) in some polluted cities (Paris more than 10 years old)
  - Tendency to have smart cities projects with only electric engines
  - If not today, in 5 years...
## Motivations (2)

<table>
<thead>
<tr>
<th></th>
<th>EVs</th>
<th>ICVs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price per new car</td>
<td>Minimum 22k€</td>
<td>Minimum 7500€</td>
</tr>
<tr>
<td>Driving range</td>
<td>150-200 km</td>
<td>400 km-600km</td>
</tr>
<tr>
<td>Time to refuel</td>
<td>From 20 min to 6 hours</td>
<td>6 min</td>
</tr>
<tr>
<td>Life time</td>
<td>6-8 years Warranty</td>
<td>X Years</td>
</tr>
<tr>
<td>CO2 emissions</td>
<td>0 emission while running; Some according to the energy mix while charging</td>
<td>From 90 g to 250g/km</td>
</tr>
<tr>
<td>Noise pollution inside and outside the car</td>
<td>Very low</td>
<td>Function of the technology</td>
</tr>
<tr>
<td>Energy cost for 100 km</td>
<td>1€ to 2€/100 km</td>
<td>4-15 liters/100km * price per liter</td>
</tr>
<tr>
<td>Provider flexible ressources to the grids</td>
<td>Positive contribution if managed efficiently</td>
<td>None</td>
</tr>
</tbody>
</table>
Motivation (3) Evs enjoy a Double dynamic: Increase in ENERGY DENSITY & decrease of COST

Source: IEA Global EV Outlook 2016
THE LITHIUM-ION BATTERY MEGAFAC TORIES ARE COMING

Production capacity of lithium-ion batteries is anticipated to more than triple by 2020

- **LG Chem**: Capacity: 7GWh, Nanjing
- **Tesla**: Capacity: 35GWh, Nevada
- **Foxconn**: Capacity: 15GWh, Anhui
- **BYD**: Capacity: 20GWh, Various
- **Boston Power**: Capacity: 10GWh, Various

*Current Demand* by 2020 (Anticipated Growth)

- **2013**: 25GWh
- **2014**: 50GWh
- **2015**: 75GWh
- **2016**: 100GWh
- **2017**: 125GWh

*Benchmark estimates, not all data disclosed by companies. **Instant planned capacity stated for graphical purposes, slower ramp up expected.*

Data by: visualcapitalist.com
Motivations (4)

Distribution of the Thermal car uses per day in France

80% trips < 60km \(\Rightarrow\) Mean = 12 km \(\Rightarrow\) 24 km/Day
The year 2015 saw the global threshold of 1 million electric cars\(^1\) on the road exceeded, closing at 1.26 million. In 2014, only about half of today's electric car stock existed. In 2005, electric cars were still measured in hundreds. 2015 also saw more than 200 million electric two wheelers on the road, and 170 000 buses, primarily in China.

**EV sales and market share in a selection of countries and regions, 2015**

**Key point:** The two main electric car markets are China and the United States. Seven countries have reached over 1% EV market share in 2015 (Norway, the Netherlands, Sweden, Denmark, France, China and the United Kingdom).
Current deployment in continental France (June 2016)

- Number of Electric (EV) and plug-in electric vehicles (PHEV) registered
- Number of public charging points installed
- EV and PHEV: only 0.2% of the total French car fleet... but a sharp growth since 2010

Almost 90,000 vehicles registered in more than 13,000 towns (85% are EV)
More than 14,000 public charging points located in almost 2,000 towns
Increase of private owners higher than companies

Source: Enedis, AAADAta, Gireve
The Energy Transition Law sets an ambitious target of 7 million charging points by 2030, and 1 million by 2020. **104,626 charging points in June 2016**

- Public: 14% (51,554)
- Residential: 35% (36,618)
- Office: 26% (26,454)

**625 MVA of installed capacity in June 2016**

- Normal charging (up to 7.4 kW): 72% (448 MVA)
- Quick charging (22 kW): 24% (150 MVA)
- Fast charging (43 kW and more): 4% (27 MVA)

Installed capacity is growing faster than the number of charging points due to the development of quick public charging points.

