Challenges of E-mobility

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Outline of the presentation

• Why Electromobility is starting?
• Why is it promising for Grids?
• Why is it promising for Users?
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• Why Electromobility is starting?
• Why is it promising for Grids?
• Why is it promising for Users?
EV sales for personal cars + Electric buses

<table>
<thead>
<tr>
<th>Region</th>
<th>2018 H1</th>
<th>2017 H1</th>
<th>% Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>394</td>
<td>192</td>
<td>+105%</td>
</tr>
<tr>
<td>Japan</td>
<td>27</td>
<td>29</td>
<td>-7%</td>
</tr>
<tr>
<td>Europe</td>
<td>195</td>
<td>137</td>
<td>+42%</td>
</tr>
<tr>
<td>USA</td>
<td>122</td>
<td>89</td>
<td>+37%</td>
</tr>
<tr>
<td>Other</td>
<td>45</td>
<td>24</td>
<td>+86%</td>
</tr>
</tbody>
</table>

Why it is starting?

Public action: Sticks and Carrots

Range anxiety decrease

Basic infrastructures exist
Sticks and carrots

Sticks: Banning policies @ local level + emission reductions for cars

Carrots

- Public subsidies
  - EV PHEV selling subsidies (State level + local)
  - Charging infrastructure subsidies
  - R&D subsidies
Why it is starting?

Public Subsidies
Range anxiety decrease
Basic charging infrastructures exist
EVs enjoy a Double dynamic: Increase in ENERGY DENSITY & decrease of COST

Source: IEA Global EV Outlook 2016
Less costs => More capacity / car => less range anxiety

Evolution of the size of the battery in kWh per car

After 2020 = Cost reduction will normally used to reduce the cost of the EVs
Switching from « range anxiety » to « charging anxiety »

Where and when I can charge?
Minimum charging infrastructures allows to start equipment

7 logical options to charge but 95% of the charging is made at home but a lot seems to be needed elsewhere to secure the EV buyer
Business models and Data to “explore” for infrastructure charging deployment

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Place</th>
<th>Home</th>
<th>Work</th>
<th>Fast charge</th>
<th>Tesla Supercharger Charging stations</th>
<th>Ionity Charging stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>3-7 kW</td>
<td>3-22kW</td>
<td>22-50 kW</td>
<td>50-150 kW</td>
<td>350 kW</td>
<td></td>
</tr>
<tr>
<td>Time to charge</td>
<td>8-24h</td>
<td>1-3h</td>
<td>40 min</td>
<td>30 min</td>
<td>20 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>200km</td>
<td>400km</td>
<td>500 km</td>
<td></td>
</tr>
<tr>
<td>Usages</td>
<td>Commuting trips</td>
<td>Commuting trips</td>
<td>All usages</td>
<td>All usages</td>
<td>All usages</td>
<td></td>
</tr>
<tr>
<td>Investment cost per charger</td>
<td>200-500€</td>
<td>500-3k€</td>
<td>15k€-25k€</td>
<td>35-60k€</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Cost of recharge</td>
<td>2-3€/100 km</td>
<td>4€</td>
<td>5 -7€</td>
<td>10-15€</td>
<td>50-80€</td>
<td></td>
</tr>
</tbody>
</table>
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Why is it promising for TSO?
EV killing duck curve?

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)
Problem... Rules are inadapted
Barriers to entry in frequency-regulation services markets: Review of the status quo and options for improvements

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Barriers to entry in frequency-regulation services markets: Review of the status quo and options for improvements

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Market integration or bids granularity to enhance flexibility provision by batteries of electric vehicles

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Why is it promising for DSO?
EV solving « Death Spiral » for DSO revenues?

PV

Incentive to install PV increase

Decrease revenues for DSO

Regulator increase tariffs

Total costs of the system Increase = Efficiency issue

Non equipped consumers see a increase of the bill = Equity issue
Network tariffs need to be redesigned for decentralised storage solutions

But how?
Decentralised – time consistent - market based – transparent - solution for charging-discharging

- Decentralized = price signals per node per time: 3 informations: Where / When / Prices associated
Decentralised – time consistent – market based – transparent solution for charging-discharging

- Decentralized = price signals per node:
  - 3 informations:
    - Where
    - When
    - Prices associated for
      - Charging
      - Discharging
      - Per services offered
Simulation results for PJM

Max load hour P nodal prices in $/MWh

[mapping information]
German exemple of DSO’s issues
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EVs reduce opex of Building / house by savings Connexion charge (W) and Consumption (Wh)
Empowering consumers
Off grid, cutting taxes, networks charges...

9OCT2012 press-released
29APR2012 sales-stared

1.5kW V2L
PowerBox

30MAY2012 press-released
**SEP2012 sales-stared

6kW V2H
EV power station
Energy-Networks-taxes-other “costs” => looking for savings with “Behind the meter solutions”
Conclusions
Who EVs are going to help?

Energy Markets / grids / Behind the meter uses?
Depends on regulators decisions...

1. Energy market for EV: Need to change the rules
2. Vehicle to Transmission grid: Need to change the rules
3. Vehicle to Distribution grid: Need to change the rules

1. Vehicle to buildings = VtoB: Out of regulators scope
2. Vehicle to Home = VtoH: Out of regulators scope
3. Vehicle to Load = VtoL: Out of regulators scope
To help this process Florence School of Regulation will open soon an Electromobility Area
Selected Literature


• Rodríguez Brito Maria Gracia, Ramírez-Díaz Alfredo Jesús, Ramos-Real Francisco J., Perez Yannick, 2018, *Psychosocial traits characterizing EV adopters' profiles: The case of Tenerife (Canary Islands)*, Sustainability 2018, 10, 2053.


