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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EV sales for personal cars + Electric buses

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>500 km</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

Olivier Borne\textsuperscript{a,1}, Klaas Korte\textsuperscript{b}, Yannick Perez\textsuperscript{c,d,*,1}, Marc Petit\textsuperscript{a,1}, Alexandra Purkus\textsuperscript{b}

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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
- Decrease revenues for DSO
- Incentive to install PV increase
- Regulator increase tariffs
- Non equipped consumers see an increase of the bill = Equity issue
- Total costs of the system Increase = Efficiency 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
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...

9 OCT 2012 press-released
27 APR 2012 sales-stared

1.5kW V2L PowerBox

30 MAY 2012 press-released
**SEP 2012 sales-stared

6kW V2H EV power station
Breakdown of residential electricity bills in different jurisdictions in 2014-2015

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

• Ramírez Díaz Alfredo, Marrero Gustavo, Ramos-Real Francisco, Perez Yannick, 2018 *Willingness to pay for the electric vehicle and their attributes in Canary Islands*, RSER Vol 98, December 2018, Pages 140-149.


• 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.