- **14,509 public points in June 2016**
- **55,000 public points in 2019**

- The number of public charging points should be increased almost fourfold by 2020 (14,000 to 55,000)

- Installed capacity of the public charging points will grow even faster
And the window of opportunity is open ...
## GLOBAL EV FORECAST COMPARISON

<table>
<thead>
<tr>
<th>Sales</th>
<th>Scenario</th>
<th>Powertrain</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BIPE Green Constraint</td>
<td>BEV</td>
<td>1,351,434</td>
<td>2,270,912</td>
<td>3,401,518</td>
</tr>
<tr>
<td></td>
<td>Bloomberg</td>
<td>BEV</td>
<td>936,455</td>
<td>3,745,819</td>
<td>13,110,368</td>
</tr>
<tr>
<td></td>
<td>BIPE Green Constraint</td>
<td>PHEV</td>
<td>1,265,130</td>
<td>4,171,103</td>
<td>8,457,032</td>
</tr>
<tr>
<td></td>
<td>Bloomberg</td>
<td>PHEV</td>
<td>1,404,682</td>
<td>4,214,047</td>
<td>7,959,866</td>
</tr>
</tbody>
</table>
BUT
Motivation (6)

• EV drawbacks are partially due to Market Failures
  – Positive externalities are not paid at real value
    • CO2 reduction: How much, in terms of grams and €?
EVs emit less CO$_2$ than conventional cars

- With the 2010 carbon intensity, a typical EV emits about 66g CO$_2$/km
- EVs will be even cleaner in the future as the power sector continues to decarbonise by 2050

*EURELECTRIC smart charging paper, 2015*
Figure 1: CO₂ allowances price since 2005

- Discussions on 2020 targets
- Economic and financial crisis
- Energy efficiency
- Fukushima
- "Backloading" proposal, then rejected
- Debt crisis and degraded growth outlook
- New equilibrium in a context of slow recovery
- Publication of 2005 verified emissions

Source: Climate Economics Chair from ICE ECX data

Futures DEC12 until December 2012 then ECX Daily Futures
Motivations (6)

• EV drawbacks are partially due to Market Failures
  – Positive externalities are not paid at real value
    • CO2 reduction => CO2 markets are not efficient: 4-10 euros per ton for 2 units per year
    • Health benefits by reducing toxic emission => measures?
Motivations (6)

- EV drawbacks are partially due to Market Failures
  - Positive externalities are not paid at real value
    - CO2 reduction => CO2 markets are not efficient
    - Health benefits by reducing toxic emission => measures?
    - Oil import reduction => saving for purchaser, benefit for society in terms of independence?
    - Industrial/Services job and local wealth creations
  - Need more precise evaluation of Willingness to Pay for Electric vehicles characteristics in different environments
What is the EV « Chiken and Egg » problem?

- Average EV can not run for more than 150-200 real km
- So little sales
- So no need to build a charging network for Evs
- So EVs can not be largely sold...
What are the actual solutions and the ways forward?

– By Public Policy action
  • National base policy
  • Local base policy

– By innovations
  • Companies driven innovations
  • By new research project to value storage flexibility in energy markets
Disclaimer
Only successfull cases are treated here!

- Better place is not treated
- PSA 1941-1996 experiment with EVs
- ...
And not dealing with deep history of innovation...
What are the actual solutions and the ways forward?

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Top-selling light-duty plug-in electric vehicle global markets
(cumulative sales through September 2016 by country/region)

Europe: 570,000
United States: 521,403
China: 521,649
California: 244,592
Japan: 145,000
Norway: 121,330
France: 99,918
The Netherlands: 98,295
United Kingdom: 90,000
Germany: 66,674
EV market share

Market sales shares of EVs reached over 1% in **bolded** EVI countries.
Norway as successful “Public Incentive” model?

