Trying to push for innovation between two industries: the VtoX experiment

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Electric vehicles are challenging for Grid operators

1. Vehicle to Transmission grid = VtoG
2. Vehicle to Distribution grid = VtoG
3. Vehicle to buildings = VtoB
4. Vehicle to Home = VtoH
5. Vehicle to Load = VtoL

=> VtoX
Outline

1. The electromobility challenges
2. Solution by markets coordination
3. Solution by contracts
4. Conclusion
Sales are booming

**Figure 1 • Evolution of the global electric car stock, 2010-16**

Notes: The electric car stock shown here is primarily estimated on the basis of cumulative sales since 2005. When available, stock numbers from official national statistics have been used, provided good consistency with sales evolutions.

EVs enjoy a Double dynamic: Increase in ENERGY DENSITY & decrease of COST

Source: IEA Global EV Outlook 2016
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

![Graph showing average CO2 emissions of new cars and EVs for EU countries](EURELECTRIC smart charging paper, 2015)
The electricity sector needs more flexibility provisions

Connected EV Fleets are potentially very flexible resources...
Electromobility : Energy or Capacity issue ?

**In energy (TWh)**

- In France
- 2020 : 525 000 VE
  - = 1,3 TWh (source : RTE)
  - 0,2% of the total
  - => no energy problem

**In capacity (MW)**

- Max peak consumption:
  - + 100 GW
  - 3% per year
  - + 28% in 10 years
- 2020 : 525 000 VE
  - No coordination with 3 kW → 1,5%
  - No coordination with 22 kW → 11,5%
  - Today Fast charger technologies are booming : 120 kW to 400 kW
  - + local issues with distribution grid / RES
Outline

1. The electromobility challenges
2. Solution by market coordination (cooperation)
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EV fleet for one Market or for Markets?

Which possible markets?

Profitable markets for EVs:
- little amount of energy, quick responsiveness
- remuneration based on availability and not utilization unless high number of EVs
Step 1: Proof of concept

Frequency participation with EV fleets:
PJM – Denmark – Netherlands – (France: Launching phase for reserves + balancing market)

1500 €/year and per car in PJM Zone
For « frequency regulation market base Provision » Kempton (2016)

<table>
<thead>
<tr>
<th>Charging point capacity (kW)</th>
<th>Revenus /VE/ year</th>
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<tbody>
<tr>
<td>Primary</td>
<td>Secondary</td>
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<tr>
<td>3</td>
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<td>7</td>
<td>22</td>
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Sources: Codani, Petit & Perez (2016)
But

Rules of the game are created for previous generation technologies
Size of the bids / Time granularity...
and
they act as barrier to entry for new tech
See Borne et al. (2018)
How to push for innovation?
How to push for innovation?
Looking for technical solutions + Forum creation on Electromobility

- Since 2013, Armand Peugeot chair organises a international conference “forum type” (academics + regulators + industrial actors) for experiments sharing and identification of the new challenges to be overcome
  - Singapore 2015
  - EU Workshop of FSR with EU regulators 2017 & 2018
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>08h15</td>
<td>Registration</td>
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<tr>
<td>08h45</td>
<td>Opening words</td>
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<tr>
<td></td>
<td>Eric Brousseau, Chair Governance and Regulation</td>
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<td>Danièle Attias, Jan Lepotuere and Marc Petit - Armand Peugeot Chair</td>
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<tr>
<td>09h00 - 09h40</td>
<td>Perspectives on Norway’s supercharged electric vehicle policy</td>
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<td>Erik Figenbaum - Institute of Transport Economics - Norway</td>
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<td>09h40 - 10h20</td>
<td>Japan and the Future of Automobile Industry</td>
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<td>Tatsuya Suzuki - Nagoya University, Japan</td>
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<td>10h20 - 11h00</td>
<td>EU deployment plans for EVs</td>
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<td>Christian Thiel - JRC Petten</td>
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<td>Coffee Break</td>
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<td>11h00 - 11h30am</td>
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<tr>
<td>11h30 - 12h10</td>
<td>Towards a Theory of Business Ecosystems</td>
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<td>Michael Jacobides - London School of Economics</td>
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<tr>
<td>12h10 - 12h50</td>
<td>Tesla as the creation of an EV Ecosystem</td>
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<td>Yurong Chen – CentraleSupélec and Armand Peugeot Chair</td>
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<td>Lunch Time</td>
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<td>12h50pm - 02h00pm</td>
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<td>02h00pm - 02h40pm</td>
<td>Vehicle to Grids in the Us: A review</td>
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<td>Willett Kempton - Delaware University</td>
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<td>02h40pm - 03h20pm</td>
<td>The Parker Project in Denmark: First results</td>
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<td>Peter Bach Andersen – DTU</td>
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<td>03h20pm - 04h00pm</td>
<td>GridMotion project in France</td>
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<td>Paul Codani, PSA Group</td>
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<td>Coffee Break</td>
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<td>04h00pm - 04h30pm</td>
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<td>16h30 - 17h00</td>
<td>EV in France in 2035</td>
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<td>Thomas Veyrenc – RTE, France</td>
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<td>17h00 - 18h15pm</td>
<td>Roundtable: The future(s) of electromobility</td>
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<td>Chairman: Eric Lalillard (PSA)</td>
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<td></td>
<td>Christophe Bonnery (Enedis); François Colet (Vedecom); Michael Jacobides (LSE); Romain Beaumes (Nexans); Willett Kempton (Delaware university), Thomas Veyrenc (RTE, France)</td>
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<td>06h00pm end of the conference</td>
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How to push for innovation?
Looking for technical solutions + Forum creation on Electromobility

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• Goals are
  – to share the state of art of field experiments and projects with main actors
  – Build a network and use the other experiments
  – Build a French experiment: Gridmotion project.
French new Project : Gridmotion Project 2017-2020

**B2C**
50 EV unidirectional

**B2B**
15 EV bidirectional

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- **B2C Movie**
- **B2B Movie**
1. The electromobility challenges
2. Solution by markets coordination (cooperation)
3. Solution by contracts (no cooperation)
4. Conclusion
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
- Sharing potential benefits with the consumers and / or DSO
- Actors involved : Bouygues / Renault…
Contractual solution with the Distribution Service Operator (DSO)

V2G for DSOs

- Ancillary services
  - Frequency regulation
    - Reactive Compensation
- Voltage control
- Constraint Management
  - Deferral investment
    - Short term congestions
    - Post Fault Management

If V2G avoids investments, at least the value of V2G has to equals CAPEX and OPEX of the avoided reinforcement.
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
  - Providing Distribution grid services (optional)
And the off-grid « solution » VtoL

• “Tesla-Solar City” proposes implicitly “off grid green” solution
  – Home Storage Solution + Solar Roof + EV with 100kWh batteries...
Conclusions
Electric vehicles are challenging for Grid operators

1. Vehicle to Transmission grid = VtoG
2. Vehicle to Distribution grid = VtoG  
   If cooperation
3. Vehicle to buildings = VtoB
4. Vehicle to Home = VtoH  
   If no cooperation
5. Vehicle to Load = VtoL
3 Main problems to overcome

1. Regulations are barrier to entry for EV Fleets in most markets
   
   => To date 2 strategies are played: Test on Markets + NC

2. Communication Standards war (15118 / CHAdeMO...)

3. Building cooperation between Grids and automotive industries
   
   1. for optimal charging infrastructure deployment
   2. For Grid service provision
   3. With few habits to do it...
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


