Les véhicules électriques connectés : opportunités et contraintes

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Outline

1. The electromobility challenge in energy markets: Coordination issues
2. Coordination by markets
3. Coordination by contracts
4. Conclusion
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2. Coordination by markets
3. Solution by contracts
4. Conclusion
From Old days to EV smart grids issues

- Massive RES (5%)
- Frequency management opportunities
- Voltage issues and management opportunities
- Renewable
- On-site Storage
- Backup Power
- Residential
- Commercial
- Industrial
- EVs
Today EV market & storage of energy seems...

Total world EV sales

Distributed Storage units to optimize in MWh
Energy or Capacity issue?

In energy (TWh)
• 2013 in France
  – 476 TWh
  – 40 000 VE
• 2020: 525 000 VE – VHR
  – = 1,3 TWh (source: RTE)
  – 0,2% of the total
  – => no energy problem

In capacity (MW)
• Max peak consumption:
  – 100.5 GW (7 feb 2012, 19h)
  – 3% per year
  – + 28% in 10 years
• 2020: 525 000 VE-VHR
  – No coordination with 3 kW → 1,5%
  – No coordination with 22 kW → 11,5%
  – + local issues with distribution grid / RES
Uncoordinated EV Fleet: a capacity issue
Uncoordinated EV Fleet: a capacity issue
DUCK SEASON
More PV => more Duck issues => coordination 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 => coordination issues
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 => coordination issues?

Source: Holttinen et al. (2011)
The electricity sector needs more flexibility provision

Connected EV Fleets are very flexible ressources
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Profitable markets for EVs:
• little amount of energy, quick responsiveness
• remuneration based on availability and not utilization
How to coordinate disperse storage unit as valuable 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
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
Combination of 3 inputs to create “bundle of valuable 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 responsibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Balancing services</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Congestion management</td>
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<td></td>
<td></td>
<td>- <strong>Intraday-market</strong></td>
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<tr>
<td></td>
<td></td>
<td>- Coupling With RES</td>
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<td>- ...</td>
</tr>
<tr>
<td>Block orders</td>
<td>MWh</td>
<td>- Day head market</td>
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<td>- Effacement</td>
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<tr>
<td></td>
<td></td>
<td>- Time of Use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Couplage avec les EnR</td>
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<tr>
<td></td>
<td></td>
<td>- ...</td>
</tr>
</tbody>
</table>
Case Studies

Frequency regulation
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
**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><strong>Primary</strong></td>
<td><strong>Secondary</strong></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
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<tr>
<td>7</td>
<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 2015
A very nice contribution to TCO
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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
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

Vehicle-to-building

Agrégateur

TSO or DSO
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## Comparison of coordination mechanisms

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<thead>
<tr>
<th></th>
<th>Coordination by Markets</th>
<th>Coordination by contracts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleet size</td>
<td>Thousands or more</td>
<td>Single to Hundred</td>
</tr>
<tr>
<td>Regulations to be changed</td>
<td>Regulation need to be redesign to allow VtoG (Codani et al. 2015)</td>
<td>None</td>
</tr>
<tr>
<td>Collaboration with the energy sector</td>
<td>Creation of a two-sided market</td>
<td>Simplified with the local aggregator / Building energy manager</td>
</tr>
</tbody>
</table>
Electromobility solution is

• 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...)