<table>
<thead>
<tr>
<th>PI</th>
<th>Model</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tesla Model X</td>
<td>601</td>
</tr>
<tr>
<td>2</td>
<td>Toyota RAV4</td>
<td>581</td>
</tr>
<tr>
<td>3</td>
<td>BMW i3</td>
<td>520</td>
</tr>
<tr>
<td>4</td>
<td>Toyota Auris</td>
<td>492</td>
</tr>
<tr>
<td>5</td>
<td>Mitsubishi Outlander PHEV</td>
<td>427</td>
</tr>
<tr>
<td>6</td>
<td>Volkswagen Tiguan</td>
<td>416</td>
</tr>
<tr>
<td>7</td>
<td>Toyota Yaris</td>
<td>405</td>
</tr>
<tr>
<td>8</td>
<td>Volkswagen e-Golf</td>
<td>392</td>
</tr>
<tr>
<td>9</td>
<td>Volkswagen Golf GTE</td>
<td>358</td>
</tr>
<tr>
<td>10</td>
<td>Skoda Octavia</td>
<td>315</td>
</tr>
</tbody>
</table>

With 29% share of Evs in 2016. 33% September…
Package of Policies in Norway

1. Action toward demand stimulation
   – VAT tax exemption
   – Highway fees exemption
   – Local tax exemption
   – Access to buses lane in cities

2. Building a safety network of Fast charging at the entry of main cities to secure last miles stress + on highways critical points

3. No action toward offer: no Norwegian EV manufacturers.
Limits of the Norwegian Model

• Cost of the public support
  – Implicit valuation of pollution reduction, infrastructure building, health value, social innovation... are very high.

• The design of the demand side policy is biased in favour of expensive cars because the help is in % of the car price.
But it works even for smaller cars by effectively reducing the TOC.
Limits of the Norwegian Model

• Cost of the public support
  – Implicit valuation of pollution reduction, infrastructure building, health value, social innovation... are very high.

• The design of the demand side policy is biased in favour of expensive cars.

• How reproducible it can be by other countries?

• What policy after 2018?

• Ending Thermal Cars in 2030...
What are the actual solutions and the ways forward?

- **By Public Policy action**
  - National base policy
  - Local base policy

- **By innovations**
  - Companies driven innovations
  - By new research project to value storage in energy markets
Car sharing of EVs for « local urban » model?

- A way to mitigate the TCO constraints => renting the asset (thermal and Electric cars)
- More than 1000 cities around the world are using Car sharing solutions to reduce urban congestions
- and few of them with EVs Fleets to reduce pollution
  - local public experiments with a clear successful business model: Bolloré Autolib.
Driving forces

- Economically and politically:
  - Local Urban Emission limits (climate protection / Urban Citizen claims), expansion of fluctuating RE and consistent user financing.

- Behaviourally:
  - ‘permanently online’, pragmatic multimodality (‘using instead of possessing’) and the erosion of status of possession (+ ‘possessing instead of using’).
The parisian exemple

Economic organisation

- Public private partnership 2011 for 180 M€:
  - Bolloré invest in the all integrated service from Battery design, car, to IT system
  - Local public authorities invest in charging stations (1 station – 4-7 plugs => 50k€)
  - Secure the investment of Bolloré in case of losses.
  - Initial goal was to be profitable in 2018 with 80 000 customers.
  - 2013: More than 100 000...
  - Show off effect in Paris for EVs.

Infrastructures

- 3 000 EV cars running
- 1 000 charging stations (more than 4 000 low intensity plugs) open 24h/365
- No parking fees / no waste of time looking for a place to park
- Smart App to find and book EV
- No need to return at the initial point
- 120 € for annual fees + 5,5€ per 30 m of use
- Each car is rented 6-7 times per day => manage problem of over use...
Smart app overview
New business model to overcome TCO?

- New cities are buying Bolloré like solutions
  - Hanzu (China)
  - Minneapolis (USA)
  - London
  - Bordeaux
  - Lyon
  - Turin
  - Los Angeles / Rio de Janero... (avec PSA)

- NB: Big data are produced about real mobility practices and a lot of economic analysis will be needed...
Limits of the EV car sharing experiments

- Only a “small” fleet of EVs are actually running
  - 2011 : 1000 cars
  - 2013 : 2000 cars
  - 2015 : 3000 cars
  - 2016: 3800 cars

- Not all cities around Paris have participated
  - Policy bias / Costs
  - Side effect on suburb housing prices would be a nice work to do...

- What is the minimum population density in a given environment to « worth the cost »?
  - In other words : => some economic studies can be made here...
Conclusion for Public policy design

• We have 2 interesting cases but a lot of innovation / creativity to define the optimal public policy (EU / Nation / Local)
  – Charging network decision?
  – What is the optimal ratio: plug/car ?
  – Level of involvement of public actors?
  – Innovative actions still need to be made and analyzed
    • France Coupling of demand subsidy (6 300 € + 2700 if you destroy an old diesel car)...
    • Germany : zero subsidy and a nice counter example benchmark...
What are the actual solutions and the ways forward?

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– By innovations
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  • By new research project to value storage in energy markets
Tesla as the successful “Apple cars”

- The last start up since Ford in US Car industry: 2004
- Luxury high performance EV:
  - Make a expensive full electric car with XXL battery (85kW)
  - Rely on "slow Moore's law." Processor doubling in power every 18 month, batteries doubled in power every 10 years.
  - Model S, the sports sedan released in 2013, earned the distinction of Motor Trend Car of the Year
  - In US market Model S outsold the Mercedes Benz S Class, the BMW 7 Series, and every other large luxury sedan in 2013.
  - Model 3 SUV presales and sales start October 2016
Superchargers today (120kW) for 30 m charging for 170 miles for free (+ wifi)
IT – Car-merging services
The limits of the TESLA model?

• Manufacturing Millions / Thousands?

• Setting the worldwide « superchargers » standard for XXL batteries is a challenge
  – How to cooperate with DSO / TSO to install needed superchargers in all places?

• Response of large classical cars manufacturers
  – BMW / Audi... Toyota...

• New “Tesla vision” : PV + EV + Home Storage
What are the actual solutions and the ways forward?

– By Public Policy action
  • National base policy
  • Local base policy

– By innovations
  • Companies driven innovations
  • By new research project to value storage flexibility in energy markets
Why do we need more flexibility in electrical systems?
Today EV market & storage of energy seems...

Total world EV sales

Distributed Storage units to optimize in MWh
From Old days to EV smart grids issues

1. Massive RES (5%)
2. Production décentralisées 95%
3. Frequency management opportunities
4. Voltage issues and management opportunities
Duck Season
More PV => more Duck issues

The duck curve shows steep ramping needs and overgeneration risk

Sample Net Load – March 31, 2012

ramp need
~13,000 MW in three hours

overgeneration risk

(from the California Independent System Operator)
More wind => more flexibility required
The Spanish case

30-september-2010

Wind 1%
17:45h

6-February-2013

Wind 66.5%
15:50h

Source REE, ENAGAS
More wind => more costly flexibility required

Source: Holttinen et al. (2011)
Flexibility by market coordination
Traditional natural monopoly regulation:

– All services provided by long term contracts
– Fixed price for the length of the contract with the national minister or regulator
– Example in France, regulated tariffs for:
  • T/D
  • Energy
  • Reserves
  • Renewables

• No Room for EV!
Traditional natural monopoly regulation without markets

- All services provided by long term contracts
- Fixed price for the length of the contract with the national minister or regulator
- Exemple in France, regulated tariffs for:
  - T/D
  - Energy
  - Reserves
  - Renewables
- No Room for EV!

PJM as a “Grid services” future?

- Using markets to provide Grid services in liberalized electricity systems:
  - Introduction of markets for:
    - Energy (MWh)
    - Capacity (MW)
    - Transmission Rights
    - Reserve Markets
    - Demand response
    - ...
- But Rules need to be recrafted accordingly!
Which possible markets?

Profitable markets for EVs:
- little amount of energy, quick responsiveness
- remuneration based on availability and not utilization

EV fleet for one Market or for Markets?
How to coordinate disperse storage unit as flexible resources?

Combination of data
1+2+3
Into new algorithms (to be tested)
to deliver « market like products to be traded on energy markets »
Input 1: Definition of EV resources provision

Vehicle-to-grid

Agrégateur

TSO

Vehicle-to-building

Agrégateur

TSO or DSO
Input 2: Definition of EV Trips & needs

1. Commuting Privately owned Fleet
   – You go to work and return home: very predictable and easy to capture.

2. Collective fleet
   1. used in a coordinated way
      • Postal / delivery services fleet / Last mile delivery
   2. used in a uncoordinated way
      • Companies cars given to staff
      • Renting cars companies

=> Trip definitions: when, how long, risk...
Input 3: design of Charging infrastructure
Input 3: design of Charging infrastructure
## Strategies for charging: +/-

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
</table>
| Dumb Charging                              | ✓ Easy implementation  
✓ User friendly                                                      | × Overload of transformers and lines  
× Voltage deviations  
× Peak power increase  
× Increase of electricity CO₂ intensity  
× Electricity cost increase  
× Needs to reinforce the grid |
| Off-peak Charging                          | ✓ Easy implementation  
✓ Demand profile flattened  
✓ Better integration of wind energy at off-peak hours  
✓ Delay in grid investments | × Imbalances due to rapid increase of power consumed by PEVs  
× Possible overload of transformers and lines  
× Possible voltage deviations  
× Willingness of the customer required |
| Smart Charging (Valley filling)            | ✓ Ancillary services provision  
✓ Demand profile flattened  
✓ Better integration of wind energy at off-peak hours  
✓ Delay in grid investments | × Complex implementation  
× ICT technologies required  
× Willingness of the customer required |
| Smart Charging (Peak saving)               | ✓ Ancillary services provision  
✓ Peak power reduction  
✓ Optimal integration of intermittent RES  
✓ Reduction of electricity CO₂ intensity  
✓ Less investments in network reinforcements | × Very complex implementation  
× ICT technologies required  
× Willingness of the customer required  
× Premature degradation of batteries resulting of using V2G  
× Energy losses in grid-battery-grid transmissions |

Figure 3.16. Advantages and drawbacks of different strategies for PEVs integration
Combination of inputs and maths to create “bundle of valuable flexible resources” for the energy markets

<table>
<thead>
<tr>
<th>Times</th>
<th>MW or MWh</th>
<th>Services on market base if exist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second</td>
<td>MW</td>
<td>- Frequency regulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Voltage regulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Quality of delivery</td>
</tr>
<tr>
<td>Hour</td>
<td>MW</td>
<td>- Tertiary reserve market</td>
</tr>
<tr>
<td></td>
<td>Or MWh</td>
<td>- Demand respons</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Balancing services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Congestion management</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Intraday-market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Coupling With RES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- ...</td>
</tr>
<tr>
<td>Block orders</td>
<td>MWh</td>
<td>- Day head market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Effacement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Time of Use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Coupling with RES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- ...</td>
</tr>
</tbody>
</table>
Case Studies
Frequency Regulation market revenues

Revenues from grid services for EV

Pilot project for emerging technologies in the ancillary services markets
EV as frequency control resources

• Why do we need a steady frequency?
  – material performances
  – risk of saturation for devices with magnetic circuits

• Who is responsible?
  – TSOs

• How?
  – Balancing production and demand at each moment
In other countries, values are function of market design-fleet characteristics and charging points capacities

<table>
<thead>
<tr>
<th>Sources</th>
<th>Analyzed region</th>
<th>Participated market</th>
<th>Net Profit €/Month/Vehicle</th>
<th>Regulation power</th>
<th>Battery/ Vehicle constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kempton and Tomic 2005</td>
<td>USA</td>
<td>Regulation up and down</td>
<td>112-165</td>
<td>10-15 kW</td>
<td>Electric drive vehicles</td>
</tr>
<tr>
<td>Tomic and Kempton 2007</td>
<td>USA, Four different control areas</td>
<td>Regulation down (Th!nk City) Regulation down and up (Toyota RAV4)</td>
<td>4.3 – 43 (Th!nk City) 6 – 64 (Toyota RAV4)</td>
<td>6.6 kW</td>
<td>100 Th!nk City vehicles (Nicd), 252 Toyota RAV4 (NiMH)</td>
</tr>
<tr>
<td>Larsen et.al. 2008</td>
<td>Denmark</td>
<td>Secondary and Tertiary control</td>
<td>6 – 160</td>
<td>power: 2 kW, 20 kW, 20 kW</td>
<td>EDV: Capacity: 5 kWh, 5 kWh, 20 kWh,</td>
</tr>
<tr>
<td>Camus et.al. 2009</td>
<td>Portugal</td>
<td>Secondary and Tertiary control</td>
<td>18</td>
<td>3.5 kW</td>
<td>Plug-in Hybrid and electric vehicles</td>
</tr>
<tr>
<td>Andresson et.al. 2010</td>
<td>Sweden/Germany</td>
<td>Control energy market</td>
<td>30 – 80 (Germany, coal fired power plants) 19 ; 7 (Sweden, Hydro power plants)</td>
<td>3.5 kW</td>
<td>Plug-in hybrid EV (10 kWh, Maximum depth of discharge 20 %) Charging and discharging efficiency are 94 %</td>
</tr>
<tr>
<td>V2G-Strategies 2011</td>
<td>Austria</td>
<td>Secondary and Tertiary control</td>
<td>7.32 – 63.94</td>
<td>10.5</td>
<td>Electric Vehicles (16 kWh, 24 kWh, 48 kWh)</td>
</tr>
</tbody>
</table>
Frequency remunerations for EV: PJM real case / France exploration

1500 €/year and per car in PJM Zone for only « frequency regulation market base Provision »

<table>
<thead>
<tr>
<th>Charging point capacity (kW)</th>
<th>Revenues /VE/ year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Secondary</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
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<td>3</td>
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<tr>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>22</td>
</tr>
</tbody>
</table>

Sources: Codani, Petit & Perez 2016
A very nice contribution to TCO
Flexibility solution by contrats
Contractual solutions for VtoH

- Objectives of the House manager
  - Minimizing energy cost over time
  - Maximizing auto consumption of local renewable energies if incentives are aligned
  - Distribution grid services provision (optional)
- Sharing potential benefits with the consumers
- Nissan and Mitsubishi Motors are taking a lead in commercialization, products already in the market.
- V2H field demonstration test programs have been conducted in Japan.

## History of V2H

### Products and standards

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<tbody>
<tr>
<td>(3/11 earth quake and tsunami)</td>
<td>8/2 Nissan V2H demo</td>
<td>4/27 Mitsubishi Power box</td>
<td>Nichicon L2H “EV power station”</td>
<td>3000 V2H units are in service in Japan</td>
<td>Endesa V2G Mitsubishi-electric.</td>
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</table>

- L2H ver2
- Mitsubishi-electric.
Contractual solutions for VtoB

- Objectives of the site manager
  - Minimizing energy cost over time
  - Maximizing auto consumption of local renewable energies
  - Minimizing the peak demand toward networks
  - Limiting the investments in networks reinforcements
- Sharing potential benefits with the consumers / networks managers
Japan exemple

Park homes OKURAYAYAMA, apartment complex with V2H and shared EV -2011 NOV

- Shared area of apartment complex is backed up in emergency. EV supplies power for TV, radio, lightings and mobile phone charge for ten days.

- EV is car-shared by the residents in daily use.
Contractual solution with the Distribution Service Operator (DSO)

If V2G avoids investments, at least the value of V2G has to equals CAPEX and OPEX of the avoided reinforcement.
Flexibility provision with EV fleets

- Not perfectly done yet...
  - VtoG experiment around the world (US / Denmark...)
  - Majors success with regulation power: mainly frequency control.
- Expected benefits from coordination:
  - Costs savings / resources provision
  - Capacity reduction need (Less peak demand investment)
  - RES coupling: less grid stress
  - Demand response resources
- Main problems to overcome
  - Rules and Market regulation to adapt for EV Fleets
  - Communication standards (15118 / CHAdeMO...) to clarify
- Coordination via hydrids are probably part of the solution (spin-offs...)
Does it worth the cost?

To be added on the « benefit » of ownership

Including the
1. added costs of measurement
2. aggregation services cost
3. Marginal Battery degradation cost
Conclusion on innovations by companies and Spin-off

- Tesla is the promoter of a disruptive innovation from PV to storage (EV or home or building base)

- A lot of studies have to be made to promote new business models based on energy markets /contractual potentials.
Conclusions

4 incomplete solutions!
Predicting the future of EV is hard

If you were asked in the 1980s about having a camera in your phone... what would you have imagined?
Selected Literature


